Simon K.S. Cheung · Lam-for Kwok
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Hybrid Learning

Innovation in Educational Practices

8th International Conference, ICHL 2015
Wuhan, China, July 27–29, 2015
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Preface

Welcome to the proceedings of the 8th International Conference on Hybrid Learning (ICHL 2015). This year, ICHL 2015 was held in Wuhan, China, with our new host, Central China Normal University, during July 27–29, 2015.

In the past decade, hybrid learning has become one of the promising approaches to teaching and learning. Not only emphasizing an effective integration of face-to-face and technology-mediated learning, hybrid learning also encompasses any innovative combination of different modes of learning. It provides a way forward for creating learning experiences to compensate for the shortcomings of, or at least to complement, conventional face-to-face learning. ICHL 2015 provided a platform for the exchange of knowledge in these areas among researchers and practitioners.

The theme of ICHL 2015 was "Hybrid Learning in Practice." Focus was placed on innovation in education practices, especially on how hybrid learning is adopted in an innovative way to enhance teaching and learning effectiveness. The conference included keynote talks and parallel paper presentations. This year, we received a total of 104 paper submissions. After a rigorous review process, 34 papers were finally selected for inclusion in this volume. The selected papers cover various aspects of hybrid learning, including computer-supported collaborative learning, experiences in hybrid learning, improved flexibility in learning processes, learning styles and behaviors, and the pedagogical issues of hybrid learning.

We would like to take this opportunity to thank the following parties who made the conference a success: (a) the Organizing Committee; (b) the Program Committee; (c) the conference organizers; (d) the conference sponsors; (e) all the conference participants; and (f) all the supporters.

We trust you will enjoy reading these papers.

July 2015

Simon K.S. Cheung
Lam-for Kwok
Harrison Yang
Joseph Fong
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Virtual Reality-Based Learning Environments: Recent Developments and Ongoing Challenges

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Abstract. Virtual Reality (VR) technologies bring new opportunities and challenges to teaching and learning. Virtual Reality Learning Environment (VRLE), a VR-based interactive environment incorporating instructional design for educational purposes, nowadays draws great attention of interdisciplinary scholars. In this paper, we first introduce the current status of VRLE-based research studies from various perspectives and then summarise the on-going challenges based on previous research studies and our own experience in this research area.

Keywords: Virtual reality · Virtual reality learning environment · Human-computer interaction · Special education

1 Introduction

The proliferation of Virtual Environments (VEs) developed for entertainment, game-play and education in recent years is driven partly by advances in and the reducing costs of the enabling technologies for immersive multimedia and natural multimodal interfaces. These technologies enable a user to interact with objects and/or characters within a virtual scenario designed to stimulate certain affects which in turn gives rise to a user experience that may not be possible to acquire easily or safely in the physical world. Due to these unique advantages of VEs, in the past decade, many VEs have been developed for serious applications in psycho-therapy [39], skill-based training [42] and education [29]. A recent survey of educational virtual environments defined a Virtual Reality based Learning Environment (VRLE) as "a virtual environment that is based on a certain pedagogical model, incorporates or implies one or more didactic objectives, provides users with experiences they would otherwise not be able to experience in the physical world and redounds specific learning outcomes" [29]. This definition puts emphasis on the pedagogical approach and the intended learning outcomes that underlay the design of the VRLE and the associated learning content, in which way it distinguishes VRLE from other types of VEs and interactive contents such as those designed purely for gaming or entertainment purposes.

From a pedagogical perspective, although in traditional learning environments (e.g., classroom, laboratory or fieldwork settings) learners have the opportunities to try and explore as part of the learning process, teacher-guided linear learning still

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dominates for most of the time. Furthermore, physical constraints frequently limit what can be simulated or what kind of authentic experience can be acquired in a classroom or laboratory setting. On the other hand, by virtue of its immersiveness and natural interaction with the learning content and using the pedagogical approach of constructivism, VRLEs motivate the learners to freely explore within the virtual space to achieve the learning outcomes, and provide unprecedented learning experience within a safe and controlled environment.

The learning cycle in VRLEs typically follows that of the Experiential Learning model [18] and begins with a learner being encouraged to explore a virtual scenery and to carry out a set of learning tasks within the environment. The VRLEs are programmed to react appropriately to the learner's action or behavior via providing multisensory feedbacks, which prompt the learner to react upon his/her actions and to formulate new ideas or solutions to the tasks at hand that s/he can then try or test out in the environment. This learning process can be repeated at almost no cost, through which learners will gradually build their own knowledge or skills on specific learning domains.

Comparing to the enabling technologies for VRLEs ten years ago, the three main areas oftechnologies that supporting VRLE-based teaching and learning, saying immersive virtual realitytechnologies, multimodal interface technologies, and development tools for VR contents, aremore accessible. Some commercially available VR-enabling products (e.g., Oculus Rift, Microsoft Kinect, Unity 3D game engine, etc.) further lower the cost of tailor-made VRLE development and deployment.

In this paper, we will briefly review the recent developments of VRLE and particularly we will focus on some representative VRLEs developed between the five years period of 2010 to 2014. These VRLEs will be discussed with reference to their underlying pedagogies and theories, learning domains, contents, and interactive design.

2 Learning Theories for VRLEs

Cognitive Load Theory (CLT) and constructivism (as a learning theory) are the two dominant learning theories that are predominant in guiding the design of VRLE and the associated training protocols. In this section, we will briefly introduce both of the theories and discuss how they are applied to guide the design of VRLEs.

2.1 Cognitive Load Theory

The Cognitive Load Theory (CLT) was proposed based upon the concept of Working Memory (WM) (a.k.a., short-term memory). Short-term memory is very limited in terms of capacity and persistence [30]. On the contrary, modern cognitive science research suggests that Long-Term Memory (LTM) appears to have an unlimited capacity, and information is stored and organized in LTM as schemas, and postulated that learning mechanism in human is based upon the interplay between WM and LTM (See Fig. 1.) [31].

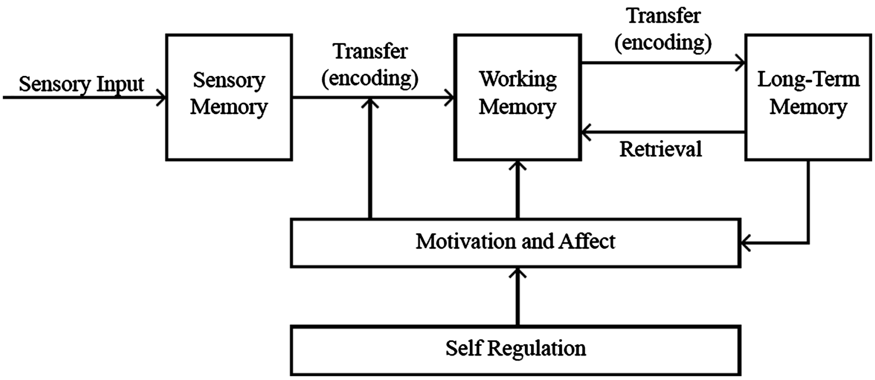

Fig. 1. Cognitive-affective theory of learning with media [31]. The diagram shows not only the interaction between Working Memory and Long-Term Memory during cognitive processes, but also the effects of motivation and affect on the processes

Specifically, three types of cognitive load have been identified in previous research studies [46, 33]; they are (1) extraneous cognitive load, (2) intrinsic cognitive load, and (3) germane cognitive load. CLT suggests that, when designing learning contents, we need to minimize extraneous cognitive load [34], appropriately manipulate intrinsic cognitive load (e.g., [45] incorporates Intelligent Tutoring System (ITS) approaches to VRLE), and maximize germane cognitive load [6].

2.2 Constructivism (as Learning Theory)

Constructivism admits that the external world is real and objective but everyone may interpret the external world in his/her own way based on personal experience and knowledge [19].

The major challenge of applying constructivism approaches either in VRLEs or other types of learning environments, from the pedagogical perspective, is how the environment or facilitators can support learners in an efficient and appropriate way. Previous research studies question that VRLE-based learning programs without appropriate guidance and feedbacks, especially in the early stage of learning or at the point where the learner encounters great difficulty, may be inefficient [48, 2, 47]. For example, learners may need extra time to get used to the learner-scenario interactions or the immersive VR displays in order to avoid disorientation.

There are also concerns on unexpected learning outcomes if insufficient support (e.g., scaffolding, debriefing, etc.) is provided to learners [21].

Hauptman [13] suggests using self-regulating questions to scaffold learning when applyingconstructivism. The study investigates whether self-regulating questions can improve learning effectiveness via a self-designed and self-develop program called Virtual Space. The experiment conducted on a population of 194 using factorial design reveals evidences showing that self-regulating questions make VRLE-based learning more efficient, in terms of enhancing learners' spatial thinking. Besides, other studies had also suggested introducing collaborative learning as a supportive tool of applyingconstructivism [3, 25, 14]. In those collaborative VRLEs, learners proactively provided support to their peers who encountered difficulties. Huang and Hu [14] evaluated and analyzed the peer learning behavior in a self-designed collaborative mathematics learning virtual environment. Results show that the students were more active in the collaborative environment and "not only solved the (geometry) problem on their own tables and white boards, but also criticized peers' solutions and helped.. . to get answers".

In summary, researchers and scholars are aware of the shortcomings of constructivist approaches when applied to VRLEs (e.g., problem-based learning, experiential learning, discovery learning, case-based learning, etc.), and have attempted to overcome them by introducing self-regulation, peer support or support from instructors as part of the learning process. However, Fowler [9] points out that although many studies have adopted various approaches based on constructivism, few of them had "a clear (theoretical) pedagogical model" to guide and inform the design and use of the VRLEs.

3 Learning Domains for VRLEs

VRLEs have been applied in various learning domains (e.g., biology and ecology, language learning, mathematics, chemistry, history, art, etc.) in previous research studies. Most of these learning and training programs benefit from two advantages of VRLEs. First, VRLEs help spatial cognition training; and second, simulations and simulated situations can be easily recreated, presented, and repeated in the virtual reality setting.

3.1 Spatial Cognition Training

Since spatial cognition has been shown to be the foundation of many other learning topics, VRLE has been developed and used extensively for spatial cognition training.

For example, [37] and [23] are two novel studies using VRLEs on visually impaired people for spatial cognition training. In conventional VRLEs, visual stimulation dominates the sensory inputs. However, visually impaired people can hardly been visually stimulated. In both studies, the authors successfully recreated virtual indoor environments with automatic speech guidance according to real indoor environments, so that learners can sense the environments via auditory and haptic stimulations. [13] and [50], on the other hand, use VRLE for spatial cognition training in a more conventional way. Traditional spatial cognition training requires learners to mentally manipulate two-dimensional shapes or three-dimensional objects. This supposes to be a challenging task because there are no direct visual feedbacks during mental manipulation. VRLEs are ideal for this kind of training, because any kind of manipulation can be instantly visualized.

Besides the four studies mentioned here, the use of VRLEs as a tool for spatial cognition training can also be found in [22, 28, 27, 24, 22] investigates the possibility of using spatial memory to help students remember history chronology. Merchant et al.

[28] and Merchant and Goetz [27] use VRLE to help students learn Valence-shell Electron Pair Repulsion theory (VSEPR) in chemistry. According to all the authors of these mentioned publications, achieving the intended learning outcomes requires spatial thinking ability either directly or indirectly.

3.2 Learn by Simulation

VR environments are designed to make users sense presence [44]. Hence, the technology must be able to simulate the real world in terms of visual fidelity, laws of physics, and sometimes even social interactions. In such simulated and highly interactive environments, students are free to experience and explore. Most of the topics in science and engineering learning indeed encourage and require students to test hypothesizes via controlled experiments and precise measurements. We see some of the studies using VRLEs directly as a tool for laboratory sessions in, for example, [40, 32]; or fieldwork sessions in [10, 38].

In the Hummingbird Survival learning scenarios [16] developed based on the SAMAL Model for affective learning proposed by Ip et al. [15, 18], we not only simulate and model the hummingbird flying physics and surviving criteria in the scenario but also implement the learner-scenario interaction based on motion and pressure sensors (Wii remote and balance board), so that learners can experience the simulated learning content in a much more immersive and intuitive way.

VRLEs can also be programmed to simulate social situations. For example, [5, 26] aim to help learners with special education needs. These studies make very good use of VRLEs as tools to recreate and simulate social situations. Those social situations allow learners, especially learners with Autism Spectrum Disorders (ASD) or Autistic Syndrome Conditions (ASC), to practice their social skills and social functioning in a safe and private environment without the risk of embarrassing themselves or others. We will further address several examples in Sect. 5.1.

4 Education Activities for VRLEs

Various educational activities have been applied in recent VRLE-based research studies (e.g., problem-based learning, inquiry-based learning, discovery learning, role playing, collaborative learning, virtual laboratories, virtual fieldwork, etc.) with the characteristics of VRLEs in mind. According to previous surveys (e.g., [29, 8, 49]) and our study, problem-based learning, inquiry-based learning (a.k.a., discovery learning) and collaborative learning are the three most widely adopted education activities for VRLEs.

4.1 Problem-Based Learning

Problem-based learning is the education activity in which learning is driven by solving problems. Specifically, learners are first given an authentic problem, and during learning, learners are expected to solve this particular problem in the virtual environment via solving a series of sub-problems. There are many VRLE-based studies explicitly state the adoption of problem-based learning (e.g., [13, 28, 14, 50], etc.). The two major issues of problem-based learning are that (1) at the very early stages of learning, when learners are not familiar with the environment enough, they could possibly lost their interests and motivation; and (2) in the later stages, misconcepts could form if there is not enough support or guidance. Hence, several studies suggested that after the VRLE-based training, instructors should help students clarify any misconcepts via post-learning activities (e.g., debriefing, and consolidation, etc.) [41].

4.2 Inquiry-Based Learning

Inquiry-based learning typically started with a topic or a task. The learners were required to observe, pose their own research questions, design research methods, collect data, analyze data, draw conclusions, and present the findings. VRLEs provided the ideal environments for this type of education activity; in the virtual environment, learners are free to explore unfamiliar or even hostile and inhabitable environments (e.g., underwater world, disaster scenes, Mars surface, the VEL science project[1] [38]) without worrying about their safety or the accuracy of their virtual data collection tools.

4.3 Collaborative Learning

Collaborative learning is a constructivism approach that can invoke and practice collaboration skills among learners. In practice, collaborative learning is recommended and adopted by many modern VRLE-based learning and training programs based on constructivism. The reasons are quite simple: (1) large scale collaborative learning cannot be easily realized in conventional learning environments due to physical and geographical constraints [7, 35]; and (2) the peer-based activities (e.g., peer review, peer sharing, etc.) are proved to be pedagogically beneficial, especially when incorporating with other constructivism approaches [3, 25, 14].

As the development of high speed network connections and in-browser VR technology (e.g., WebGL), two major open collaboration VR platforms, Second Life[2] and Open Wonderland,[3] have been widely used in VRLE research studies adopting the paradigm of collaborative learning (e.g., [10, 28, 27, 12, 4], etc.). These latest research studies on applying collaborative learning in VRLE-based training programs focused on investigating the very fundamental question; that is compared to real world settings (e.g., classroom, lecture hall, etc.) which allow collaborative learning, how VRLEs influence collaborative learning. To answer this question via psycho-educational experiments, most of the latest research studies we mentioned above simulate and recreate the real world settings in the VR for the intervention, so that only the medium of learning content delivery will be changed while the basic environment settings are

[1] http://www.velscience.com/

[2] http://secondlife.com/

[3] http://openwonderland.org/

kept the same (i.e., basic environment setting, as an independent variable, is controlled). From the psycho-educational experiment point of view, those studies are well designed and give concrete and solid evidences showing that VRLEs encourage peer activities [28, 27, 12]. However, we see that most of these studies do not fully benefit from the adoption of VR technologies. Specifically, the recreation of real world settings without introducing or exploiting the unique features of VR (e.g., the ability of simulating complex processes purely based on learner-scenario interaction, etc.) seems to be done mainly for the purpose of psycho-educational experiments and did not take the full advantages of VR-based collaborative learning.

5 VRLEs for Special Education

Because of the characteristics and uniqueness of VRLEs mentioned above, several pioneering studies investigate the possibility and pedagogical guidelines of applying VR technologies for special education. In this section, we discuss the use of VRLEs for learners with Autism Spectrum Disorder (ASD) or Autistic Syndrome Conditions (ASC) and for learners with intellectual disabilities.

5.1 VRLEs for Leaners with ASD or ASC

According to [1], individuals with ASD have "neurodevelopment disorders characterized by deficits in social perception and cognition, subtle impairment of verbal and non-verbal communication, presence of idiosyncratic isolated interests, and repetitive behaviors". The major objective of using VRLEs for learners with ASD or autistic features is to help them improve their social competence via practicing in simulated real-world social situations. By applying VR-based learning rather than real-world situated learning, embarrassment and potential danger can be avoided.

For example, the collaborative VRLE proposed in [5] aims to help learners with ASD or ASC understand empathy, which is considered as a wider definition than "theory of mind". The authors recreate a restaurant setting and script four social scenes in which the learner may utilize empathy. Because the virtual setting and learning content are replicated from daily life, the learners are expect to generalize and transfer what they have learned in the VRLE to their daily life. As expected, during training and post-training maintenance sessions, the learners all exhibit improvements in terms of understanding of empathy comparing to their baseline performance. However, the experiment was conducted on only three participants with ASD. The results are therefore not particularly conclusive unless the effects could be demonstrated on more individuals.

Lorenzo et al. [26] help learners with Asperger Syndrome (a.k.a., high functioning ASD) using similar technologies but for different purposes. The study aims to improve learners' executive functioning via organizing, planning and executing tasks with persistent attention in the VRLE. Specifically, the authors design 16 tasks (e.g., preparing materials for the following school day, asking the teacher questions, inviting a friend to play at home, etc.) to be executed in the VRLE. Each of the 16 tasks will be carried out for 5 times. The training will last for almost one school year excluding school holidays. It seems the excessive and highly repeated training is necessary for learners with ASD, because by interpreting the collected data, we can observe cases of relapse in terms of executive performance after summer holidays. However, if relapse does exist, there is lack of evidence to show the program's long-term effects.

Although the above studies as well as other relevant studies, which use VRLEs to help learners with ASD or ASC, indeed show some promising results, the effectiveness, especially long-term effectiveness and knowledge or skill transferring rate which are quite critical for learners with ASD or ASC, needs to be further investigated [36].

5.2 VRLEs for Learners with Intellectual Disabilities

The learning difficulties that teenage and adolescent learners with intellectual disabilities are facing during every day learning are severe. These learners need simultaneous repetitions to develop cognitive awareness and to acquire and practice generic skills [43]. VRLEs provide such safe and highly repeatable environments for them to learn.

Based on the SAMAL Model [15, 18], Ip et al. [17] further extended the use of VRLEs for severe intellectually disabled (SID) learners. The novel programme consists of 8 specially designed virtual reality learning scenarios to help SID learners in 4 learning domains (see Fig. 2). They are (1) safety awareness domain, (2) cause and effects domain, (3) balance and coordination domain, and (4) sensational experience learning domain. Preliminary quantitative evaluation shows that both in school setting and in off-campus settings, most of the SID participants are more engaged and motivated. Interviews with the teachers and the parents indicate that knowledge and skills SID participants learnt in the VRLE can be successfully transferred to real life.

The major challenge of designing VRLEs for learners with intellectual disabilities is how to make the learning contents adaptive to the learners' ability. Because of the variety of their intellectual disabilities, intrinsic cognitive load of the same learning content could be dramatically different from individual to individual. Also, intellectual disabilities, especially severe intellectual disabilities, could possibly be accompanied by physical disabilities, which limit the interaction between learners and the environment. Hence, the content design and instructional design should consider the learners' special needs as much as possible.

6 On-going Challenges and Open Issues of VRLEs

VRLE is a relatively new medium for teaching and learning. Questions on the learning effectiveness of using VRLEs have been raised since the emergence of this medium.

Traditional evaluation approaches require rigorous psycho-education experiments. For example, to apply the most commonly used ANCOVA approach, each learner needs to be assigned to either the control group or the intervention (treatment) group randomly [20]. Even this is very difficult to achieve for most of the school-based VRLE research studies, because the randomness requirement of ANCOVA approach and

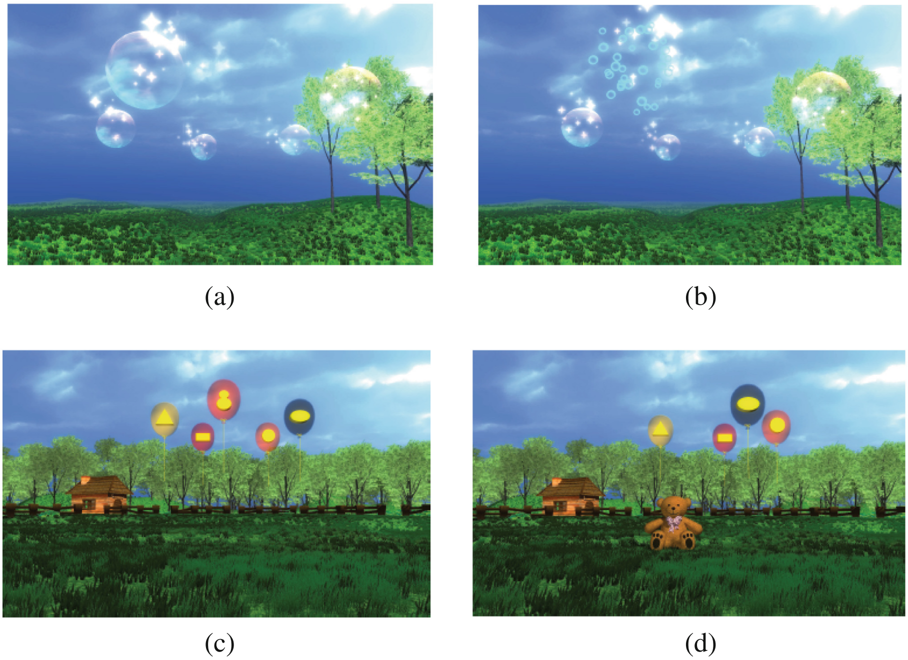

Fig. 2. Screenshots of InSPAL learning scenario "Touch-to-Change" and "Coloured Balloon Sculpture" [17]. The learning scenario "Touch-to-Change" ((a) and (b)) is designed to be visually less complex than "Coloured Balloon Sculpture" ((c) and (d)) is, in order to lower the cognitive load of learners during their very first exposures to the VRLE.

other experimental designs makes the research hard to be integrated into school curriculum and could cause potential logistic issues.

Besides challenges on the practical adoption of experimental designs, unlike psychological experiments which are usually carried out in laboratory settings in a relatively short time, education programmes usually last for months in unstructured open settings. Hence, even if the evaluation results appear to be promising, it may not be possible to tell whether it is due to the programme or other uncontrolled variables. Similar concerns have been reported in [11].

Another major concern on the effectiveness of VRLE-based education programmes is that most research studies failed to assess long-term knowledge and skills transferring. Although many previous research studies favor VRLE as a tool enabling harmless simulation of physical or social situations, how to guarantee the transferring of knowledge and skills learners acquired in VRLEs needs to be further investigated via long-term observation and assessment.

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What Really Works in Hybrid Learning: A Cognitive Perspective

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Abstract. This paper synthesizes two decades of research focused on understanding what "really works" in education, with a focus on hybrid learning environments. A cognitive perspective approach shaped research on diverse learning environments. All of these learning environments had empirical foundations for improving student learning outcomes. The fundamental conclusion reached is that development of hybrid learning environments must be driven by educational research that would be on the scale and rigor analogous to large clinical trials designed to promote evidence-based practices in healthcare.

Keywords: Theories of cognition · Personalized learning · Adaptive learning · Competency-based learning · e-learning · Misconception development · Healthcare curricula · CIT curricula

1 Introduction

Over two decades, we studied frameworks for evidence-based approaches to improve science, technology, engineering, and mathematics (STEM) education in the United States [1]. Much of this work focused on factors shaping exclusions of students from STEM majors, especially minority, women, and first generation university students. We tried to provoke the educational community to start framing educational research that would be on the scale and rigor analogous to large clinical trials designed to promote evidence-based practices in healthcare. Early research analyzed factors shaping success of STEM students in four-year baccalaureate liberal arts colleges in the United States [2, 3]. Scant research explored the suites of psychological factors shaping cognition and learning. Beginning in 1996, we took advantage of the growing international interest in computer-based simulative environments to design and study complex learning objects built as virtual worlds. These were designed for computer-based tutorial systems or nested within environments that were the early precursors of learning management systems for online and hybrid courses. Using the National Research Council guidelines as a foundation [4–6], we initiated a decade long effort (2001–2011) to build evidence-based educational environments that could be sensibly

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nested: (a) within emerging computer-based tutoring systems; (b) within serious games designed for education; and (c) integrated into the rapidly evolving online learning management systems.

2 Knowledge Gaps

2.1 Gaps in Our Understanding of Cognition and Learning

During a decade of work, we identified ten knowledge gaps that remain unresolved. For your review, we present these gaps below:

1. How does an educational environment impact disposition to engage in a learning process?
2. What are the relationships between the level of realism in an educational environment and learning outcomes?
3. How do you define the threshold of experience within an educational environment that leads to measurable learning outcomes?
4. What are the knowledge domains being developed during learning?
5. In which knowledge domains has learning been retained and how stable is that retention?
6. What is the disposition to act on the knowledge gained from learning within an educational environment?
7. How well can the knowledge be transferred to related problems in the same domain area?
8. What learning outcomes (conceptual and performance competencies) are developed during the learning process while working within an educational environment?
9. How are misconceptions developed during and sustained after working within an educational environment?
10. How do teacher-student and student-student social networks or e-communities impact learning.

Development of misconceptions proved the gap most difficult to study. An interesting body of work on personalized learning environments evolved in Europe [7–9]. However, our studies of misconception development resulted in a methodology that allowed study of all ten gaps, but focused on misconception development [9–13]. We argue the neurologically dynamic condition of a "misconception" instantiated, even temporarily, within a person's mind is that person's state of being unaware some knowledge domains and cognitive processing are incomplete or incorrect, and how we believe we are right even when we so often are not [14–17].

The methodology we developed was applied to study all ten gaps [9, 10]. Indeed, and though we focus on hybrid or blended education, these ten gaps are common problems for any educational format or setting. No learning management systems (LMS) or course designs, to date, bridge the ten gaps listed above. From an operational research perspective, part of the difficulty is the startling diversity of hybrid-bended courses that have been designed and implemented—the majority with scant evidence that they really work to improve learning. This diversity of course types imposes enormous barriers to studying how hybrid learning "*might*" improve learning outcomes and bridge the gaps we have been discussing.

2.2 Taxonomies of Hybrid Courses

So far, we have not found a coherent theoretical framework to guide systematic studies of the enormous complexity inherent in hybrid-blended learning. There are few truly systematic delineations of all of the possible types of blended learning courses as well as courses not yet developed but imaginable in the ever evolving milieu of educational technology.

We developed a taxonomy for hybrid-blended learning courses with full communication capacities, which means such course include all or multiple forms of communication, including social networks, with interactions among students, among students and faculty members, and among students and sources outside of a course. Table 1 shows Course types disaggregated by the relative proportion of face-to-face (F2F) and online course elements. To simplify, we used Low Percentage F2F ($\leq$35 %), Medium Percentage F2F (36–70 %), and High Percentage F2F (>70 %). We further disaggregated course types by degree of complementarities of the face-to-face and online course components [11, 18].

For course structure, we included: (1) Complete Release – all materials of all course elements are available from the start and remain accessible throughout the course duration; (2) Time Hierarchical Release – with course materials released on a time schedule and without requirement for demonstration of student mastery; (3) Topic Hierarchy without Mastery – course elements are released to students by topic-subject area cluster but without condition of their mastery of prior topic-subject cluster; (4) Topic Hierarchy with Mastery – course elements are released by course topic-subject area cluster and with the condition of mastery of the prior topic-subject cluster. We then added an additional disaggregating variable suite related to the degree of educational scaffolding provided for each course structure. To simplify somewhat, we used the terms "Guided" to mean high levels of scaffolding and "Unguided" to mean no or little educational scaffolding related to the course structure and how to move through that structure. Table 1 shows this taxonomy as a $\{6 \times 8\}$ matrix of cells, each cell representing a type of hybrid course. In Table 1:

- Cell "A" represents blended courses that have a low percentage of faculty face-to-face components (so mostly online), with the face-to-face and online course elements integrated and complementary, with course materials released at the start of the course and available throughout the course, and with guidance provided to the student by scaffolding on how to proceed through the course.
- Cell labelled "B" represents blended courses that have a medium percentage of faculty face-to-face components (more balanced face-to-face and online elements), with the face-to-face and online course elements not very well designed to be complementary, with course materials released on a timed schedule not necessarily correlated with topic-subject clusters, and with little guidance provided to the student by scaffolding that would facilitate how to proceed through the course.

- Cell labelled “C” represents blended courses that have a high percentage of faculty face-to-face components (thus, little online), with the face-to-face and online course elements integrated and complementary, with course materials released by topic-subject cluster and on the condition of student mastery or prior topic-subject clusters, and with guidance provided to the student by scaffolding that would facilitate how to proceed through the course.

We believed that any study of “what really works” in blended learning would have to accommodate all of the course types in our taxonomy. Examining the history of blended and more recent developments, we felt the taxonomy was a reasonable starting point for the development of theory related to how, why, when, and with what outcomes does blended learning really work to improve students’ and trainees’ learning outcomes. In particular, we explored the robustness of the taxonomy in the context of integrating theories of cognition and behavior into instructional design. Our research turned to a focus on course types A and D in Table 1.

Table 1. Blended course taxonomy derived from the Rudak-Sidor taxonomy.

		Course structure							
		Complete release		Time hierarchy		Topic hierarchy		Topic hierarchy with mastery	
Face-to-Face		G	U	G	U	G	U	G	U
Low (≤35 %)	C	A							
	NC								
Medium (36–70 %)	C	D							
	NC				B				
High (>70 %)	C							C	
	NC								

C = Complementary, NC = Not Complementary, G = Guided by Scaffolding, U = Unguided by Scaffolding.

3 Evidenced-Based Educational Simulations

3.1 Theories of Cognition and Design of Instructional Materials

During the period 1998–2014, we studied how cognitive and learning sciences could inform instructional design, especially in development and evaluation of complex learning objects within online course components. Patel, Yoskowitz, Arocha, & Shortliffe [19] pointed out that in healthcare delivery settings cognition will be shaped by the situated encounters in that workplace, which are dynamic and strongly influenced by social contexts as well as by a diverse array of other elements in the setting such as technology, temporal and spatial heterogeneity in the patient’s condition, changing shifts of providers caring for the same patient, and ongoing coordination of many different tasks and decisions as well as health information management [19].

Effective action requires development of pattern recognition capabilities as providers move from novice to expert.

We conducted an analogous analysis for computer sciences education, studying a system built by Northern Arizona University to provide a personalized learning experience for an online CIT curriculum [9]. For both healthcare and CIT curricula frameworks we examined students' cognitive processing and knowledge formation. One can find a variety of models for cognition and learning, summarized nicely by Patel and colleagues [19] for healthcare education. We believe such models are easily extended with validity to CIT education as well as other discipline domains [13, 20]. However, through time a student is exposed to many new educational and life experiences.

As a starting point, we examined several theories of cognition. We realized that a very sophisticated virtual world could be constructed as an educational simulation and such a world might be valuable to test theoretical frameworks that have been proposed for cognition—for example cognitive load theory, cognitive flexibility theory, adaptive character of thought theory, and situated learning theory. Some of these theories cluster into more individualistic structured learning—such as adaptive character of thought and cognitive load theories. Others fit within what many educators call constructivist learning theories—such as cognitive flexibility theory and situated learning theory [19]. We also realized that most educational simulation developers had not developed their simulations from grounded theory or have not conducted research on students' learning outcomes using different instances of their simulations using different theoretical framework or a synthesis of frameworks to inform the design and various engines of the simulations. We concluded there were no rigorous large scale studies (i.e. analogous to clinical trials) of simulation design that would give us an empirical foundation for "what really works" to improve student learning outcomes, let alone knowledge retention, knowledge transfer, development of misconceptions, of any of the other knowledge gaps described earlier in this paper.

As we built different models of education simulations for healthcare education, we could choose a theoretical framework for cognition and that framework would drive instructional design. Within that design, we could build very sophisticated virtual worlds and assess conceptual and performance competencies. Here, we are using conceptual competencies as a thorough understanding of a knowledge and/or skills domain. Often conceptual competencies are further elaborated as: (1) competencies in which a person can describe how and why to use the knowledge or skill in different but appropriate contexts (generativity [19]); and (2) competencies in which a person can describe how to use the knowledge or skill in situations that are unfamiliar (robustness; [19]). However, performance competencies are those competencies in which knowledge is acted on as an expression of a variety of behaviors and decisions or skills that are implemented in the real world or some very close simulation of the real world.

We were able to build simulations that engaged students in opportunities to demonstrate competencies, knowledge, and skills. For simulations without haptic interfaces or augmented reality, we could not embed and measure performance competencies involving psychomotor activities. However, we were able to assess conceptual competencies and through longitudinal studies see how measures of conceptual competencies and disposition to act on knowledge and skills acquired might predict performance competencies.

3.2 Evidenced-Based Educational Simulations with Engines for Capturing Cognitive Traces of Student's Learning

As use of hybrid-blended and totally online courses increased, we studied how to nest into such courses educational simulations that had an empirical foundation for improving student learning. We chose to design simulations that were grounded in the situated learning theory of cognition. This constructivist theory posits that learning develops within the activity, context, and culture in which it is situated. From an instructional design perspective, a simulation based on situated learning would involve learners in what some call a *cognitive apprenticeship* that provides a variety of engagements that support learning of a knowledge and skills by enabling learners to develop and use their cognitive tools within authentic activities of the knowledge-skills domain. [See University of Oregon, Accessed January 20, 2015; Reference: http://otec.uoregon.edu/learning_theory.htm#SituatedLearning] We used situated learning theory to develop course maps, such as the diagrammatic representations shown in Figs. 1 and 2.

Course maps provide a sensible way to organize competency or learning outcome domains (C in Figs. 1 and 2), and for each competency to delineate specific educational objectives (O in Figs. 1 and 2). Educational objectives can be developed into teaching-learning-assessment modules (M in Figs. 1 and 2), with each module comprised of suites of potential interactions or student engagements (I in Figs. 1 and 2). Each interaction is a set of one or more learning activities, and each learning activity has a suite of assessments as well as diagnostic feedback and scaffolding for each assessment (respectively LA, A, and D in Figs. 1 and 2). In Fig. 1, we can imagine a learning activity its respective assessment suite and the respective diagnostic feedback and scaffolding suite—for example, in Fig. 1 follow competency C_i to Objective O_{i2} and then to module M_{i2}. Module M_{i2} has four interactions I_{21}—I_{24}. Interaction I_{21} has four learning activities—LA_{211}-LA_{214} each of which has its respective assessment and diagnostic suite.

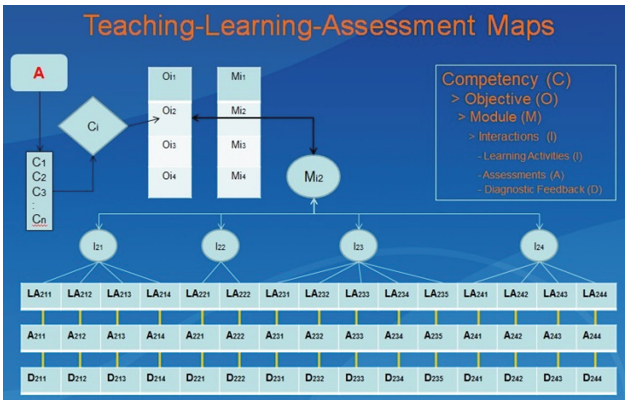

Fig. 1. Diagrammatic representation of a course map for some course A (e.g., Course Type A from Table 1).

The design of the modules, interactions, learning activities, assessments, and diagnostic-scaffolding suites becomes idiosyncratic to the theoretical framework being used. Furthermore, as learners construct knowledge they often require exposure to related learning activities in order to sensibly build an understanding of complexity in a knowledge-skills domain. In Fig. 2, we diagrammatically represent some clusters of related learning activities that are organized under different interactions. Note also in Fig. 2 that a research engine has been inserted to collect data on assessments completed by a student when engaging only in LA_{211} but also when assessed within a related set of knowledge-skills domains embedded within in a larger cluster containing LA_{211}, LA_{213}, LA_{214}, LA_{221}, LA_{222}, and LA_{231}.

Figure 3 shows a clinical setting from one of our simulations—a virtual outpatient clinic on the first floor of a virtual hospital. Figure 4 shows patients being seen in the outpatient clinic as well as some patients who have been admitted to the hospital. A student could be assigned a set of learning activities related to progress of an acute condition in a patient and so have to analyze that patient's electronic medical record from the outpatient clinic as well as within a hospital unit. Furthermore, for some assignments a student could visit and assess the patient in the clinic or a hospital unit, then enter their finding into the electronic medical record. From a situated learning theoretical framework, we developed virtual clinic and hospital settings and nested within those settings enormous numbers of possible interactions with patients, collection of patient data (including interactions with both the patient and the patient's significant others), giving medications and conducting procedures, entering data into the patient's electronic medical record, analysis of patient data, observations of clinical staff interacting with the patient, consultation with other healthcare providers, and access to a medical library. This approach to instructional design created the activities, contexts, and culture of planning and delivering healthcare by engaging learners in a cognitive apprenticeship within authentic activities.

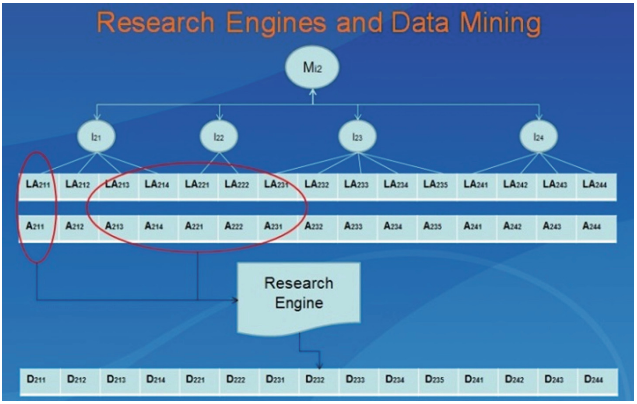

Fig. 2. Diagrammatic representation of a curse map in which clusters of Learning Activities and their respective Assessments are monitored by a software engine that collects data on a student's movements through the course.

Fig. 3. Navigation screen for outpatient clinic that allows selection of patient and then working with that patient in various clinical setting (e.g., Exam Room, Laboratory, Check Out). Within each clinical setting, a student can engage in observing care planning and delivery of the patient, collect patient data, and enter data into a medical record.

Fig. 4. Screen shots of a virtual hospital simulation that show patients in the outpatient clinic as well within a hospital unit.

3.3 Cognitive Traces

During research studies, we evaluated several ways to follow the cognitive traces of decision making by students within simulations accessed within online teaching-learning-assessment environment. In simple terms, every simulation or complex learning object, indeed every element of an online course, can be operationalized as a virtual place, usually a simulation component or a web page. From that virtual place, a student can access other virtual places as they engage in activities accessed from navigational pathways from any page. We built monitoring systems that followed a student's pathway through every virtual place visited and also measured the time spent in each place. Thus, we could construct what some call space-time worms that were cognitive traces of sequences of decisions made by a student within a virtual world or complex learning object or the course components of an online course. Figure 5 provides a schematic representation of a student's journey within an online simulations.

Using Fig. 5 as a reference, suppose a student starts with a module in an online course, say M_{ij}, and then enters the environment of interactions I_{jk}. From the I_{jk} page, they can navigate to a variety of learning activities, in this figure L_{jkl}, L_{jkm}, and L_{jkn}. The levels 1^0, 2^0, 3^0, and so on, represent levels of navigation within the virtual world simulation, learning object, or course component. So, in Fig. 5, the student enters the module, then the learning activity cluster L_{jkl} (2^0) engages in learning activities at 3^0 and 4^0 navigation levels, completes an assessment at the 5^0 level, and gets on-demand diagnostic feedback or additional scaffolding after the assessment.

Our data collection research engine collects the identifying data tags for each page and records the time spent on each page—this is the space time worm or cognitive trace of the student's work within the teaching-learning-assessment environment. In addition, the data collection engine gathers all assessment outcomes along the pathway and maps these to the space-time worm generated. A key piece of research related to assessment engines led to a software system we called eXAM^3, which is shown diagrammatically in Fig. 6 [21].

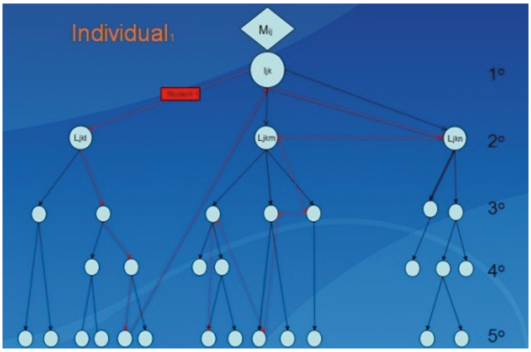

Fig. 5. A student, here designated Individual$_1$ enters a virtual world, learning object, or component of an online course. The read arrows mark that students pathway through various virtual places.

The administrative dashboard for eXAM^3 allows an instructor to enter assessment items, diagnostic feedback related to the item, and educational scaffolding related to the item. Each assessment item can then be placed within a cognitive taxonomy of the instructor's choice. In Fig. 6, we show three levels of a taxonomy as well as four categories of assessment item within each level. The assessment taxonomy an instructor selects would ordinarily evolve from or be dictated by the theory of cognition in which the teaching-learning-assessment environment had been grounded.

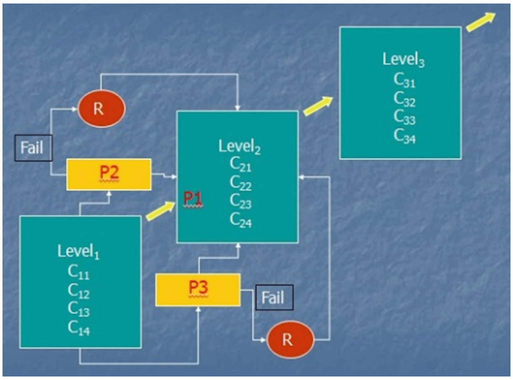

Fig. 6. A diagrammatic representation of the assessment engine eXAM^3. This engine allow establishment of different cells of assessment, using a {Level x Category} architecture. (e.g., different content or different kinds of problems).

If the student scores higher than the threshold for pass, they enter Pathway P1—the next level of assessment items. However, they have access to diagnostic feedback that describes areas of weakness and strength with specific recommendations for additional review and mastery work. If a student scores lower than the pass threshold but equal to or higher than the marginal threshold, they enter pathway P2 and can retake the assessment and either pass into the next level or are sent on a remedial pathway delineated by the diagnostic feedback provided. If the student scores below the fail threshold they enter pathway P3, which first allows them to try to jump to the next level. If they fail again, P3 sets them on a remediation path that is delineated by diagnostic feedback. The key is that the diagnostic feedback does not give the correct answers to assessment items but directs the student to content and skills domains that need to be reviewed and mastered.

As a familiar example, though one not quite appropriate for situated learning theory, suppose that a learning environment had been built around Bloom's revised taxonomy [22]. The categories within each cognitive process could be the four knowledge domains—Factual, Conceptual, Procedural, and Metagcognitive. An instructor would create assessment items for each {level-category} cell in the taxonomy, and then set three thresholds—pass, marginal, or fail.

The space-time worm and the eXAM^3 assessment engine provide researchers and instructors with new types of tools that can be used to create evidence-based practices in education. On one level, faculty members have detailed information on the amount of time a student spent within various course components and the cognitive trace of their learning activities in space-time worm. Faculty members also have much more detailed information a student's breadth and depth of knowledge and skills development, as well as progress a student makes on remediation pathways. On the course or curriculum level, students' space-time worms and results of eXAM^3 type assessments engine can provide rich opportunities for program self-study and research on refining instructional design to optimize student learning outcomes.

4 Adaptive Learning Within Hybrid Courses

We now examine hybrid courses we have developed within a framework of grounded theory, evidence-based design of learning objects, and pedagogical strategies as well as educational scaffolding that have some evidence of "really working" to improve educational outcomes. Section 4.1 examines healthcare courses, while Sect. 4.2 explores course development in computer sciences. These courses were developed at the University of Ontario Institute of Technology. Section 4.3 examines a study of a computer science curriculum at Northern Arizona University.

4.1 Health Information Management Courses

In 2006, one of the authors (J. Tashiro) was assigned to develop a health informatics course at the University of Ontario Institute of Technology. The university had moved quickly into hybrid learning formats. We decided to build and implement the informatics courses within a research design that would inform the university's transition to hybrid learning. The course used situated learning theory as the grounded theory for instructional design. In this framework, we posited learning develops within the activity, context, and culture in which it is situated. We therefore involved students in the situated experience of working as healthcare professionals to use health informatics. The course created a cognitive apprenticeship for students by providing engagements that supported learning knowledge and skills within authentic activities of healthcare professionals working with health informatics systems.

To make the course consistent with other online courses at UOIT, all content was released within BlackBoard at the start of the course. Course content and facilitated face-to-face discussions were complementary (please take a look at Cell D in Table 1). The BlackBoard LMS allowed us to set up a folder structure:

- One set of folders contained lectures available as videos with audio by the instructor as he discussed and showed PowerPoint productions that contained animations, complex images, and the instructor's notes being written into each slide to emphasize key content. The slides also had hyperlinks for the students that opened options for additional related content. In the lecture folder, we also provided MP4 audio recordings of the lectures, a PDF of the PowerPoint lectures, and the PowerPoint presentation without instructor audio and notes.
- A second set of folders provided an online library with all required reading easily available to students.
- Course content folders contained the syllabus.
- A course schedule folder provided details of course activities and a course activity planning map.
- Assignment folders and subfolders provided assignments for each week.
- A special folder contained a portal to an educational simulation of a virtual hospital (see Figs. 3 and 4). The virtual hospital was designed as the community in which authentic learning activities could take place. We embedded a lot of scaffolding into the simulations, including a virtual guided tour and instruction manual for

navigating the virtual hospital. Online discussions boards were open to create the feel of a hospital intranet. The simulation was accessed through the BlackBoard course instance, but was actually nested within a secure virtual server that allowed fast access to any student with an internet connection. UOIT was the first laptop university in the province of Ontario—all students had university computers and internet access.

- A final folder offered a portal to eXAM^3, the sophisticated online learning assessment system described earlier in this paper [21].

eXAM^3 allowed students to complete self-assessment tests of their knowledge and skills at any time. The assessment engine had options for a variety of assessment types, including complex problem solving using nested videos and data sets students had to analyze. Students could take an assessment as many times as they liked. Each time, they were presented with a set of items that were randomly chosen from the item data base for a particular subtopic within a topic area of the course. The question pools were large enough to preclude students getting many of the same questions at each self-assessment—basically a student engaged in a new assessment set at each sitting, getting a "test" that was equivalent in content and skills covered for each course topic area. The assessment engine did not give students the correct answer to a question, but provided detailed information about specific readings or lecture PowerPoint slides in which they could find the answers to questions. This model of assessment precluded students trying to memorize the "*correct*" answers to an assessment item. The instructor could use a dashboard to examine each student's use of the assessment system and the results of self-assessments.

Graded assessments included proctored face-to-face examinations and short papers. There were four proctored examinations during a semester and items were randomly selected from the appropriate assessment item database of the assessment system to create each graded test. Assessment items were then transferred to hardcopy and provided to the students during the examination period. We also studied how to collect the space-time worm data that would become a model for our adaptive courses. The short papers were graded by an instructor and teaching assistant team.

However, we still struggled with the fundamental set of confounded questions: —"What really worked, how, when, for whom, and with what outcomes?" The central problem was that we still lacked rigorous tools for tracing decisions by students and mapping some kind of cognitive trace to misconception development. As mentioned earlier, we believe that being able to delineate misconception development is crucial to bridging the other knowledge gaps that plague our abilities to create truly evidence-based approaches for developing and implementing hybrid-blended learning (indeed, any kind of teaching, learning, and assessment).

Building on our experience in undergraduate health informatics management, and also starting work on an adaptive learning software system, we created models for professional development courses to serve healthcare workers. One of the authors (R. Tashiro) conducted a series of case studies within the healthcare information technology industry over a 20-year span. This work explored challenges and pitfalls of professional development for healthcare providers implementing an electronic health record (EHR) system. The EHR application is often touted as the industry's panacea for many of the problems that plague the healthcare industry in many countries—improved timeliness and accuracy in collecting and displaying patient clinical information, reduction of unnecessary tests/procedures, and overall cost reduction are just a few of the many woes faced during the American clinical transformation to ubiquitous use of EHR systems. A comprehensive professional development program is critical to a successful implementation and improved patient care. Analyses of over 50 different EHR implementations with over a dozen healthcare organizations across the United States led us to develop a set of competency domains as the focus of professional development training for EHR implementation. Using the types of learning map models shown in Figs. 1 and 2, as well as selecting situated learning as a theoretical framework for cognition and learning, the following competencies became the backbone of knowledge and skills to be taught within a hybrid course for professional development prior to EHR implementation.

1. Readiness for Organizational Change.
2. Governance Structure.
3. Current State Workflow Analysis.
4. Resource Allocation.
5. Effective Educational Technology for Clinical Transformation.
6. Evaluating Implementation Outcomes in the Context of Patient Outcomes.

Each competency domain was deconstructed into learning modules, and each learning module into learning activities with their respective learning outcomes assessments and diagnostic feedback to learners. For example, the Current State Workflow analysis competency has the following modules:

- Building a model of patient journeys through a clinical setting.
- Identification of workarounds and inefficient processes that lead to human error in clinical care or result from software deficiencies.
- Documentation and clinical-IT team integration for documenting and modelling current state processes that leads to better understanding of these processes and how they impact individuals/departments.
- Identification of knowledge gaps that result in departments and/or individuals not following evidence-based practices of care planning and delivery.
- Analysis of usability issues in effective use of electronic health records, especially why individual clinicians make mistakes at critical junctions.
- How to develop an effective evidence-based clinical transformation that results in patient-centric and evidence-based healthcare planning and delivery.

The course design had interesting consequences. We had to build a new type of educational environment, and one much more complex than the original adaptive learning model we envisioned. The result was an adaptive learning environment developed by Tashiro, Tashiro, and Alvarado-Yule [23], named “Adaptive Intervention Management—AIM” (patent pending). AIM overcame the general failure of e-learning educational systems to collect rich and high quality data on educational methods and materials. The system provides options for diverse educational modules; such diversity is very important when addressing the idiosyncrasies different hospitals face when educating staff for implementing new electronic health records.

Additionally, AIM allows various cognitive models for a learning environment or for a particular underlying framework of behavioral change embedded within a module's instructional design. Basic functionality contained mapping of content to learning activities and educational resources in order to create one or a suite of modules based on the cognitive or behavioral models of education chosen by a particular hospital. AIM became a significant improvement over conventional educational systems that adopt only one model of cognition or behavioral change. For example, different hospitals may prefer different models of cognition for the design of their professional development educational systems.

We also had to build better engines for monitoring learners' progress within learning activities as well building better assessment and feedback engines. In brief, AIM had an administrative dashboard that allowed a faculty member to select different choices of cognitive and/or behavioral frameworks. Once a framework was selected, the system created the database structure into which we could load appropriate learning activities, evidence-based assessments of learning, and mapping of assessment outcomes to a database of diagnostic feedback. Such a system would provide clinical staff with data on their progress toward understanding the complexities of implementing electronic health records in their particular clinical setting. AIM made it possible to analyze the trajectories of critical variables that shape clinical staff decisions to change behaviors related to implementing electronic record systems, the stability of such decisions and subsequence behavioral change, the transferability of such decisions to related situations, and the potential for misconceptions being developed related to such decisions. AIM became the prototype for a more complex system we call **MISSED**—**M**isconception **I**nstantiation as **S**tudents **S**tudy in **E**ducational **D**omains, which is discussed in the next section [10].

4.2 Computer Sciences Courses at University of Ontario Institute of Technology

As we worked in healthcare areas, we began to expand our thinking to other knowledge domains, particularly computer sciences. This work was led by two of the coauthors—Vargas Martin and Hung. Both are members of the Faculty of Business and Information Technology at University of Ontario Institute of Technology. Both were teaching hybrid courses. For example, Dr. Hung taught E-Business Technology ($\sim$ 60 students) and Web Services for E-Business Security (55–65) students. Dr. Vargas Martin has taught Introduction to Programming ($\sim$170 students), Cryptography and Network Security ($\sim$60 students), Cryptography and Secure Communications ($\sim$20 students), and Programming the Mobile Web ($\sim$50 students). Key findings emerged during development and implementation of these courses; some of these were discussed in Sect. 4.1 for the Health Information Management course. However, the following issues may be of interest to faculty searching for what works to improve student learning in computer sciences courses.

- Sometimes a faculty member cannot find a good textbook that covers the topics in the course. Consequently, faculty members must create their own libraries of resources for students and sensibly nest these into the learning management system.

Most of the materials will be online—such as research articles in IEEE/ACM Digital library, technology standards published in World Wide Web and OASIS, white papers from industry, and videos at Youtube.
- Quizzes and exams in some of the classes used *Respondus* (a lockdown browser) and were proctored in the classroom.
- Assignments were nested into the learning management system.
- *MyProgrammingLab*, an online resource from Pearson Education which includes numerous exercises in synchrony with some textbooks' sequence of topics.
- For some course instances, lectures were taught online, in real time, and recorded for later access. The course also included face-to-face tutorials taught by the Teaching Assistant.
- Class size shaped the use of certain learning management system functionalities, such as discussion groups, e-community development, and effective use of social media.

For these computer science courses, we also asked: "What really worked, how, when, for whom, and with what outcomes?" The development of the AIM and MISSED systems provide working models for completely adaptive learning systems. Yet, even with functional systems and a research foundation supporting the efficacy of these systems, colleges and universities have invested enormous amounts of funding into learning management systems. Such investments lock instructors into using what the university has purchased. Introducing systems like AIM and MISSED would require a university partner willing to shift their hybrid-blended learning format and focus to include integration of adaptive learning environments that could be nested within the educational technologies and LMS already implemented.

4.3 Computer Sciences Curriculum at Northern Arizona University

In Fall 2014, we opened a discussion with Northern Arizona University (Flagstaff, Arizona, USA). Northern Arizona University (NAU) had developed a Personalized Learning online program with university support supplemented by a $1 million grant from EDUCAUSE and the Bill & Melissa Gates Foundation. One of the authors (J. Tashiro) had the opportunity to examine the NAU Personalized Learning (PL) online program and suggested a collaborative project. In brief, we were able to conduct a number of Gedanken experiments that were essentially sensitivity analyses for layering an adaptive learning environment into a system like NAU's PL. We believed this approach might have tremendous potential for finding cost-effective solutions to implement more rigorous evidence-based approaches in building and evaluating hybrid-blended and totally online courses and curricula.

Tashiro and colleagues [9] described the NAU PL online interface and course models. Designed in partnership with Pearson and officially launched on June 3, 2013, the NAU PL has three Bachelor degree programs: Computer Information Technology, Small Business Administration, and Liberal Arts. We were interested in these programs because they have an interesting model of online work and faculty mentoring. All content is entirely online and self-paced. However, students also receive direct mentoring from faculty and experts in the field of study, which introduces a hybrid learning component. Furthermore, NAU PL makes all content available to the student at the time of enrollment, so he or she can work as fast, or as slowly, as he or she would like. The student enrolls for 6-month subscriptions, and they are able to complete as many lessons as they would like during the subscription. Interestingly, this subscription is a flat USD$2500 fee, which includes all fees and textbooks. PL is a traditional degree program that has been deconstructed and reconstructed around specific competencies. The NAU PL philosophy and offerings can be reviewed at http://pl.nau.edu/.

The NAU PL model followed best practices of curriculum mapping. A panel of faculty, experts working in the field, subject matter experts, and specialists in teaching and learning delineated measurable competencies that together would be a reasonable core for a Computer Information Technology major. Ten Competency Domains were identified: (1) Information Technology Foundations; (2) Data Management and Administration; (3) IT Business Operations and Leadership; (4) Information Security and Policy; (5) Enterprise Architecture, Network and Telecommunications Technology; (6) Software Engineering and Development; (7) Systems Administration; (8) Business Analysis and Design; (9) Web-based Systems and Technologies; (10) Information Technology.

Using learning maps similar to those shown in Figs. 1 and 2. Each Competency Domain was expanded into one or more measurable Objectives. In turn, each Objective was analyzed to develop Lessons that would achieve the Objective. Each Lesson environment offers a Lesson Guide, a Pretest, Topics, a Posttest, and Mastery. Each Topic area has direct access to a suite of Learning Activities related to the Topic, and each Activity offers a variety of Learning Objects available to the student. The website listed above provides more details about Competency Domains.

The current number of students per faculty mentor is set at 150. Mentors meet with students once a week and on an as-needed basis, using the student's preferred communication environment (e.g. Skype). Subject-matter mentors meet in tutorials with a student based on the respective student's need related to specific content. Faculty mentors provide life-, academic-, and career-coaching. Lead faculty and faculty mentors are full-time faculty. Subject matter mentors are part-time faculty members.

Tashiro and colleagues [9] formed two research teams, one from NAU and the second from UOIT. We asked the basic question—"How can simulative environments and new types of assessment engines be integrated with adaptive learning engines to create much more personalized teaching-learning-assessment environments with truly adaptive capacities." We used the **MISSED** research engine to conduct a series of Gedanken experiments on the NAU-PL environments [24, 25]. In this work, we modelled the learning management system for the NAU PL CIT courses as a set of compartments that must articulate within a courses as well as across courses in order to create a coherent and substantive curriculum. Furthermore, we studied the nature of signals received and sent and received by any compartment of the teaching-learning-assessment environment.

Of course, each compartment could be accessed by a student, and so we needed to add data collection processes to each compartment in order to know what a student "did" within a compartment. These initial studies led us to conclude that the dynamic nature of any given compartment, especially temporally and spatially heterogeneous interaction with different students, would be critically important to building truly adaptive educational environments that could adapt to an individual student as he or she worked within a compartment. Finally, we recognized and studied how each compartment opened to a number of Learning Activities associated with a specific Topic of a specific Lesson within a particular Competency Domain. And, such Learning Activities more often than not evoked one or more Learning Objects with which a student could engage (see Figs. 1 and 2).

We studied how to layer monitoring middleware among and within compartments. Such middleware could record an individual student's navigational and engagement decisions as well as time spent in various activities. Using monitoring data coupled to learning assessment outcomes within the simulations, we could map students' learning and competency outcomes against expectations delineated by panels of content and skills experts [26–31]. To provide a better context for such middleware, please examine the diagrammatic representation of the **MISSED** research platform provided in Fig. 7. Images show preliminary studies that we conducted with Canadian health sciences students. Two patents (now pending; references [24, 25]) resulted from this work. Figure 7 diagrammatically shows the interconnected software engines that monitor educational activities as follows:

1. A student works within the online components of a hybrid course, and engages within a competency domain's objectives, respective modules, interaction clusters of learning activities and associated Learning Objects—all their work is within a Web-based interface, designed as a personalized Inclusive-Adaptive System that assesses a student's accessibility needs and preferences for a personalized educational environment.
2. The Inclusive-Adaptive Interface collects data on the student's needs and preferences, creating a Student Profile database that becomes part of an Electronic Learning Record.
3. The Student Profile data stream to a MatchMaker system that selects an Instructional Deign Template (IDT) based on a theory of cognition and behavioral change selected by a faculty member and consistent with the course content, but informed by the student's needs and preferences.
4. The MatchMaker engine then reads the metadata from the template.
5. The Assembler Engine reads the IDT and metadata brought to it by MatchMaker, searches Learning Object Repositories to find and collate learning activities, resources, educational scaffolding, learning assessments, and feedback personalized for the learner, and then organizes the assemblage to create a Web-based personalized teaching-learning-assessment-diagnostic Educational Environment.
6. Students engage within the Educational Environment (and for some types of hybrid classes also engage in face-to-face settings, such as faculty mentoring, live skills labs, low-fidelity or high-fidelity simulations related to computer information technology).

7. Within the Web-based Educational Environments, each student is constantly monitored by middleware called PathFinder that follows choices made within the Educational Environments and also times a student's engagement in learning activities, resources, assessments, and using diagnostic feedback [23–29].
8. Within the face-to-face environments in some course types (e.g., live skills lab), a student is monitored during learning-demonstration activities, using a video-capture and analysis system called MAXIT EDUCATION [25] that efficiently collects assessment data on students' performance competencies.
9. Prior to, simultaneously with, or after learning-demonstration activities, students enter an assessment engine called eXAM^3 [21] which assesses their learning outcomes within a cognitive taxonomy selected by the faculty member (e.g., Bloom's Revised Taxonomy or a rubric for a CIT Competency Domain or a cognitive taxonomy consistent with a particular cognitive theory).
10. PathFinder, MAXIT EDUCATION, and eXAM^3 stream a student's data to a data analysis and knowledge system called DATUMM.
11. DATUMM, in turn, analyzes the data, creates new information about the student, and sends this information back to the Student Profile. These new information sets are integrated into the Student Profile, with revised data and information facilitating adaptive changes to the flow beginning with the MatchMaker and ending in new configurations of the Educational Environment. Importantly, data from the Student Profile also stream into a subcomponent—the Electronic Learning Record, through time creating a longitudinal record of a student's progress.

Research with the **MISSED** research platform led us to conclude that we could collect data on students' conceptual and performance competencies and thereby create a very detailed Electronic Learning Record (ELR). The ELR also can be constructed to receive data and information from multiple courses, and so create a much more detailed and informative multidimensional student transcript.

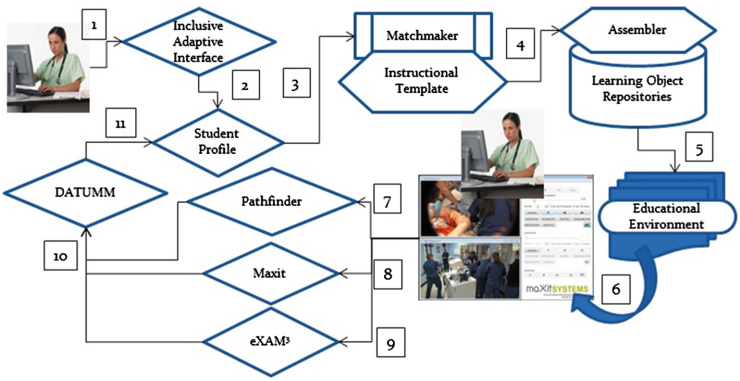

Fig. 7. Diagrammatic representation of the MISSED environment piloted in research on health sciences education.

5 Summary and Conclusion

In summary, systems like MISSED AIM, and eXAM^3 offer a way to study students' development of misconceptions and then to remediate such misconceptions. Our work provided substantial evidence for the efficacy of not reinventing the wheel, but layering into extant learning management systems some adaptive capacities that have a strong research base for bridging the ten knowledge gaps we have identified. Such bridging will lead to authentic assessment of students learning outcomes. However, a key point is that learning management systems and instructional design should be based on grounded theory, but currently there is no consensus theory of cognition and learning. The lack of consensus suggests the need for large-scale cross-thery comparisons of cognition-learning models. Learning management systems, adaptive learning environments and associated instructional materials offered by academic publishers still have many weaknesses. Tashiro [32] critiqued some of the ethical problem both publishers and faculty create when they do not use evidenced-based materials and methods in creating the teaching-learning-assessment-feedback environments used in courses and curricula. Why, for example, have educators not demanded the analogues of clinical trial research for instructional methods and materials? Indeed, a very interesting absence in research is cross-theory testing of models of cognition and learning. We could start there.

What would we need? We would need flexible but powerful systems like MISSED, AIM and eXAM^3 that had the capacities allowing researchers to choose a theory of cognition and learning. For a particular theory, the teaching-learning-assessment-feedback environment must be assembled so that such an environment was consistent with the theory selected. Learning activities with their embedded learning objects, respective learning assessments, and associated diagnostic feedback and educational scaffolding would all be dictated by the grounded theory selected. As with any other learning management system, we would load learning activities, learning objects, assessments, and diagnostics feedback and scaffolding into database repositories. Systems like MISSED and other truly adaptive learning environments simply have more flexibility in types of repositories that would be called into the dynamic formation of a teaching-learning-assessment environment consonant with a particular theoretical framework. In the decade of "big data" analytics, we are poised to step towards educational research and praxis that is evidence-based and as predictive as the best clinical care in the world.

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Applying Social Enterprise Concept: Exploratory Study at Bangkok Metropolitan Administration Schools

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Abstract. The study focuses on examining the opportunity to apply the concept of social enterprise to strengthen teaching and learning for the upper secondary school level. This is part of the ongoing reforms in education that need to increase the level of flexibility and external participation when deploying the national curriculum, especially mathematics and sciences (http://www.unesco.org/fileadmin/MULTIMEDIA/INSTITUTES/UIL/confintea/pdf/National_Reports/Asia%20-%20Pacific/Thailand.pdf (as of March 4, 2015).). Altogether, a total of nine upper secondary schools in Bangkok Metropolitan Administration (BMA) were visited and examined. Overall findings on the visits are described. Then, possibility of adapting the social enterprise concept to help extend from project-based learning is discussed.

Keywords: Social enterprise · Project-based learning

1 Problem Background

Offering health and human services has often been complex within the public sector. Education is considered to be an integral part which is critical for economic and social development of a country. When discussing the term education as public service, there is a need to begin with a curriculum, school administration, lesson plan, classroom teaching and learning, assessment and evaluation, and counselling. It is also critical that student achievement, skills and expertise (for the 21st Century), and continuation of higher education be considered (Junpeng, 2012).

In Thailand, the national curriculum is developed by Ministry of Education while the implementation belongs to Ministry of Education, Ministry of Interior (which oversees local governments), private schools, and teacher training schools (which belong to various public universities). See Appendix A for Thailand's education structure. Health and human services have included public health, early childhood

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education, primary/secondary education, higher education, life-long learning and life skills, recreational services such as public parks and library[1].

It is important to note, due to the decentralization of key health and human services which began in late 1980 s, local governments have started to provide the services to match with the needs of its constituents (Kotkam, 2000). This policy aims to ensure more accountability and responsiveness to local needs. Local governments, including two special administrative zones- Bangkok Metropolitan Administration or BMA, and Pattaya City Administration or PCA, have focused on life-long learning which essentially cover all aspects of education[2].

The gap that has been cited when dealing with education includes two areas: (1) design and implementation of the curriculum, and (2) aim and attained results of learners or students (Hallinger and Bryant, 2013). For the first gap, the curriculum design focuses on fundamental skills and essential knowledge that the learners should exhibit at the various levels. Then, the providers (i.e.., schools belonging to different sectors and agencies) will implement the curriculum by providing the lesson plan, conducting teaching and learning, and assessing and evaluating the learners. The second gap focuses on the results which have shown whether students have achieved or attained the results as planned (or aimed). See Fig. 1 for the approach used to summarize the gap in Thailand's education- primary and secondary levels. Also, see Table 1 on the test results.

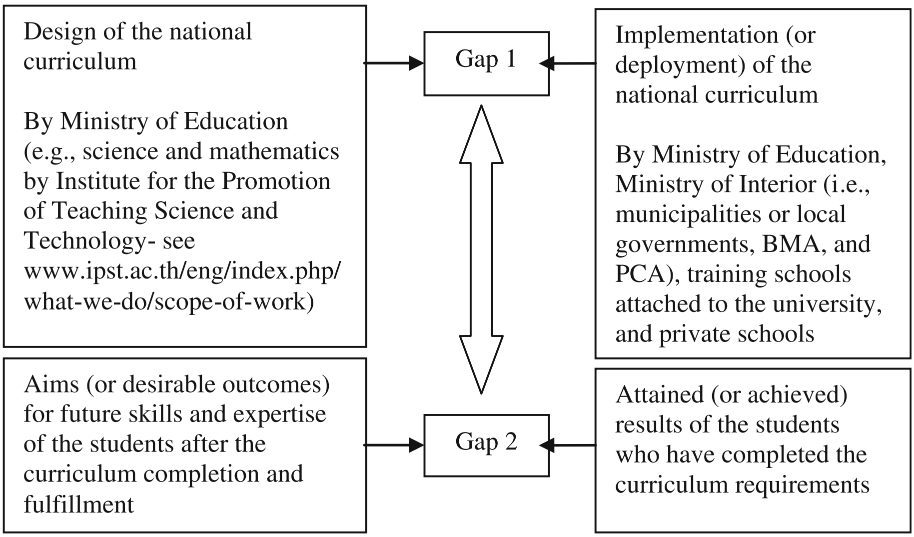

Fig. 1. Gap analysis within the Thai context

[1] See http://www.unesco.org/fileadmin/MULTIMEDIA/INSTITUTES/UIL/confintea/pdf/National_Reports/Asia%20-%20Pacific/Thailand.pdf (as of March 4, 2015).

[2] See www.bangkok.go.th/main/page.php?269-Education (as of March 10, 2015).

Table 1 Gap on the attained results

Group	Primary Level		Secondary Level	
	Math	Science	Math	Science
Ministry of Education	446	456	440	464
Private schools	487	509	419	441
BMA schools	502	522	433	457
Municipality schools (or other local governments)	476	495	424	450
SATIT schools (university teacher training schools)	540	562	554	552

Note:
1. The scores are based on TIMSS (Trends in International Mathematics and Science Study).
2. SATIT is denoted for the teacher training schools attached to the university's Faculty of Education.

The gap between the aim and attained results points to the possibility of allowing more flexibility in the curriculum implementation. This flexibility is based on the following presumptions.

- There is a need to allow private and people sectors to involve more in the curriculum implementation.
- National-based curriculum tends to focus on the continuation into higher (university) education which may not be relevant to the students with poorer background. They likely attend the schools under the jurisdiction of Ministry of Interior.
- The possibility of all schools having the similar level of classroom and laboratory readiness as well as qualified teachers is practically none.

The concept of social enterprise has been widely practiced in Thailand, especially the schools located in the rural areas[3]. In Thailand, the opportunity to adapt social enterprise depends on the empowerment of high school students who eventually will become future entpreneurs. According to Thai Social Enterprise Office (www.tseo.or.th/about/social-enterprise/means), the term social enterprise implies an organized effort in terms of an enterprise that uses commercial strategies to maximize improvements in human, community, and environmental well-being, instead of financial returns or gains. Not only in Thailand, this concept has gained more recognition in Asia and Europe which lead to new developments in the area of social innovation and social public-private partnership (Gibson and Davies, 2008, and Defourny and Kim, 2011).

Because of the poor family background and the inability for many schools (including those belonging to Ministry of Interior and locating in the country's rural areas), learning science and mathematics at the upper secondary level can be a challenge[4]. This challenge stems from a lack of proper classroom and laboratory, a lack of budget, a lack of qualified teachers in specialized subjects (e.g., physics, chemistry, biology, etc.). Learning by listening and observing has also hinders the development of

[3] See www.asef.org/images/docs/Session%201.3_Nuttaphong%20Jaruwannaphong%20(Thailand).pdf as of March 2, 2015.

[4] See www.journeys-way.org/social-enterprise-and-community-development/ as of March 4, 2015.

many needed skills for the 21st century and the innovativeness and creativity among students. Motivation appears to be another major problem facing senior high school students who choose not to attend the university. It is important to recognize that generation Z students tend to be more independent and connected to surrounding communities, and should be recognized for this potential (Mok and Welch, 2003). Apparently, the curriculums today at the school or university levels have not been revised to correspond to this trend.

2 Objectives

The study aims to explore the opportunity and potential to adapt the social enterprise for the BMA schools. Presently, BMA is managing 438 schools with over 360,000 students and 15,000 teachers. Note that there are also many schools in Bangkok which are under the jurisdiction of Ministry of Education. The study primarily focuses on the upper secondary level as the students are familiarized with project-based learning or PBL.

3 Methodology

The approach for this study focuses on the school visits, the interviews with school directors and subject teachers, and the assessment on teaching methods and lesson plan (which can be the foundation for social enterprise's application). With the arrangement from BMA's Department of Education, the visits cover a total of 9 upper secondary level schools. The study visits are also conducted together with teacher supervisors from BMA's Department of Education.

4 Findings

The findings from the visits to 9 upper secondary schools can be summarized as follows. These findings are grouped into the key areas which are essential for the application of the social enterprise concept. See Appendix

Teaching methods and pedagogical approaches:

- Some teachers have shown self-initiative in developing and implementing pedagogical approaches and tools. The teachers have realised that they need to implement a "hands-on" approach and let the students take part in the experiments. Observation is not enough. Experimental learning and project-based learning have been implemented and tried with varying levels of success. Using small groups and a shift towards a student centred approach (flipped classroom) have also been highlighted by the majority of teachers.
- Mathematical tools have been developed by one teacher using different colours to help students differentiate between multiplying, subtracting, addition and subtraction. In other cases, the teachers have also been designing their own tools, and books and placing greater emphasis on group work and student participation.

- Many teachers are willing to try new approaches they just don't know how to go about it. The lack of English skills is also an issue, can they read about and update their teaching methods, or can they use e.g. "youtube" to search for different ways to make their classes different and more interesting for students. Another problem lies with a lack of available equipment/tools. Teachers in some cases have the knowledge and the will to transfer that knowledge, but the lack of, and number of tools available means that this is not always possible.

Taking learning outside the classroom:

- Local community and BMA facilities have been used by some schools. A local "butterfly" park belonging to the BMA has been used to develop a survey, facilitated by the teacher, with students split into groups and using their mobile phones to take pictures. The results of this survey have been documented using ICT, thus combining a number of skills. Other similar "field trips" have been taken using for example, the local Mall to show students how Math can be observed in a "real world" setting, and other teachers have been using the school buildings and grounds as PBL exercises, with students having to develop tools to measure heights, angles, etc. Other schools have been using BMA museums for field trips and taking the learning out of the classroom. Initial steps have been taken to combine and conduct field-trips that combine different subject areas, e.g. Math/Biology.
- One of the key discoveries is the lack of knowledge on how to use pedagogical approaches and combine subject matters with some schools and teachers. Many teachers also have no idea how to use the resources around them. There are canals, lakes, gardens and rice farms surrounding some schools, but the teachers do not have the necessary skills or support from principles to make use of these for a number of subjects.

Community involvement:

- There are a number of very impressive projects and products being produced at BMA upper secondary schools. One of the most impressive findings is the project where students found some polluted land, measured the pollution levels, and with the help and support of the local community cleaned up the canal and the land, and started growing their own flowers. These flowers were sold at the local market and the profits were invested back into the land, where other crops such as rice and corn are now being grown.
- There were also a number of other projects where students had developed organic product that were more environmentally friendly and just as good as chemically produced ones. Dish washing liquids, mosquito repellent, skin lotions and filters to remove fat and other impurities from waste water are the examples of the products based on PBL. Many of these projects were done collaborating with other groups as well as with the local community, students have got their parents involved so these projects result in a sense of pride for not just one student, but the whole community. These types of projects are teaching the children practical lessons on science, math, entrepreneurship, collaboration and also environmental issues. As the science teacher remarked "pollution is not a problem, it's an opportunity."

Lesson plans

- Some schools have also been using teachers from higher levels to help teachers at lower levels develop lesson plans to ensure that the skills needed by students at these higher levels have been taught. Some schools have also experimented with using more than one teacher for larger classes
- Teachers from different subjects have been collaborating in order to coordinate and develop lesson plans that work in conjunction with each other, integrating themes and content. This enables the students to relate to a single theme on a number of levels.
- Despite the attempt to work together, many teachers are teaching subjects that they are not qualified to teach and are not familiar with, so again it's easier to go through the motions and follow the curriculum and book.

In service training and teacher support

- This is the area that needs to be addressed in order to ensure the continuous success in the use of experimental learning and the PBL. Blending younger teachers with the group of elders who have worked with the students is needed. There seems to be frustration amongst some teachers, as they don't seem to think that there is anywhere to turn to if they are having problems or need help or support.
- One teacher has made efforts to provide a "support network" for other teachers using Facebook, where teachers can offer each other support and learn from one another. He has over 1000 followers already, but again it's too much work, and responsibility for one teacher, along with all their other duties.

Assessment and evaluation:

- Steps have been taken in some schools to improve how both teachers and students are assessed, but maybe the approaches could be improved. It's great that steps have been taken in order to improve the current practices. In many schools students are assessed mainly on academic achievement, with the individual class teachers being responsible for this assessment.
- Joint assessment and evaluation for PBL remain the challenge since the collaborative culture is still developing. This collaboration depends on the support from school directors. Then, a further challenge is to counsel the students about important skills to sustain the results based on the PBL. The shortcoming of current school counselling seems to take the form of career guidance. A few schools have a very high turnover rate for councillors. This is probably due to it's a very demanding and sensitive job. The parents of the students often work for the daily wages so parental support is likely limited.

5 Discussion and Conclusions

For the PBL, the vast majority of products and initiatives developed were focused on being organic and environmentally friendly, using local resources and involving the local community. Many of these projects were conducted with the emphasis on collaborating with other groups as well as with the local community. Students have got their parents involved, so engaging in these types of projects, has resulted in students gaining practical experience in twenty first century skills, while simultaneously generating a sense of social responsibility not only for the student, but also for the whole community.

Trilling and Fadel (2009) point out that "one of education's chief roles is to prepare future workers and citizens to deal with the challenges of their times……. To be a productive contributor to society in our 21st century, you need to be able to quickly learn the core content of a field of knowledge while also mastering a broad portfolio of essential learning, innovation, technology, and career skills needed for work and life." Learning this core content and actively engaging students to actively learn these skills, both inside, and outside the classroom, is the key challenge facing education in Thailand.

Strictly adhering to the curriculum has based on my observations not tackled the problems of providing these skills to students, especially those from poorer backgrounds. Social enterprise initiatives and community based projects, are however teaching children practical lessons on science, math, entrepreneurship, collaboration and also environmental issues, thus providing them with many of the skills associated with being a productive contributor to the society.

The current strictly adhered to curriculum is skewed to focus on students that have the means and the ability to continue onto higher education. More practical skills needed by the majority of students to become active, and productive members of society are often neglected, as they are not the goal of the curriculum. A number of BMA schools have produced quite impressive environmental projects and handicrafts, but there is a gap in knowledge that could and should be filled by local companies via public private partnerships (PPP's), who have the necessary expertise, as teachers and students mainly lack the necessary knowledge and expertise to expand or push these projects further, benefitting both students, schools, communities and enterprises, while having an important impact on human and workforce development both the short, and long term.

Use of social enterprise is not new in Thailand. Several initiatives from the Royal Family are considered as part of social enterprise through social innovation. For instance, the brand Doi Tung by the Mae Fah Luang Foundation[5] is globally recognized. Instead of focusing on the adults, social enterprise is viewed as an alternative in providing needed education for the students who are from poor background and do not intend to enroll in higher education institutes. From the study visits, it shows that the key areas to help initiate this social enterprise concept are in place, especially the use of PBL as part of classroom teaching and learning. The discussion of the findings with the experts from the healthcare sector (which has adapted the concept to help the community better utilize local materials for basic medicines, including natural insect repellent) also helps ensure this possibility.

[5] See www.doitung.org/home.php?lang=en as of March 11, 2015.

Appendix A

Thailand's Educational Structure

<table>
<tr><th>Aprox. age</th><th>Aprox. grade</th><th colspan="2">Education Level</th><th colspan="2">Degree</th></tr>
<tr><td>24</td><td>19+</td><td colspan="2">Doctoral degree study</td><td colspan="2">Ph.D. or advanced professional degree</td></tr>
<tr><td>23
22</td><td>18
17</td><td colspan="2">Master's degree study</td><td colspan="2">Master's degree</td></tr>
<tr><td>21
20</td><td>16
15</td><td rowspan="2">Undergraduate program</td><td rowspan="2">Higher vocational education</td><td colspan="2">Bachelor's degree</td></tr>
<tr><td>19
18</td><td>14
13</td><td colspan="2">Diploma</td></tr>
<tr><td>17
16
15</td><td>12
11
10</td><td>Upper secondary education</td><td>Vocational secondary school</td><td rowspan="3">Basic Education</td><td></td></tr>
<tr><td>14
13
12</td><td>9
8
7</td><td colspan="2">Lower secondary education</td><td rowspan="2">Compulsory education</td></tr>
<tr><td>11
10
9
8
7
6</td><td>6
5
4
3
2
1</td><td colspan="2">Primary education</td></tr>
<tr><td>5
4
3</td><td></td><td colspan="2">Pre-primary education</td><td></td><td></td></tr>
</table>

Source: Office of the Basic Education Commission, Ministry of Education

Appendix B

Potential PBL for Future Social Enterprise Applications


วิชูทิศเบเกอรี่
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Wichutit Bakery

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Connecting Dots for Ubiquitous Learning Analytics

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Abstract. A Ubiquitous Learning Log (ULL) is defined as a digital record of what a learner has learned in daily life using ubiquitous computing technologies. It allows learners to log their learning experiences with photos, audios, videos, locations, RFID tag and sensor data, and to share and reuse ULL with others. The number of ULLs will keep increasing as the learners keep learning. The sheer volume of ULLs will be accumulated in the ubiquitous learning system called SCROLL. It creates a necessity to analyze the ubiquitous learning logs to provide learners with appropriate learning logs in accordance with their learning abilities, context, time and location. However, researchers on analysis and visualization on ubiquitous learning is very few, and there are not yet previous works that visualize relationships among learning logs on spatial and temporal dimensions. Therefore, this paper introduces the overview of SCROLL, and then describes an innovative visualization system which integrates network visualization technologies and time-map in order to visualize the ubiquitous learning logs accumulated in the SCROLL.

1 Introduction

In past decade, many researchers in the educational engineering area have been studying focusing on ubiquitous theme. For example, CSUL (Computer Supported Ubiquitous Learning) or context aware ubiquitous learning (u-learning) have been constructed using computing technologies such as mobile devices, QR-code, RFID tag and wireless sensor networks [10, 13]. CSUL takes place in a variety of learning spaces, e.g. classroom, home and museum. Also, it provides the right information using the contextual data like location, surrounding objects and temperature.

There are such language learning and learning of nature science on application domains of CSUL. For example, Hwang et al. [14] reported about their ubiquitous learning system that students can study butterfly ecology, using PDA (Personal Digital Assist) at an elementary school nature science course in Taiwan. In their developed system, the learners can developed a concept map based on what they have learned from text book. Also, they can revise and review their concept map using PDA in the field.

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DOI: 10.1007/978-3-319-20621-9_4

On the other hand, Ogata et al. [11] reported about their ubiquitous learning system called SCROLL (System for Capturing and Reminding of Learning Log) that allows learners to log their learning experiences with photos, audios, videos, location, QR-code, RFID tag, and sensor data and so on, and reuse them with others. The goals of SCROLL are lying in helping users to easily record their learning experiences and recall them via the context, recommending other learners' learning experiences for them, finding out individuals' learning habits and supporting their learning accordance with personal learning habits.

These learning dataset in the ubiquitous learning system include spatiotemporal data. Spatiotemporal data usually contain the states of an object, an event or a position in space over a period of time. In the spatiotemporal data mining, they explored many challenges in representing, processing, analyzing and mining of dataset in spite of complex structures of spatiotemporal objects and the relationships among them [3–5].

Similarly, many issues have been raised about relationships between the learners and the ubiquitous learning logs in SCROLL. Their challenge is significant because it is important for learners to recognize what and how they have learned by analyzing and visualizing, so that they can improve their way of learning [13]. Mouri et al. [8, 9] proposed an innovative visualization system which integrates network visualization technologies and time-map in order to visualize complex relationships among them. Consequently, their system succeeded to reveal relationships between the learners and ubiquitous learning logs.

2 Related Works

2.1 Mobile CSCL and Context-Aware Ubiquitous Learning

Researches on the educational designs to enhance communication skills and to increase learning opportunities with mobile technologies are among the most popular topics in the researches on mCSCL (mobile Computer Supported Collaborative Learning). Consequently, it is expected facilitating their interactions and feedbacks among students or teacher and students.

For example, Gustavo et al. [2] constructed a mobile learning environment based on the theory of constructivist education, and succeeded to maintain students' motivation and making students increase active social interactions. In their experiment they assigned 7-year-olds with the tasks to learn alphabets and syllables in the group learning style. They compared the two learning modes: Syllable-mCSCL (collaborative learning using mobile device) and Syllable-CL (without mobile device). More social interactions among the participants were observed in Syllable-mCSCL mode, while, lack of the motivation and interest was observed in Syllable-CL mode, which were regarded to be serious problem in learning process.

Similarly, Wong et al. [16] reported a collaborative learning aimed to form Chinese character component based on mCSCL. The objective of their study is to reinforce rules of orthography to students. They found awareness patterns of orthography among students' social interactions. However, in these mCSCL studies, the researchers did not take into consideration the methods for visualizing the linking relationships between location and time.

Researchers on context-aware ubiquitous learning, on the other hand, have been constructing ubiquitous learning environments where we can study anywhere and anytime. They integrated knowledge and location information by using cutting-edge technologies such as RFID-tag, QR-code, NFC-tag and GPS.

For example, Hwang et al. [13] attempted to guide their learners towards the optimal learning path by using mobile device and the RFID-tag attached to plants. If students arrived at the target plant by using their system, the system will give some questions to the learner. For example, if students do not know the plant name, the system will ask the plant features (shapes, color, trunk and so on). By answering them in accordance with the questions, the system will present hints or candidate items of the plant. Consequently, students succeeded to deepen their knowledge of plants..

In contrast, Li et al. [6] accumulated all the location information to the database on the server by using GPS sensor. The accumulated data to the database include not only the data collected in one evaluation experiment but also those collected by a number of the research studies for a long period of the SCROLL project (2011 $\sim$ 2014) [12]. At the present stage, there are not enough researches on visualization of relationships among knowledge, location and time from a large amount of raw ubiquitous learning logs. As one of the reasons, it has been pointed out that it is difficult for most mobile learning systems to accumulate learning logs for a long period.

To tackle these issues, this paper describes innovative visualization methods in order to reveal them. It allows us to reveal not only the relationships among knowledge obtained by learners but also the relationships between knowledge and locations, and knowledge and time by using visualizing relationships among ubiquitous learning logs in SCROLL.

2.2 Learning Analytics

In recent years, with the spreads of LMS (Learning Management System) and CMS (Course Management System), Learning Analytics (LA) analyzing various evidences in the education and learning has been drawing an attention [15]. It is expected enhancing the quality of education by detecting effective and efficient learning information because these histories are reflecting on learners' activities.

To date, LMS and LMS enabled us to record learners' access logs onto server. The LA aims for practical use based on learning mechanisms revealed by visualizing, mining and analyzing vast amount of learning data. This paper focuses on the SLA (Social Learning Analytics), a subset of the LAK (Learning Analytics and Knowledge) [1]. The SLA puts forward presenting appropriate information to learners at the appropriate timing through the dashboard in real time.

Therefore, this paper aims to reveal about relationships between learners and ubiquitous learning logs on spatiotemporal fields. It is expected to contribute to educational improvement and strategies below;

(1) This study facilitates the analysis of learners by visualizing all data on spatiotemporal.

This study enables future prediction about learners and learning environment from visualized learning logs.

3 SCROLL

3.1 Design

In order to support such formal note taking and reminding, we designed and implemented our ubiquitous learning system called SCROLL. One of the objectives of SCROLL is to support international students in Japan to learn Japanese language from what they have learned formal and informal setting. It adopts an approach of sharing user created contents among users and is constructed based on a LORE (Log-Organize-Recall-Evaluate) model [11].

In the "Log" process, when learners face problems in daily life, they may learn some knowledge by themselves, or ask others for help. The system records what s/he learned during this process as a ULL. In the "Organize" process, when a learner tries to add a ULL, the system compares it with other ULL, categorizes it and shows similar ULL if they exist. By matching similar objects, the knowledge structure can be regulated and organized. In the "Recall" process, the learner may forget what s/he has learned before, Rehearsal and practice in the same context or others in idle moments can help the learner to recall past ULL and to shift them from short-term memory to long-term one. Therefore, the system assigns some quizzes and reminds the learner of her/his past ULL. In the "Evaluate" process, it is important to recognize what and how s/he has learned by analyzing the past ULL, so that the learner can improve what and how to learn in future. Therefore, the system refines and adapts the organization of the ULL based on the learner's evaluation and reflection. All the above learning processes can be supported by SCROLL.

3.2 System Interface and the Learning Scenario

SCROLL mainly focuses on language learning field. One of typical scenario of its use is to assist international students to study Japanese in Japan. In this case, Japanese language learners, who face rich learning contexts every day, can gain much knowledge from their daily lives in different kinds of situations, such as shopping in the market, seeing a doctor in the hospital, having a haircut in a barbershop, visiting the museum and so on.

The learners can record those situations and their experiences as ULL with a photo using desktop PC or mobile device and SCROLL as shown in Fig. 1.

Learners can reflect what they have learned using this interface anytime and anywhere. The learning log includes author name, language, created time, location (latitude and longitude), learning place and tag. The system will categorize automatically created time and learning place to each attribute. For example, if a learner learned an envelope at the Fukuoka post office (Fukuoka is the name of a prefecture in Japan), the system will add automatically "Post office" of the attribute name to database.

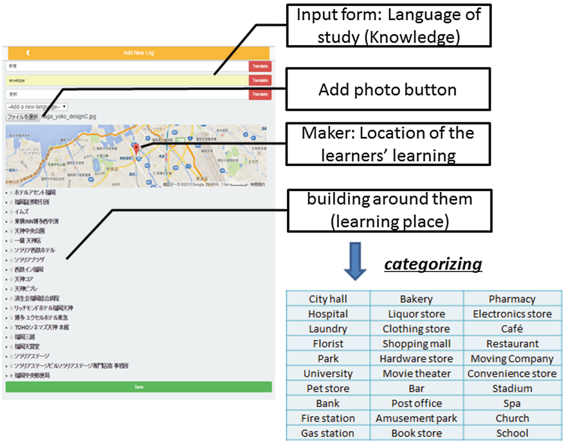


Fig. 1. Adding a ubiquitous learning log

The learners can review past ULL by using quiz function as shown in Fig. 2. There are three types of quizzes generated automatically by the system, which are yes/no quiz, text multiple-choice quiz and image multiple-choice quiz. Figure 2 shows an image multiple-choice quiz interface generated automatically based on the meta-data of ubiquitous learning logs.

The learner learns an envelope at the post office and he saves the knowledge as learning log on SCROLL server. After that, there are cases for the quiz function to handle with the learning log [6]:

(1) Recall via context: When the learner enters the post office again, the system will provide him with reminder quizzes in order to support him recall the envelope.
(2) Study when you prefer: If the system finds that the learner has a learning habit that he usually studies at home in the evening. If the system detects that it is evening and the learner is at home, the system will prompt him to review what he learned.
(3) Learn from other: If another learner enters the post office and she has the same language ability with the previous learner, the system will recommend the learning log about the envelope for her.

Learning Log Dashboard (L2D) in SCROLL shows these quiz histories and their learning logs histories. L2D is to enable learners to reflect on their own activities and to reinforce what they have learned [7]. L2D focuses on statistical data on every learner's usage of the system. L2D shows the number of learning logs that a learner uploaded and the number of completed quizzes, as well as memorized learning logs and incorrect answer of the quizzes. It is easy to grasp incorrect answers on a word and to control in the dashboard.

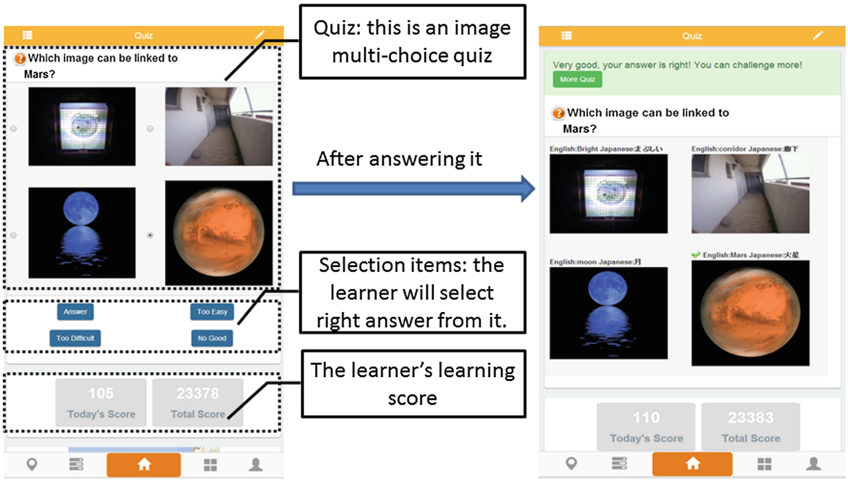


Fig. 2. Quiz interface

In order to reveal relationships between learners and ubiquitous learning logs, the visualization and analysis engine is implemented. In the next Sect. 4, this paper will introduce visualization system for analyzing ubiquitous learning logs.

4 Visualization System for Analyzing Ubiquitous Learning Logs

4.1 Structure Based on Network Graph in SCROLL

To visualize and analyze several relationships between the learners and the ubiquitous learning logs, we have uniquely defined them as three-layers structures as shown in Fig. 3.

The upper layer contains each author in order to confirm position of own or other learners. For example, if a learner learned various ubiquitous learning logs on SCROLL, there is a possibility that other learners had already learned it. Therefore, when the learner learned them, they can grasp other learners' status with past learning experiences. That is, they can know "who should we ask the knowledge".

The intermediate layer contains the knowledge that learners learned. Also, some fields of learning tasks can be included in this layer. For example, some task-based learning in ubiquitous learning environment can be carried out using knowledge and event. The scalability of the layers can be enhanced and the field of visualization can be widened by linking one's own learning logs to the knowledge learned by doing tasks.

The lowest layer contains data such as location and time. The layer allows the learners to grasp when and where they have learned by revealing place and time.

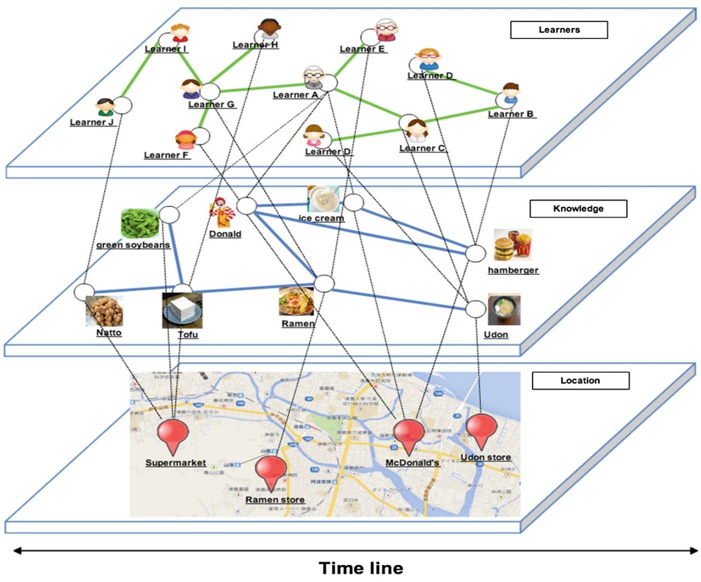


Fig. 3. Three-layer structure in SCROLL

Analysis by categorizing three-layers has following advantages:

(1) Places with a large number of links to the related knowledge are the places where they can learn a lot of knowledge. For example, if a certain supermarket or convenience is related with a lot of knowledge such as natto (a traditional Japanese food made from fermented soybeans), green soy beans, tofu, miso soup, and cup noodle, by analyzing relationships between the knowledge and the location. The System can provide learners with a valuable learning information.

(2) Knowledge which is related to many places is the knowledge which we can learn in various places. For example, if a learner experience tea ceremony of a traditional Japanese culture at the university in Japan, a set of tea ceremony related knowledge (e.g. tea, seize: to sit in the correct manner on a Japanese tatami mat) can be learned in other various places. The tea can be learned by purchasing at the supermarket and the constellation (seiza in Japanese) can be learned at the martial art gym.

4.2 The Layout Types of the Network Graph and the Color of Visualized Nodes

The layout consists of using the original layout we have developed as shown in Fig. 4. The original layout will be categorized four areas. The knowledge centered on collocational network is shown in time-series order what they have learned. Similarly, the spatial collocational network is visualized the place linking each other, and the temporal collocational network is visualized the time linking each other.

The learners might get confused when they recognize past learning logs because there might be too many of visualized nodes. Therefore, it is definitely necessary to establish some criteria for distinction of each node. To effectively distinguish kind of each node, we defined as below using node color (Table 1).

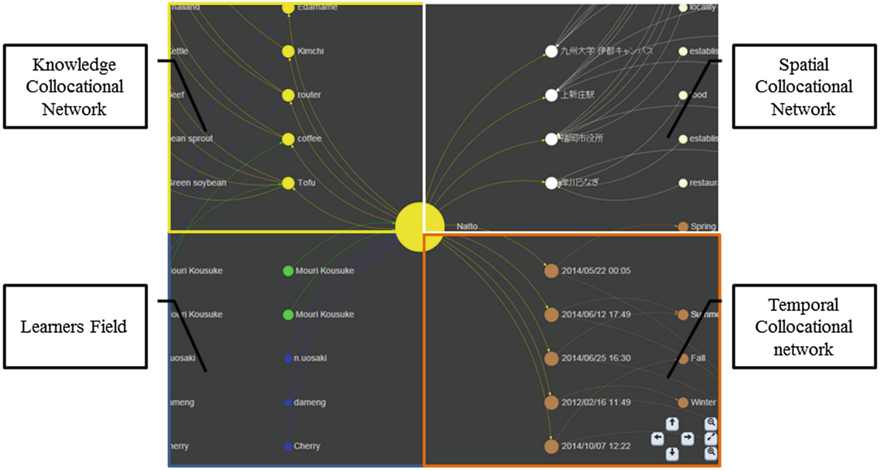


Fig. 4. Original layout

(1) Pink color node shows the learner's own name on the upper layer. If connecting the pink node to yellow node on the intermediate layer, edge color will be decided as pink so that they can be easily recognized as the learner's own logs.
(2) Blue color node shows the names of other learners on the upper layer. If connecting the blue node to yellow color node on the intermediate layer, edge color is decided blue color.
(3) Green color node shows the names of veteran or famous learner on the upper layer. Ig connecting the yellow node to the green node on the intermediate layer, edge color will be decided as green color.
(4) Yellow color node shows both the learner own knowledge and the knowledge of other learners. For example, the learner can recognize his own knowledge because edge between the learner own name on the upper layer and the knowledge on the intermediate layer is pink color. In addition, the learner might discover knowledge of other learners related to own knowledge.
(5) White color node shows the location of the learners on the lowest layer. The node includes latitude, longitude, building names and the attributes.

4.3 Visualization Interface Combining Network Graph and Time-Map

Time-map is a library of javascript, which collaborated with Google map and SIMILE (Semantic Interoperability of Metadata and Information in unLike Environments)

Table 1. Color to distinguish the kind of nodes

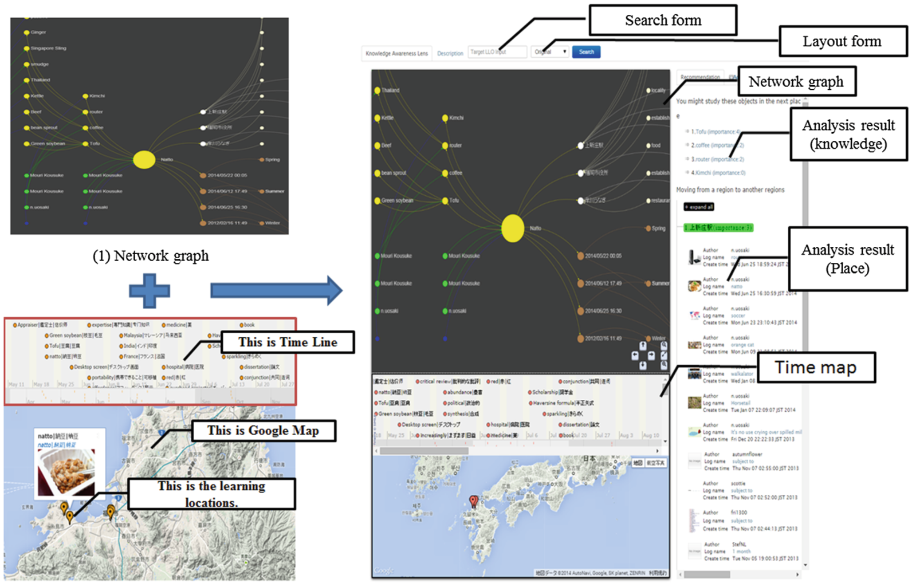
Node	Layer	Node color
Learner's own name	Upper layer	Pink
Named of other learners	Upper layer	Blue
Veteran or famous learners	Upper layer	Green
Knowledge of learners	Intermediate layer	Yellow
Location of learners	Lowest layer	White
Created time of the knowledge	Lowest layer	Brown

TimeLine. SIMILE focuses on developing robust, open source tools that empower users to access, manage, visualize and reuse digital assets. The time-map function means that the user can scroll the timeline and then the Google map will display the learning logs recorded during learners' selected period. It is designed to help learners to reflect what they have learned.

For example, if a learner clicks his learning logs on timeline, Google map will display their positions as shown in Fig. 5(2). After visualizing log information, Time-map will facilitate learners to reflect on their logs with spatial and temporal information. They are able to grasp their learning context and time zone. Also, it is a possibility that the geographic information is a clue of recalling what they have learned.

In this paper, the interface combining network graph as shown in Fig. 5(1) and Time-map as shown in Fig. 5(2) for visualizing relationships between the learners and ubiquitous learning logs is shown Fig. 5(3). It consists of the following component:

(1) Search form: This input form is used to search target word (e.g. 'natto' and 'tofu') on the all networks of SCROLL.
(2) Layout form: The learners will choose one layout in this select form (e.g. Random layout, Force-directed layout, Yifan multilevel layout and original layout).
(3) Network graph: The network graph shows the layout calculated by the system, and the layout in Fig. 5(3) shows a sample of the original layout. Also, the network graph and time map function are linked each other. For example, if a learner clicked a certain node on the network graph, the time map will show the location and time corresponding to it. Therefore, learners can obtain its location and time information.
(4) Time map: Time map function consists of the timeline and Google map. It represents the shift of learning history in accordance with lapse of time. Learners might forget their learning logs when and where they have learned before. Therefore, the system will remind them of their learning logs recorded during the specified period of time by showing them on the timeline (default: two month before and after the setting time). Besides, the system will lead them to be aware of knowledge recorded right before or after the knowledge of their interest which was recorded by other learners. Therefore, it will give them a clue on what to learn in the next learning step.
(5) Analysis results (Knowledge): The analysis by knowledge is shown as a trend ranking in order to expand their learning opportunity. By arranging ULLs in the in-degree centrality order, they will know ULLs that they are likely to study in the next step. That way they are able to have more learning opportunity.



(2) Time-map (3) Visualization interface

Fig. 5. Visualization interface

(6) Analysis results (Place): Place analysis is based on locations where they have learned. The place of high importance means the location where there are a lot of opportunities to learn if visiting them. It is analyzed in the same way as in-degree centrality analysis, and the system shows the results to the learners.

5 Conclusion and Future Works

This paper describes ubiquitous learning system called SCROLL, and we introduced an innovative visualization system for analyzing ubiquitous learning logs. SCROLL allows language learners to geo-spatially tag vocabulary words they learn and update them to the system. The number of ULLs will keep increasing as the learners keep learning. By using the visualization system we described, it can be revealed relationships between learners and ubiquitous learning logs. Besides, the system will lead them to be aware of knowledge recorded right before or after the knowledge of their interest which was recorded by other learners, by utilizing network graph with time-map.

As future works, it is necessary to recommend and present past learning logs on the system in accordance with each learner's condition detected from some results such as social analysis, association analysis and decision tree. In addition, it is also necessary to evaluate whether detected analysis results are appropriate or not.

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Experiences in Hybrid Learning

Investigating the Effectiveness of the Uses of Electronic and Paper-Based Dictionaries in Promoting Incidental Word Learning

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Abstract. Although there are a numerous of studies in the facilitative effects of dictionary consultation in promoting word learning, no research has ever been conducted to investigate the effectiveness of a hybrid use of paper-based and electronic dictionaries. The present research, therefore, responds to this call and compares the effectiveness of the pure use of either paper-based or electronic dictionary and the hybrid use of both. The empirical results demonstrate the superiority of the paper-based dictionary over the electronic dictionary, the usefulness of repetition and the greater effectiveness of the hybrid use of both paper-based and electronic dictionary than the pure use of either. We further conclude that the significance of processing for constructing memory, repetition for consolidating memory and diversity for reinforcing memory should be emphasized.

Keywords: Incidental word learning · Repetition · Hybrid usage · Paper-based and electronic dictionaries

1 Introduction

The importance of word knowledge in learning a second language is widely acknowledged in the second language research literature. Word knowledge plays a significant role in communication. It is regarded as an essential item by language learners, and it has close connections with grammatical knowledge [2]. Even though there are times when communication breaks down if learners fail to place words in the proper order, pronounce them accurately, or mark them with proper grammatical morphemes [19], transmission of meaning can generally be achieved. However, the absence of the correct word often impedes the conveyance of a message completely

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[35]. Circumlocution and gestures can compensate to some extent, but they demand too much effort [19]. Knowing the right word is a vital requisite for language communication. As word knowledge is of significance for language learning, research on word learning has been one of the most active areas in SLA research in the past two decades.

2 Related Works

2.1 Incidental and Explicit Word Learning

One theoretical distinction in the literature on word learning studies is that between incidental and intentional learning. Incidental word learning refers to learners acquiring new words from contexts without intending to do so, such as picking up new words during free reading. Intentional word learning, on the other hand, refers to learners acquiring words while intending to do so, such as studying a list of new words or completing activities in a workbook for a set of target words [2]. The main purpose of intentional word learning is to deliberately commit lexical information to memory, whereas the focal attention in incidental word leaning is on something other than learning the language itself. Incidental learning is, to a certain degree, meaning-focused, while intentional learning is language-focused.

In order to distinguish intentional learning from incidental learning, Eysenck [9] proposed that it is necessary to know whether subjects were forewarned about the existence of a subsequent lexical retention test. According to Eysenck, when subjects are aware of the upcoming retention test, they pay more attention to the word meanings and forms so as to memorize them. In this case, knowing the word is an explicit aim rather than a by-product of an activity, hence this kind of learning is intentional. Yet when the subjects are not forewarned about the test, they are unlikely to be motivated to focus on word learning, hence such learning is incidental. However, contradicting this, Keating [13] observed that even though his subjects were informed of upcoming vocabulary posttests, they did not make a conscious effort to commit lexical information to memory. Thus awareness of a subsequent test did not necessarily result in intentional word learning.

In the case of incidental learning, explicit attention on a particular word and its meaning may indeed be induced, but incidental learning does not ensure learners' recognition of the precise meanings of individual words as they may sometimes consider it sufficient to grasp the overall meaning of the message. Thus, while incidental and intentional learning may be a useful theoretical distinction, it does not adequately account for word learning. Hulstijn [11, 12], for instance, has argued that it is the quality and frequency of the information processing activities that determine the retention of new information far more than the question of whether learners are forewarned of upcoming retention tests or whether they process lexical information with or without deliberate intention to commit it to memory.

Schmitt [30] held that two main processes of word learning are incidental learning, which occurs with frequent exposures when attention is focused on the use of language, and explicit learning, which occurs with focused exercises. Explicit learning is facilitative for it promises the greatest chance of information memorization by virtue of direct attention, but it is laborious and has a high demand of focused concentration. Thus explicit learning activities should be complemented by incidental learning activities, with the major emphasis on language use rather than language learning [30].

2.2 Paper-Based Dictionary Consultation

A great deal of controversy exists among the previous studies on the facilitative effects of dictionary consultation on word learning. On the one hand, some researchers believed that using a dictionary while reading led to inefficient learning. They argued that learners using dictionaries spent more time on reading than learners who read without dictionaries. Luppescu and Day [21] found that learners using dictionaries took twice as long to complete reading tasks than learners who were not allowed to use dictionaries. Studies by Bensoussan et al. [3] and Knight [15] determined that extra time spent on looking up words was unlikely to be used efficiently, as more proficient learners showed little or no gain when using dictionaries. Koyama and Takeuchi [17] even argued that using a dictionary did not always improve comprehension, because dictionary consultation interfered with readers' short-term memory and prevented them from focusing on the text as a whole. In addition, it was found that learners with access to dictionaries sometimes located the wrong dictionary entry resulting in miscomprehension [4, 21, 33].

On the other hand, some researchers argued that dictionary consultation assists reading comprehension and promotes word knowledge development. A series of three studies by Summers [32] showed that learners who used a dictionary scored significantly higher in both reading comprehension and vocabulary learning. Luppescu and Day [21], in a study of nearly 300 Japanese learners of English, also observed that learners who used bilingual dictionaries while reading performed better on vocabulary posttests than learners who read without dictionaries. Similarly, Knight's [15] research on less proficient learners of Spanish revealed that dictionary consultation facilitated reading comprehension and led to word learning even if more proficient learners showed little or no gain. Bogaards [4], who noted that learners may sometimes locate the wrong dictionary entry, also acknowledged that learners were significantly more likely to identify the correct definition in the dictionary than they were to accurately guess the meaning of unknown words from context.

2.3 Electronic Dictionary Consultation

The use of electronic dictionaries has flourished since the 1990s. On the one hand, researchers, teachers and learners are all interested as they are less time-consuming and have more updated information [7, 18, 34]. Another obvious advantage of the electronic dictionary is that it encourages exploratory browsing, and the great number of look-ups is likely to be conducive to incidental word learning [16, 23]. However, many learners may not have comprehensive knowledge of the functions and advantages of electronic dictionaries, and hence failed to make good use of them. It is therefore important for teachers to provide learners with explicit instruction in using electronic dictionaries so as to better facilitate word learning [16].

On the other hand, many scholars doubt the effectiveness of electronic dictionaries in promoting word learning. Chen [5] believed that electronic dictionaries is inferior to paper-based dictionaries as students, while using paper-based dictionaries, focused more on various aspects of word knowledge (such as part of speech, sample phrases and sentences), thus obtaining better learning results. Sharpe [31] also noted that the ease of electronic dictionary consultation resulted in the short time needed for information retrieval, which further led to shallow processing of the words being consulted, and consequently hindered the word learning.

Although there are many studies on the consultation of either paper-based or electronic dictionary, none of them has ever investigated the hybrid use of both paper-based and electronic dictionaries. The present research, therefore, investigated and compared the effectiveness of the pure use of either paper-based or electronic dictionary and the hybrid use of both, attempting to bring new insights into the field of dictionary consultation for incidental word learning.

3 Method

The present research involved two experiments, comparing the facilitative effects of a paper-based dictionary, an electronic dictionary and the hybrid use of both in promoting word learning. The first experiment compared the Collins COBUILD Advanced Learner's Dictionary (CCALD) and an electronic version of it. Yet the second one, as shown in Table 1, involves comparisons of four conditions of the use of paper-based and electronic dictionaries. Before participating in any of these two experiments, all the subjects were tested by using Paribakht and Wesche's [24] Vocabulary Knowledge Scale (VKS) to investigate their pre-knowledge of the target words.

Table 1. The six conditions in two experiments

Experiments	Conditions	Stage 1	Stage 2
Experiment 1	Condition 1	Paper-based	NA
	Condition 2	Electronic	NA
Experiment 2	Condition 3	Paper-based	Paper-based
	Condition 4	Electronic	Electronic
	Condition 5	Electronic	Paper-based
	Condition 6	Paper-based	Electronic

3.1 Experiments

Experiment 1. 62 subjects participated in the first experiment, 31 of whom completed a reading comprehension task under Condition 1, and the other 31 under Condition 2. In condition 1, the subjects were asked to read a text of 506 words and look up ten underlined target words in the CCALD for better comprehension. The same reading text with the same ten target words was applied to Condition 2. However, these two conditions were different in that an electronic version of the CCALD was provided to subjects in Condition 2. Being undergraduates from universities at Hong Kong and obtaining IELTS scores ranging from 5.5 to 6.5, all subjects shared similar levels of English proficiency. They were required to follow the instructions for different conditions strictly. 10 subjects participating in this experiment were interviewed after their completion of the task.

Experiment 2. The second experiment was similar to the first one in that the same reading text, the same ten target words, the same paper-based and electronic dictionaries were applied. Yet it was different as a second reading text of 505 words with the same ten target words being underlined was added. In other words, the subjects who participated in Experiment 2 needed to read two texts that imposed dictionary consultation of target words. All four conditions in this experiment included two parts then, between which a break of 30 min was given to the subjects. In Condition 3, the subjects were asked to firstly read the first text and look up the ten target words in the paper-based CCALD, and then read the second text and look up the same target words in the same dictionary. In Condition 4, the electronic version of the CCALD was used. Yet in Condition 5, the subjects were asked to use the electronic version of the CCALD while reading the first text and the paper-based one for the second text, and the other way round in Condition 6. The subjects of this experiment shared similar backgrounds and language proficiency levels with those of Experiment 1. 32 subjects participated in Condition 3, 30 in Condition 4, 31 in Condition 5 and 30 in Condition 6. Additionally, 20 subjects participating in this experiment were interviewed after their completion of the task.

3.2 Reading Texts and Target Words

As both experiments of this research were reading-based, it was essential that the reading texts be suitable for the research objectives and be appropriate for the English proficiency levels and common knowledge of the participants. The two texts were developed through two stages: firstly, selection of texts whose topics were likely to be similarly familiar to all subjects; secondly, modifications of these texts so as to ensure that their levels of difficulty were suitable, neither too difficult nor too easy, for the subjects. Topic familiarity has been noted to have great influence on leaners' reading comprehension and word acquisition by many scholars. Ellis [8], Nassaji [22] and Pulido [26] all found that topic familiarity and expertise in a certain subject facilitated reading comprehension and word retention. Pulido [27, 28] also noted that topic familiarity was consistent with a greater rate of successful inferencing. It was thus crucial to find a topic that was similarly familiar to all the subjects. Therefore, two topics of healthy eating and small class education had been selected. Furthermore, the texts were shortened to 506 and 505 words respectively, and also modified to ensure that the density of words unfamiliar to the subjects were approximately 2 % of the texts. To achieve this, all words used in these two texts, except the ten target words, were from the most frequently used 4000 words in terms of the word frequency list of American English [6].

3.3 Assessment

All the subjects who were not interviewed were immediately tested on their initial learning of the target words by using the Vocabulary Knowledge Scale (VKS). This VKS consists of a self-report format and an interview. It uses a five-point scale to evaluate subjects' self-perceived and demonstrated knowledge of specific words [14]. Its five scales indicate the following five incremental levels of word knowledge: (1) the word was not familiar to the subject; (2) the word was familiar but its meaning was not known; (3) a correct synonym or translation for the word could be given; (4) the word could be used with semantic appropriateness in a sentence; and (5) the word could be used with grammatical and semantic appropriateness in a sentence [24]. The VKS was not designed to estimate general vocabulary knowledge but rather to track the early development of specific word knowledge [24, 29]. It elicited the subjects' perceived knowledge of vocabulary items backed up by verification of demonstrated knowledge [14].

One week after the experiments, all the subjects were unexpectedly assessed on their retention of the target words. The delayed posttests were carried out one week after the immediate posttests following Anderson and Jordan [1], who found that one week after the end of a study period was a critical point of time for the memorization of target information. Further study conducted by Pimsleur [25] also concluded that a word which can be recalled in a delayed posttest taken one week after the initial input was very likely to have been stored in the long-term memory of the subjects.

4 Results

From the descriptive statistics of the pre-knowledge, initial learning and retention of the target words obtained by the subjects participating in the six conditions of dictionary consultation (shown in Table 2 and Fig. 2), it can be seen that: (1) the facilitative effectiveness of paper-based dictionary was greater than that of electronic dictionary in promoting word learning; (2) the hybrid uses of paper-based and electronic dictionaries were similarly effective regardless of the sequence of the use of different dictionaries; (3) the hybrid uses of paper-based and electronic dictionaries were more effective than the pure use of the paper-based or electronic dictionary.

Table 2. Descriptive statistics of the subjects' scores

	N	Pre-knowledge of the target words	Initial learning of the target words	Retention of the target words
Condition 1	31	0.07	12.09	9.08
Condition 2	31	0.08	10.94	8.56
Condition 3	32	0.06	18.06	14.93
Condition 4	30	0.07	16.83	13.87
Condition 5	31	0.07	18.97	15.88
Condition 6	30	0.06	19.01	15.90

4.1 Effectiveness in Promoting Word Learning

The effectiveness of the six conditions of dictionary consultation in promoting the learning of the target words was examined by running paired samples t-tests. The results assessing the difference between the pre-knowledge of the subjects participating in different dictionary consultation conditions and their performances in the two posttests demonstrated significant gains of knowledge about the target words. It is therefore indicated that the subjects had obtained significant development of knowledge about the target words through completing the different tasks, and these tasks had significant facilitative effects in promoting word learning (Fig. 1).

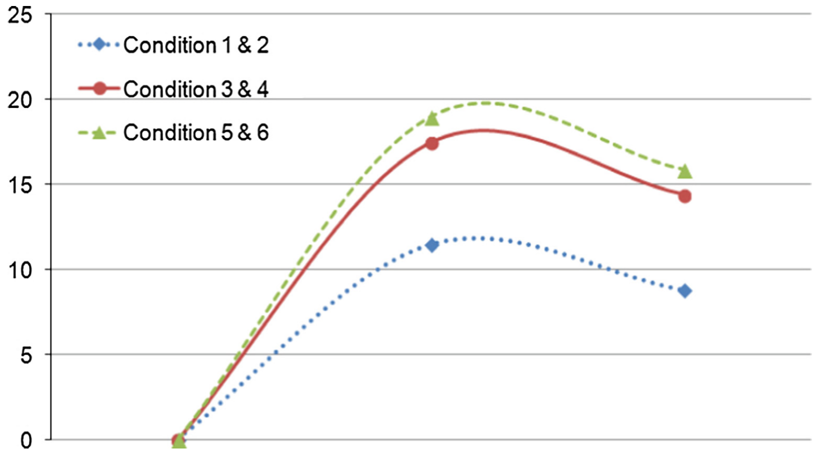

Fig. 1. Average pre-knowledge, initial learning and retention of Condition 1&2, 3&4, and 5&6

4.2 Comparing the Six Condition

To examine whether significant differences existed among the effectiveness of the paper-based dictionary, the electronic dictionary, the pure and hybrid uses of them, the scores of subjects participating in the six different conditions were compared. The results indicated that (1) the paper-based dictionary (condition 1) promoted significantly more effective word learning than the electronic dictionary (condition 2); (2) the repetitive use of dictionaries (condition 3, 4, 5 and 6) significantly increased the effectiveness of dictionaries in promoting word learning (condition 1 and 2); (3) the hybrid uses of paper-based and electronic dictionaries (condition 5 and 6) were significantly more effective than the pure use of either of them (condition 3 and 4); and (4) the hybrid uses of paper-based and electronic dictionaries in different orders were similarly effective (condition 5 and 6).

5 Discussion

In this section, we explain the results of the two experiments from the perspectives of the significance of processing for constructing memory, the significance of repetition for consolidating memory and the significance of diversity for reinforcing memory.

5.1 The Significance of Processing for Constructing Memory

The results of the first experiment of this study, which show that the paper-based dictionary is more effective than the electronic dictionary, provide further support to the arguments of Lockhart and Craik [20], Sharpe [31] and Laufer and Hulstijn [19]. Lockhart and Craik [20] postulated that the opportunity of remembering a piece of information is conditional upon the levels of processing rather than the length of time that it is stored in short-term memory. The subjects being interviewed after their task completion also revealed that the consultation of paper-based dictionary required more time and hence involved greater attention in the processing of information relevant to the target words, thus contributing to word learning. In line with Sharpe's [31] observation, our interviewees revealed that the subjects who consulted the electronic dictionary did not process the information of the target words as comprehensive and deep as those who consulted the paper-based dictionary. Additionally, our results add credit to Laufer and Hulstijn's [18] Involvement Load Hypothesis in that our interviewees acknowledged that the consultation of paper-based dictionary induced deeper and more elaborate processing of the target words than the consultation of electronic dictionary.

5.2 The Significance of Repetition for Consolidating Memory

The significantly better facilitative effects of the conditions in the second experiment (the conditions which asked the subjects to consult the target words twice) than those in the first experiment (the conditions which only imposed the consultation of the target words one time) indicate that repetitions play a crucial role in consolidating memory. Timely repetitions are facilitative for word learning [10, 36]. In accordance with this argument, our interviewees noted that it was the second time of the consultation helped them better comprehend various knowledge aspects of the target words and store such information in their memory. Some of them even admitted that they had difficulty in understanding every piece of information of the target words during their first time of consultation, yet the second chance of reading such information contributed greatly to their thorough mastery of the target words. Therefore, the subjects firmly believed that repetitions were conducive to word retention.

5.3 The Significance of Diversity for Reinforcing Memory

To reinforce the learning of the target words, it is critical to diversify the information provided to learners as the hybrid uses of paper-based and electronic dictionaries were significantly more effective than the pure use of either of them. Our interviewees pointed out that the repetition of exactly the same thing made them bored, yet the repetition of something slightly different but mainly the same facilitated their digest of the information they had processed before and prompted their further exploratory of the new information. The hybrid use of both paper-based and electronic dictionaries also enables learners to profit from the advantages of both types of dictionaries and explore the best out of them. A hybrid use of paper-based and electronic dictionaries, therefore, should be advocated as both types have certain merits and the complimentary use of them works best.

6 Conclusion

The present research firstly reviews studies in incidental word learning and the facilitative effects of paper-based and electronic dictionaries. In a response to the call for research on the hybrid use of both paper-based and electronic dictionaries, we conducted two experiments to compare the effectiveness of these two types of dictionaries, the pure use of either of them, and the hybrid use of both. The experimental results demonstrate the superiority of the paper-based dictionary over electronic dictionary, the significance of repetition for memory consolidation, and the great effectiveness of the hybrid use of both paper-based and electronic dictionaries. However, this research is limited in terms of its scope of study and the possible influence of experimental conditions, and it is hoped that future studies will offer more insights into this field.

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Flexible Hybrid Learning: Comparative Study

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Abstract. Hybrid learning has become a widely exploited approach within the ICT-enhanced instruction. Making it flexible, so that the process of learning reflecting students' needs and preferences was the problem solved in various ways at three Czech institutions of higher education. In the paper the whole process is described, describing the starting phase, which was identical at all three institutions, and comparing different models of flexible hybrid learning applied further, including the results of pedagogical experiments comparing learners' knowledge in flexible and non-flexible learning. The results did not proved clearly visible differences, as neither world-recognized research did. Despite this, authors are persuaded that research activities in this field should go on, paying deeper attention to learners' personal characteristics and other activities within the learning process.

Keywords: Hybrid learning · Pedagogical experiment · Adaptive environment · Flexibility · Learning preferences · Learning styles

1 Introduction

The process of ICT implementation within the Czech higher education system, which includes 26 public universities, started in 1999 after the new Higher Education Law No. 111/98 Coll., §21b had become effective, and the starting phase was closed in 2007 when all Czech public universities mentioned the process of ICT implementation in their annual reports. Within the analysis made by the Centre for Higher Education Studies, Prague (2006) it was declared that [1]:

– Nearly all universities declare and emphasize the use of ICT in the process of instruction and consider it as priority.
– Technical universities, closely dealing with results of technical development, ex-press more keen interest in the field of ICT than non-technical institutions.

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- Universities differ in approaching and solving the problem of implementation: technical universities often concentrate on material and technical point of view, i.e. they put emphasis on equipment and its technical characteristics, whereas faculties of education run the slow process, but they pay more attention to didactic aspects.

Several institutions were the leaders and following centers were established:

- University of Ostrava;
- VSB-Technical University of Ostrava;
- University of Hradec Kralove, particularly the Faculty of Informatics and Management (FIM), other faculties joined the process later;
- University of Economics, Prague.

All institutions provided either fully distance education, or the hybrid (blended) courses to support the full-time and part-time study programs. Rather wide exchange of experience was running with surrounding countries (mainly the Slovak Republic) and those being more experienced in this field, which resulted in participation in (European Union) projects, e.g. with Poland, Great Britain, Island, Italy, Finland, Portugal, Netherlands, Germany etc. Above all, since 2000 the eLearning conference and competition has been held at the UHK, hosting participants from the Czech Republic and Slovak Republic, whose papers were published in the conference proceedings and best ICT-supported courses for hybrid and distance education were awarded.

The problem authors of this paper focus on is how the process of ICT implementation ran in single institutions – leaders in the process, as different approaches and learning management systems (LMS) were exploited, either ready-made, or tailored to special needs of institution and designed by university staff, e.g. [2–4].

Authors of this article had following goals:

- summarize main concepts of ICT-enhanced teaching/learning on the basis of literature review;
- describe the current concepts of hybrid learning at the institutions;
- introduce the comparison of research results collected from two hybrid learning processes conducted at two institutions.

2 Theoretical Background

Depending on the share of information and communication technologies (ICT) in the process of instruction, several terms are widely used: hybrid or blended learning, web-enhanced or online instruction.

There is not a wide consensus on the definition of hybrid learning which is also called blended learning by some authors, e.g. [5–7]. The University of Washington, Bothell, defines blended courses as those where 25 % - 50 % of the traditional face-to-face class time is replaced with online or out-of-class work [8], compared to the Sloan Consortium, which defines blended learning as a course where 30 % - 70 % of the instruction is delivered online [9]. And, Yamagata-Lynch claims that “there is no agreed percentage of what constitutes a course as blended, and in many institutions there are idiosyncratic definitions of online, distance education, and blended instruction" [10].

Nevertheless, reflecting the share of in-class and out-of-class work we can define the blended and web-enhanced courses, where learners continue to meet during the normal class hours and use the online component to supplement face-to-face time [8].

Several recent studies (e.g. [10, 11]) show that much more institutions of higher learning are now showing interest in the official implementation of hybrid learning (e.g. [12]), as it is an advantage for their distance learning courses. In this way universities can be more economical as far as the use of faculty space, time and staff are concerned (e.g. [13]). Furthermore, other research studies (e.g. [14] or [15]) proved that hybrid learning/teaching had ample advantages such as learning effectiveness and learners' satisfaction.

The hybrid learning has also undergone a shift from exploiting non-portable (immobile) devices to mobile ones. In the past the process of implementation in the Czech Republic was limited by the fact that mobile devices were not available to such extent as in the developed countries. However, currently the situation has changed substantially and mobile learning can be exploited at all levels of education [16, 17]. Learners using mobile devices all days long have been literate enough to use them for education purposes. Before the process of the wide-spread use started, several questions had been researched in the Czech Republic focusing on whether students were sufficiently equipped with mobile devices, for what purposes do they use the mobile devices and what is the feedback after all [18].

Another phenomenon is intimately connected to hybrid learning, i.e. tailoring this process to learners' individual needs and learning preferences. In spite of numerous advantages, there exist several conflicting ideas. Therefore, the pedagogy might also support higher motivation and stimulation for students (e.g. [16, 19]). Moreover, hybrid learning might also match student's learning style since it can offer more interactive ways of learning and almost immediate feedback on students' tasks, assignments or tests. However, there is not still clear consensus on this issue ([16, 20, 21], and [22]). Mismatch in teaching/learning styles can cause a wide range of further educational problems [23]. Gregorc [24] discovered only individuals with very strong preferences do not study efficiently, the others may be encouraged to develop new learning strategies. Mitchell [25] emphasizes making the educational process too specific to one user may restrict the others. Up-to-now only limited number of studies have demonstrated that students learn more effectively if their learning style is accommodated [20].

Taking into consideration the research results in learning styles by the above mentioned authors and many others, methodology on how to implement learners' preferences into instruction was deeply worked out. However, Honey was the first one who asked question about learning styles in e-learning [26]. After monitoring the likes and dislikes about e-learning in the group of 242 respondents he concluded, their opinions did not differ so much as he had expected, despite various types of learners definitely had different features in mind, when speaking e.g. about learning at my own pace.

In the Czech education environment the Ross and Schulz´s approach (in [27]) and Gregorc´s concept (in [24]) were applied in hybrid learning reflecting learning styles preferences, i.e. the concrete/sequencing, abstract/sequencing, concrete/random and abstract/random websites were designed. Mares proposed to adjust the World Wide Web to various learning styles, i.e. to sensory, social and cognitive preferences, and to design [30]:

- the visual Web providing static texts, images, graphs, animations, video-recordings etc.,
- the auditory Web with recordings of lectures, music, discussions,
- the kinesthetic Web providing hands-on activities and practical examples,
- the Web adapted to social preferences reflected in independent, pair or team work.

From learners' point of view, it is important for a student to be aware of his/her learning style, to know the strengths and weaknesses and be provided a variety of instructional methods to choose the most suitable ones [28].

3 Two Approaches to Flexible Hybrid Learning

The history of ICT implementation at both institutions started at the beginning of 1990s by using shared directories where study materials were presented. Step by step the e-mail service was used for communication between students, and students and teachers, followed by other services, e.g. electronic administration of credits and examinations, displaying syllabi, timetables, entrance exams results, university websites were designed. Then the professional virtual learning environment Learning Space was bought by FIM, in 2001 it was replaced by WebCT. At UO, the development of LMS Barborka started, been designed by UO academic staff.

At the same time first distance on-line courses were designed within European Frameworks, e.g. Tempus Project MUDILT (Multimedia and Distance Learning for Teachers) or PATTER (Public Administrators' Training Towards EU), ECDL (European Computer Driving License). The projects targeting at university students were conducted, e.g. OLIVA Project (On-LIne VýukA, on-line learning), to prepare both the teachers and students for e-learning in higher education. First courses were designed for subjects in the field of Informatics, Economy and Management, then in foreign languages, Psychology, Ethics etc. In 2014 more than 300 courses were available to 5000 VSB students and more than 250 courses to 2,300 students of FIM. UHK and UO also solved several international projects, e.g. Borderless Education, in co-operation with other Czech and international universities (RIUS Project (Run-up of Inter-University Study in selected universities in the Czech Republic and others).

Thus we can state, up-to-now both students and teachers have collected rather wide experience in this field. There is no doubt, the information and communication technologies provide a wide range of tools and strategies each student can choose from and learn efficiently. The result is that the student is positively motivated and able to develop the possibly highest level of knowledge in the shortest time period spending least efforts [30]. To reach such a level in the real process of instruction, the requirement for optimizing the teaching/learning arose, particularly the call for improving the flexibility of the process, mainly by applying the individualized approach [16].

3.1 Model of Flexible Hybrid Learning at University of Ostrava

The flexible and personalized education is a current research topic at the OU and VSB; where automatic adaptive learning has being exploited. The optimal adaptive process should respect students' differences in learning styles and level of their knowledge and skills [28]. On the basis of identification of their personal characteristics and qualities, students are provided such study materials which reflect their learning preferences.

The monitored features are as follows:

- sensory perception, covering verbal, visual, auditory, kinesthetic preferences (VARK questionnaire by Fleming and Mills was used);
- social aspects, dealing with individual, pair, team work (LSI – Learning Style Inventory (Dunn and Dunn, 1993);
- affective aspects, including inner and outer motivation (LSI);
- learning strategies, i.e.
  - whether learners prefer system or free work (ILS – Inventory of Learning Style, by Vermunt),
  - theoretical deductions or experimenting (ILS),
  - analytic or holistic processes (TSI – Thinking Style Inventory by Sternberg and Wagner),
  - deep, strategic or shallow learning (ASSIST – Approaches and Study Skills Inventory for Students by Entwistle).

Out of all above listed questionnaires the LSI was the only one which had been translated to Czech language and gone through the process of standardization; the others were translated and piloted by 200 UO students, for the purpose of this project. Then, further activities were applied within the process of adaptive learning:

- providing students the introductory information on how to study in online courses;
- applying the pre-test detecting learners' starting knowledge;
- applying the SSBI (Styles and Strategies Based Instruction) to detect learners' preferences;
- providing students the introductory information on how to study in online adaptive courses so that their preferences were accommodated (in this phase adequate learning strategies are also provided to students);
- designing the adaptive online course for learners with visual, auditory and kinesthetic preferences;
- run the process of teaching/learning (adaptive materials are used in the phase of independent out-of-school learning, i.e. homework);
- applying the post-test detecting students' knowledge after the process of instruction;
- collecting learners' final feedback.

The adaptive personalized instruction is directed by the expert system [3], the schema is displayed in Fig. 1.

The system consists of three parts: Student, Author and Virtual Teacher. The process is a student-centered, so the student is the center. Various types of information are required about the Student relating to main fields: starting knowledge and learning preferences, both are tested before the process of adaptive learning starts, as described

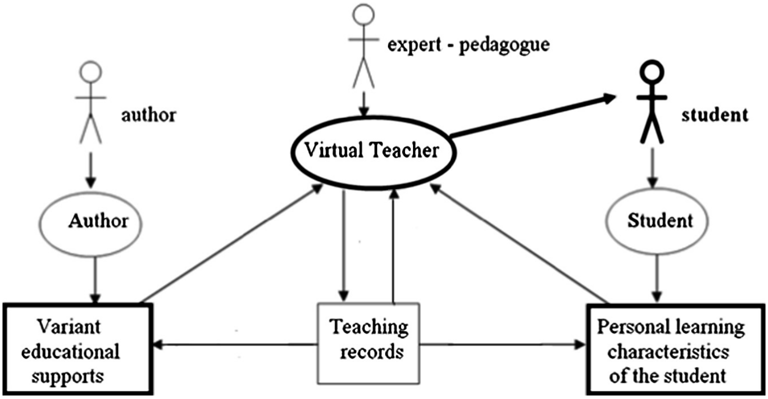

Fig. 1. Model of adaptive personalized instruction (designed by authors)

above. Author works as a modifier of student's learning; data from tests are applied in this activity, and study materials are adjusted to them. Then, Virtual Teacher reads all information about the student and recommends an optimal way of learning. Within this step pedagogic rules and didactic principles are taken into account; the final process of learning is really individualized, i.e. tailored to student's needs and preferences.

3.2 Model of Flexible Hybrid Learning at University of Hradec Kralove

The approach to flexible hybrid learning conducted at FIM (UHK) arose from the theory by C.A. Johnston. She partly agrees with theories of Piaget, Jung, Skinner, cognitive psychologists etc., i.e. with the tripartite theory of the mind – feelings, thoughts, behavior – which are expressed in the processing self, i.e. cognition, performing self (conation) and developing self (affectation). She describes the whole process of learning as a combination lock saying that cognition (processing), conation (performing) and affectation (developing) work as interlocking tumblers; when aligned they unlock individual's understanding of his/her learning combination. The will lies in the center of the model, and interaction is the key. She compares human learning behavior to a patterned fabric, where the cognition, conation and affectation are the threads of various colors and quality. It depends on the individual weaver (learner) how s/he combines them and what the final pattern is [4].

Johnston designed the Learning Combination Inventory (LCI) focusing on not the product of learning, but the process of learning, on how to unlock and what unlocks the learner's motivation and ability to learn. Respondents' answers form the schema (pattern) consisting from four categories as follows [31]:

- sequential processors, defined as the seekers of clear directions, practiced planners, thoroughly neat workers;
- precise processors, identified as the information specialists, into-details researches, answer specialists and report writers;
- technical processors, specified as the hands-on builders, independent private thinkers and reality seekers;

– confluent processors, described as those who march to a different drummer, are creative imaginers and unique presenters.

Data collected from LCI were exploited by the e-application which matches appropriate types of study materials to individual student's learning style pattern. The e-application reorganizes the Course Content page of the online course, i.e. the most appropriate types of study materials are listed there. Each topic of the learning con-tent was designed in six forms (i.e. full texts providing detailed information; short texts structured for the distance form of education, PowerPoint presentations; animations; video-recorded lectures; links to additional sources). The LCI data are provided to the e-application in the form of four figures reflecting the individual combination of the sequential, precise, technical, confluent preferences which formed the individual pattern of each learner. Single types of study materials are classified by four figures of the value of -1, 0, and 1 which corresponded to four types of processors preferences (Sequential, Precise, Technical and Confluent) as follows:

– minus one (-1) means this type is rejected, i.e. does not match the given learning style;
– zero (0) means the student neither appreciates, nor rejects, but accepts this type;
– one (1) means this type is appreciated and matches the given learning style.

Having evaluated the appropriateness of each type of study materials and exercises to single types of learning styles (Sequential, Precise, Technical and Confluent), and having detected the individual student's learning style by LCI, all data are processed by the e-application and the Course Content page is restructured for each student reflecting his/her individual learning preferences. On the individualized page of Course content the titles of preferred types of study materials are written in dark bold font while rejected ones are displayed in light color.

4 Flexible Hybrid Learning in Practice

Both models of flexible hybrid learning were verified by the method of pedagogical experiment and conducted in 2013/14 academic year following the ‘pre-test – instruction – post-test structure’. The main research objective was to answer the above mentioned question, i.e. whether students learn more if the hybrid process of instruction is tailored to their learning preferences.

4.1 Research Design and Results at the OU and VSB

The online hybrid course of English for Specific Purposes (ESP) was exploited for the research. Students attended two lessons per week (90 min) and adapted materials were available to them for out-of-school study.

Totally 40 students participated in the research; they were divided in two groups: experimental (FEI-VAK), where the adaptive hybrid learning was applied; and control group (FEI-CON), where no learning preferences were reflected. The process of instruction followed the schema displayed in 3.1.

The results showed (Fig. 2):

- both groups reached statistically significant improvement on 0.05 level (i.e. in-crease in knowledge (2.766 points in FEI-VAK group and 2.565 points in FEI-CON group; maximum 10 points);
- in FEI-VAK the variability of test scores in post-test was lower compared to pre-test (see shorter right lower box) in Fig. 4;
- both groups reached rather high test score in post-tests (8.7 in FEI-VAK and 7.6 in FEI-CON;
- above all, the FEI-VAK post-test box illustrates that the adaptive hybrid approach enhanced learning in FEI-VAK, as variability of test score decreased compared to pre-test (compare the upper right box to upper left one) and the group was more homogenous compared to the pre-test level of knowledge; and, the increase in test score was higher with students who reached weak results in pre-test.

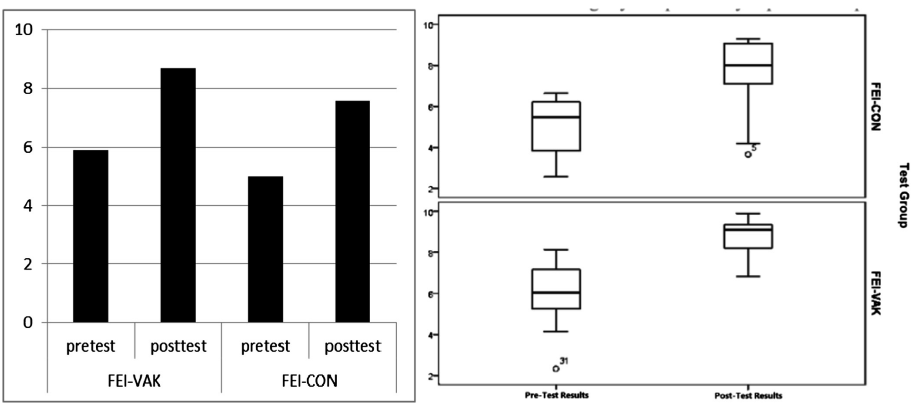

Fig. 2. Research results: University of Ostrava

4.2 Research Design and Results at UHK

The online course Library services – Information competence and education was designed. It was provided in three versions:

(1) reflecting the learner's style (experimental group 1, online course LCI, n = 108) where the e-application was used to tailor the course;
(2) providing all types of study materials to the learner; the process of selection is the matter of individual decision, the choices were tracked and compared to the LCI group (experimental group 2, online course CG, n = 103);
(3) reflecting the teacher's style (control group, online course K, n = 113) where the course was designed according to the teacher's style of instruction.

The hybrid process of instruction included the face-to-face instruction (identically 90 min per week) supported by independent study in the online course to fix and practice the learning content, develop new knowledge and be able to apply it in practice.

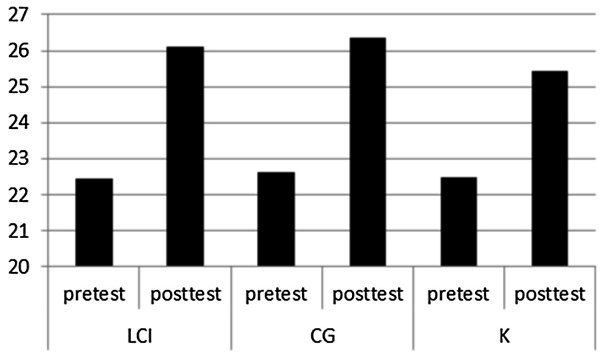

Fig. 3. Mean test scores in pretests and posttests in LCI, CG and K groups

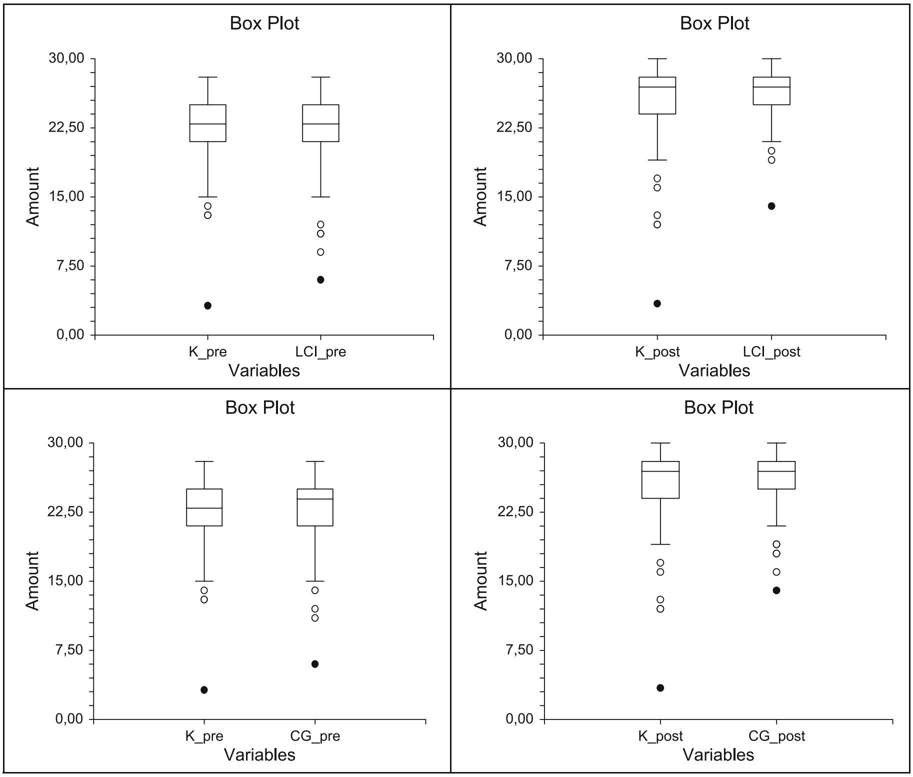

Fig. 4. Comparison of pretest and posttest test scores in LCI/K (left) and CG/K groups (right)

The sample group consisted of 324 students of University of Hradec Kralove. All students were randomly divided in three groups, each of them studying one of three versions of the same online course.

Unfortunately, no statistically significant differences were discovered in learners' performance. The mean values and test scores in LCI, CG and K groups in pre-tests and post-tests are displayed in Figs. 3 and 4.

This result was surprising and rather disappointing for the research team. Reflecting the research results of authors mentioned above (e.g. [4, 26] and others) we expected, if not significant, some larger differences would be detected in the LCI group where the face-to-face learning was supported by the online course reflecting students' learning preferences. Above all, in other researches dealing with hybrid learning which had been conducted at FIM the statistically significant differences were discovered in favor of hybrid learning, e.g. [32].

5 Conclusion

The main objective of this research was to answer the above mentioned question, i.e. whether students learn more if the hybrid process of instruction is tailored to their learning preferences.

To sum up, within these researches the contribution of adaptive hybrid learning model was detected at the University of Ostrava, but no differences were detected in an increase in learners knowledge in the sample group of University of Hradec Kralove where the process of hybrid learning was detected in three groups reflecting/non-reflecting learners preferences. Being conscious of a small size of the research sample at UO/VSB (n = 40), the results cannot be generated. But, they prove to some limited extent that the model of adaptive hybrid learning can work. Contrary to this, the research sample at UHK was rather numerous (n = 324).

Comparing these results to those reached by recognized team, they can be considered of the same type – the contribution of flexible hybrid learning was not clearly proved.

Despite all the facts, the information about both approaches to solving this problem may be useful to those who are trying to answer the same questions; consequently, to those who are trying to find other ways to reach the target.

In both solutions ICT was used to design appropriate models of flexible hybrid learning; we consider this to be the right way for further research activities in this field.

The research results show that more detailed analysis of learner's personal characteristics will be required, supported by their deeper reflection in tools of the hybrid learning process (assignments, tests, communication, schedule etc.).

From the results presented above it can be seen there is no definite solution. It is important for a student to be aware of his/her learning style, know what his/her strengths and weaknesses are and be provided a variety of instructional methods to choose the most suitable ones. In the days of fast technical and technological development, globalization, demand for further, lifelong education, the importance of education is increasing. These terms and conditions support the development of the whole system. Teachers' and students' awareness of learning styles and preferences may help substantially.

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Applying Grounded Theory Method in Building a Hybrid Learning Activities Model

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Abstract. In order to promote the practical application of hybrid learning in colleges and universities in Guangdong, a study named "Hybrid learning application patterns in colleges and universities in Guangdong province" was carried out. This study, supported by education technology centers from colleges and universities in Guangdong province, adopts grounded theory analysis method of qualitative study in summing up several patterns of hybrid learning activities of teachers and students. The result of this study has a guiding significance and referential value to promote the teaching design and application of hybrid learning practice.

Keywords: Hybrid learning · Qualitative study · Grounded theory

1 Introduction

Hybrid learning is a popular term in the field of educational technology in recent years, which is a theory or teaching mode formed after reflecting on the shortcomings of e-learning. Different scholars have different definitions of hybrid Learning. Bonk defined that hybrid learning is a combination of face-to-face instruction with online learning [1]. In this research, we think that hybrid learning appears in many forms, which is not only a mixture of face-to-face (F2F) and online learning (OL), but also a mixture of receiving knowledge and discovery learning, a mixture of autonomous learning and collaborative learning, a mixture of knowledge learning and practice, a mixture of process study and evaluation, and a mixture of applying media and learning tools.

In China, the research on hybrid learning can be mainly divided into two aspects including theory analysis and practice exploration. The theoretical analysis is mainly concentrated in the connotation, elements and design strategies of hybrid learning. Li proposed the design steps of hybrid learning and introduced four kinds of application modes of hybrid learning [3]. Huang proposed a hybrid learning course activities model and divided the process of the hybrid learning course design into three stages: analysis, activities and resources design, and teaching evaluation design [4]. The practice exploration mainly focused on applying hybrid learning in a subject or a field and carrying out the specific practice, thus developing some typical cases or typical hybrid learning patterns. According to the actual situation of the curriculum and the discipline characteristics, Zhou designed many hybrid learning modes, such as collaborative learning, inquiry based learning, case teaching, skills training, role-play etc. [5]. Huang

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constructed a hybrid learning mode for "Modern Educational Technology" curriculum based on a networked teaching platform. After the teaching practice, he pointed out that the design of curriculum content and learning activities have great influence on the application effect of hybrid learning [6].

The instructional design is the key of hybrid learning. The important part of hybrid learning is the design of teaching environment and learning resources, and the design of teachers' teaching and students' learning activities. However, there is little research on the instructional design or activity model of hybrid learning. Furthermore, many researches are just theoretical deduction, so the effectiveness remains to be tested in practice. In this paper, we apply the grounded theory to analyze some successful experience of the colleges and universities in Guangdong province and sum up several patterns of teachers and students activities in hybrid learning, so as to provide some useful reference for instructional design of hybrid learning.

There are 37 common colleges and universities in Guangdong province (not including vocational and technical colleges) and most of them have acquired networked teaching management platforms. The construction of online course resources on these platforms strongly promotes the higher education curriculum and teaching reform in Guangdong and stimulates changes in personnel training. We found that there is a batch of curriculum resources available on the network, which has embedded stories of successful experience in the construction and application of these courses. We hope that learning from this successful experience will promote the application of hybrid learning in colleges and universities in Guangdong. Therefore, under the auspices of the education technology centers in Guangdong province, a consortium was formed by Sun Yat-Sen University, Jinan University and South China Normal University to carry out the research study named "Hybrid learning application patterns in colleges and universities in Guangdong province". Through field investigation and teacher interviews, this research aims to understand the current situation of the application of hybrid learning in colleges and universities in Guangdong, and to discover a batch of good models courses and teachers in hybrid learning. Through the use of grounded theory analysis on successful experience of hybrid learning of some teachers, we summed up several patterns of hybrid learning activities of teachers and students, which has guiding significance and referential value in promoting the teaching design and application of hybrid learning practice.

2 Research Methods

This research adopts grounded theory method of qualitative research method. Grounded theory, established by Glaser & Strauss in 1967 [1, 2], is an important method of qualitative data analysis, using bottom-up procedures systematically with actual data collected in the system, looking for reflection on the social phenomenon of the core concepts on the basis of inductive methods, finding links between these concepts, thus forming a theory viewpoint. The description of the teacher's teaching experience is a piece of qualitative data. To this end, this research is divided into three parts, namely

(1) Qualitative data collected rooted in the actual environment,
(2) Qualitative data analysis, and
(3) Summary of the characteristics of teaching and learning activities of teachers and students.

3 Qualitative Data Collected

In order to obtain the rich qualitative research data of hybrid learning applications in Guangdong, we use a variety of ways:

Step 1: the questionnaire survey. We designed the "Questionnaire on basic situation of networked course construction and application in colleges and universities in Guangdong province" and requested that colleges and universities in Guangdong to fill in. Items in the questionnaire include the basic situation of platform and network resource construction, the number of online courses and usage, and recommendations of a number of the successful experience of hybrid learning courses and teachers.

Step 2: field investigation and interviews. Based on the data collected from the basic situation and recommendations of excellent cases from the questionnaire, we arranged a team of teachers and graduate students to further investigate the 24 universities.

Investigation activities include:

(1) Understanding the general situation of hybrid learning in each college and university;
(2) Listening to actual hybrid learning experience from teachers;
(3) Watching the actual scene of the classroom teaching;
(4) Collecting teaching cases, which include teaching design, presentation files (ppt), relevant network course websites and related teaching narrative;
(5) Interviewing teachers; and
(6) Holding a colloquium, which includes all interviews with digital recording, all teachers experience introduction with presentation files, and part of the lecture videos.

Step 3: the data sorted. Through investigation, we obtain the type and amount of qualitative data as shown in Table 1.

Table 1. The type and amount of qualitative data

	Data collection in projects	Number
01	Recycling questionnaires situation	24 set
02	Overall introduction (PPT) and text summary material	24 set
03	Listening to the teacher's report	71
04	Collection of teacher's teaching design and PPT	70 set
05	Face to face interviews	74 teachers
06	Watch lectures at the scene	19
07	Panel (focus group interview)	7 games
08	Materials of recording	650,000 words

After obtaining a large number of qualitative data, based on grounded theory analysis method, the point of view was formed through the induction analysis of data.

4 Grounded Theory Analysis of Qualitative Data

We use grounded theory analysis on the collected qualitative data. Before analysis, we highly focus on blended learning theory and make preliminary theoretical assumptions in the process of collecting and analyzing data; and unceasingly to test our own preliminary theoretical assumptions. We systematically collect data, reflect on the core concept of hybrid learning phenomenon, sum up the relationship between these concepts using the three-level coding method, and then form our theory viewpoint.

The three-level data coding process includes (1) open coding, (2) axial coding, and (3) select coding. Figure 1 shows the three-level data coding process.

(1) **Open coding.**

Open coding is for the purpose of analysis of the original data collected, including to point out the phenomenon preliminarily, to define the concept, and to look for the categories. Category is the concept of a higher level abstraction, which is to be used to reflect the data content and meaning. The operation process is as follows:

① "Break up" is the original recorded data and for each set of data the phenomenon reflected by a local concept is defined. A local concept is based on the theory derived from the concept of blended learning. Table 2 is part of the open coding examples; it shows the process from "break up" the original recorded data to every data definition phenomenon and gives the concept.

Through opening the qualitative data to coding, according to the basic theory of hybrid learning, more than 430 native concepts were introduced and part of them was shown in Table 3.

Table 2. Open coding examples

Examples analysis unit (interview) (part)		Conceptualization
Example 1	I will ask students and teachers together, through various channels to collect many video cases in criminal cases, and then uploaded to the network platform for students to browse it.	Resource sharing
Example 2	I will choose a batch of excellent student learning works of the students, and then put it on the network platform, I'd like to have these good students learning works for use in other grade undergraduates.	Resource sharing

② Mining category is to integrate the concepts of similar meaning to the a concept at a higher level, named category. Through the analysis, we further found that the concepts were summarized to the higher category through continuous "downsizing". This study discovered more than 50 categories and part of them was shown in Table 4.

Table 3. After open coding to introduction of native concept (part)

After open coding to introduction of native concept (part)
Course open time, training before class, study plan, BBS exchange, answering questions, the network learning resources, corrects students' papers, online platform using time, BBS exchange, job management, resources, evaluation methods, stability of the platform, platform maintain, learning behavior, application effect, project learning website, multimedia resources, resources abroad, online learning time, learning and research learning, multimedia resources, inquiry learning, evaluation methods, and student feedback, job submission time, login time, intellectual property rights ...

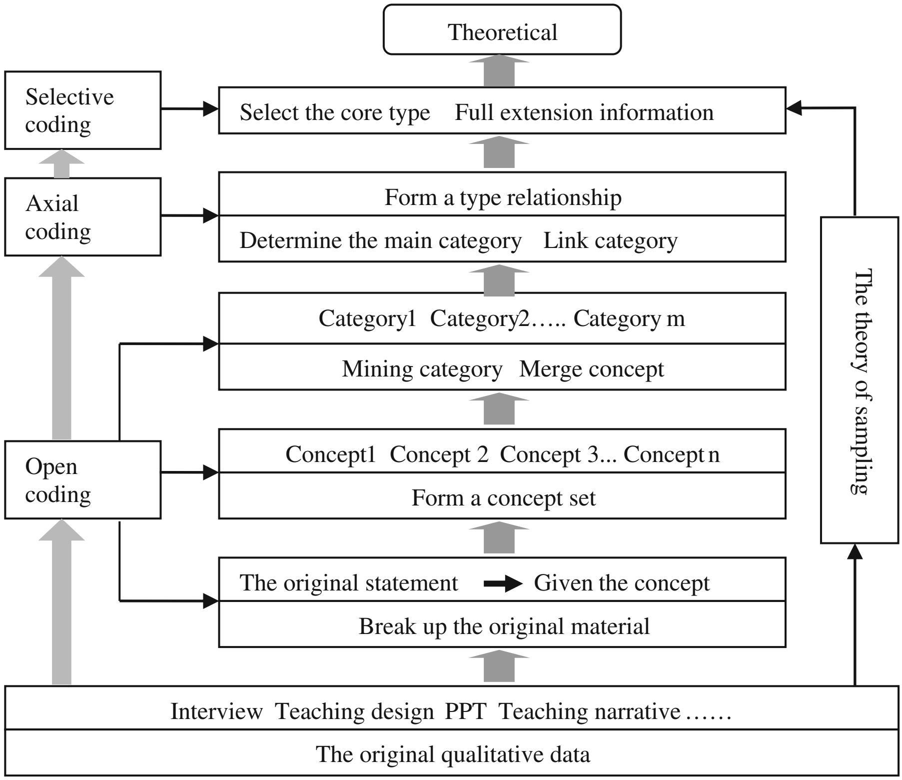

Fig. 1. Three-Level data coding process

(2) **Axial coding.**

Its main task is to find and establish the relationship between different categories, through the analysis, select one or several strong relationships, and recapitulate the association with the strong ability of the core concepts as the main category, the other as a condition and the context of a concept. The connection between the different categories gradually becomes the formation of our theory viewpoints.

Table 4. Categories and concepts that are included in part of the cases

Category	The concept of category contains
Teaching resources	Provide video case, curriculum document, project learning website, multimedia resources, Micro course resources, the introduction of foreign resources, resource update,…
Teaching activities	Organization of classroom discussion, decorate learning tasks, select important issues Guiding thinking, to guide the learning methods, online answer this question,…
Learning activities	Login web site, the group collaborative learning, understanding of learning tasks, online BBS communication, learning plan, online discussions, form opinions, online learning time, role playing, the application of social software…

(3) **Selective coding.**

Its task is to select a core attribute, and then to connect all the other attributes, make the type of data, form a clear clue, and make preliminary theoretical perspectives more completely. In accordance with the above principle, we establish a blended learning activity analysis model of teachers and students, as shown in Fig. 2, namely the teachers' classroom teaching activities, students' classroom learning activities, teacher's online teaching activities - online learning activities of students.

Use of hybrid learning in the four corners of the teaching and learning activities analysis model, we put the various associations with hybrid learning which is acquired by grounded theory of "category", formed the different types of teaching and learning activities in the hybrid learning.

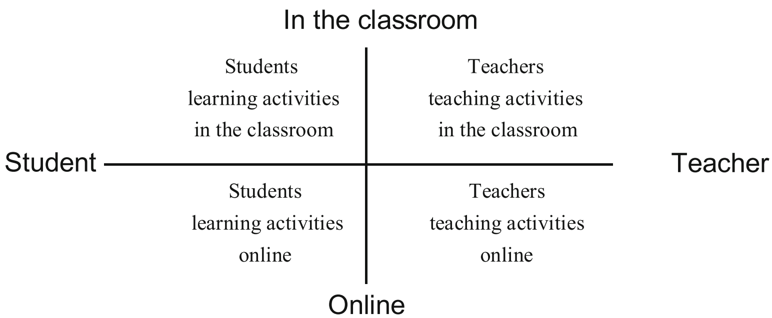

Fig. 2. Blended learning activity analysis model

5 Hybrid Learning Activity Type

Root through the above theoretical analysis, we discovered different contents and process structure in face-to-face and online teaching and learning activities from teachers and students. The formation of a case study, task driven learning, inquiry learning, and virtual simulation study and so on appear in various hybrid learning modes. All of these patterns are rooted in the actual teaching practice.

Type 1: Online Case Teaching + in Classroom Teaching

Case: Courses "Jurisprudence II" in Guangdong Business School.

First of all, the teacher provided a group of cases of related laws in video on the networked platform. Students were required to watch the web video cases with in-depth analysis and then asked some questions. In view of the questions identified, students collected and studied relevant information and discussing the cases via the network, guided by the network curriculum formation methods of the system.

Teachers organized students in a way to simulate a real court in the class, in which students played the roles as the judge, the plaintiff and the defendant, and gained experience in a simulated court, thus finished the class with a better understanding of the knowledge and migration to a higher level. We concluded that both teachers and students completed the process of knowledge construction as shown in Table 5.

Table 5. Activity process and content in type of online case teaching

	F2F		OL	
Process	Teachers' teaching activities	Students' learning activities	Teachers' teaching activities	Students' learning activities
01	◆Determine the learning task ◆Guiding learning method	◆Understanding learning task and Learning methods	◆Provide video case	/
02	/	/	◆Guiding learning method	◆Online autonomous learning
03	/	/	◆ Choose to think questions	◆Analysis of cases, ◆Ask questions
04	/	/	◆Organize group learning ◆ To guide the online discussion	◆Online discussion question
05	◆Design of moot court ◆Determine activity rules	◆Role play	/	/
06	◆ Teachers and students together evaluation and summary	◆ Teachers and students together evaluation and summary	/	/

Type 2: Online Inquiry Learning + in Classroom Teaching

Case: Courses "Oral pathology" in Jinan University Medical School.

At the beginning of the project, teachers put a variety of learning resources on to the network teaching platform, including the literatures related to oral pathology locally and abroad, foreign library websites, multimedia resources and so on.

Then the teacher released information about research questions on the platform, such as the reasons for the formation of various kinds of disease in the course. Students were required to use literatures provided online to explore, and to conduct interactive discussion with each other between classmates online. According to the results of the discussion, students sorted out the academic points of view.

After a period of time, the teachers organized data of class discussion, students' opinion, and learning outcomes. Teachers were in the process of monitoring network platform continuously and tried to understand students' learning states. Table 6 shows such a process.

Table 6. Activity process and content in type of online inquiry learning

	F2F		OL	
Process	Teachers' teaching activities	Students' learning activities	Teachers' teaching activities	Students' learning activities
01	◆Introduce general content and inquiry learning method and requirements	◆Understanding learning content ◆Understanding learning requirements	/	/
02	/	/	◆Integration of teaching resources including oral pathology project site, index of related literature at home and abroad, the library website, etc.	◆ Browse the resources
03	/	/	◆ Put forward the research question	◆Students use online resources to explore problems
04	/	/	◆ Guide students online discussion	◆Online discussion
05	◆Organize class discussion ◆To explore the learning outcomes were summarized	◆Show Learning outcomes, ◆Teachers students discuss with each other	/	/

Type 3: Online Collaborative Learning + in Classroom Teaching

Case: Course “Modern learning technology” in Sun Yat-Sen University.

The teacher formed a series of collaborative learning subjects according to the course content and built collaborative learning groups on the platform. Each group of students chose a theme, in which students in a collaborative learning group adopted division of labor according to the topic, sought for resources on the Internet, applied these resources to complete tasks to be borne by each group, again through consultation and discussion on the online platform, formed the comprehensive opinion, and completed the work together.

Lastly each team showed the learning outcomes in the classroom in various ways; the teacher conducted evaluation and summary so that both teachers and students shared the harvest of the learning outcomes. Table 7 summaries such a process.

Table 7. Activity process and content in type of online collaborative learning

	F2F		OL	
Process	Teachers' teaching activities	Students' learning activities	Teachers' teaching activities	Students' learning activities
01	◆ Introduction to course content ◆ Introduction to method of group cooperative learning	◆Establish collaborative learning team	/	/
02	/	/	◆Display multiple learning theme	◆Collaborative team choose learning theme
03	/	/	◆Provide learning resources and learning materials relevant to the theme	◆Browse the learning resources
04	/	/	◆ To guide the discussion	◆Discussion tasks of Group collaboration online
05	/	/	◆Guide the Methods of each other comments	◆ Show group learning work, watching each other comments
06	/	/	◆Published teacher evaluation opinion	◆Published personal learning experience

Type 4: Online Learning Task Drive + in Classroom Teaching

Case: Course "Secretary professional English" in Shenzhen Institute of Information Technology.

First of all, the teacher with the aid of network platform established a learning situation in flash with other multimedia content, and used the network platform to present learning tasks, to explain to students learning task requirements, and to provide the corresponding learning resources for students.

After obtaining the task, students in order to complete the task used network autonomous learning at the first place; then the study group for collaborative learning discussed and completed the learning task.

Finally, the formation of learning outcomes was uploaded to the Internet platform so that they could display and learn from each other. Teachers and students made evaluation to students' learning outcomes and study effects of each group. The learning task was completed. Table 8 shows such a process.

Table 8. Activity process and content in type of online learning task drive

	F2F		OL	
Process	Teachers' teaching activities	Students' learning activities	Teachers' teaching activities	Students' learning activities
01	/	/	◆ Release phase learning tasks and requirements	◆Read and Understanding phase learning tasks and requirements
02	/	/	◆Provide flash multimedia learning resources	◆ Browse the resources Autonomous learning
03	/	/	◆Clear group learning tasks	◆ To carry out group cooperative learning
04	/	/	◆Organize students to watching each other communication	◆Upload the cooperative learning results
05	◆ Organize class discussion	◆Published phase learning outcomes	/	/

Type 5: Online Simulation Practice + in Classroom Teaching

Case: Course "Simulation practice of enterprise operation" in Guangdong Finance and Economics University.

The course is in the form of simulation practice in training students. It realized integrated management of operations using the network platform to effectively improve the students' comprehensive quality, to shorten the cycle of personnel training, and to improve the efficiency of the personnel training. The particular way of training is to ask students following the practice links after completing the course. An online comprehensive practice content system with practice schedules was well-designed by the teacher. Then, students began simulation practice activities according to the plan.

Students studied on the network platform which provides a dynamic simulation environment to simulate practice, and the teacher used the network platform for business monitoring and educational administration. The teacher also used the platform to discuss the design scheme of the virtual enterprise, to communicate with students, to provide business consulting and online training and other activities.

Finally, according to the recorded data on the internship process on the BB platform, teachers evaluated and assessed the performance on students' self-assessment, performance of the teams and individually combining multiple evaluation criteria. Table 9 summaries such a practice.

Table 9. Activity process and content in type of online simulation practice

F2F			OL	
Process	Teachers' teaching activities	Students' learning activities	Teachers' teaching activities	Students' learning activities
01	/	/	◆Internship announcement, including Practice content and schedule	◆ read
02	/	/	◆ Provide online resources, including: Government regulations on enterprise operation, specification of the declaration form	◆The simulation to fill out The simulation to declare
03	/	/	◆Business monitoring ◆Educational administration	◆The simulation enterprise operation
04	/	/	◆Answer the questions Communication with students ◆ To guide the simulation operation	◆Ask questions Communicate with the teacher
05	/	/	◆Organize students to watching each other communication	◆The simulation enterprise information release
06	◆ Organization simulation market	◆ The simulation transaction in the simulation market	/	/
07	/	/	◆Organize students to summarize reflection	◆Release summary and experience

6 Summary

Through the analysis of the successful cases using grounded theory analysis, we discovered many categories related to hybrid learning activities, from numerous and relevant categories shown in hybrid learning activity modes. The following experience is worth to be highlighted: (1) need to attach great importance to the instructional design; (2) pay attention to introduce and integrate curriculum resources on network platform; (3) positive use of a variety of computer software as a learning tool; (4) pay attention to build the real-time interactive platform between teachers and students; (5) diversify the design of learning evaluation; and (6) emphasis on the presentation and evaluation of students' learning outcomes. By using grounded theory analysis, this study summarized hybrid learning activities of different types for teachers and students. This study has a referential value for instructional design of blended learning and may provide a positive guiding significance to the teaching reform of colleges and universities.

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Exploration of Hybrid Teaching of Software Engineering on StarC

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Abstract. In view of the problem of the low efficiency in traditional classroom teaching due to the limitation in time and space, an exploration which combines real classroom with virtual classroom in hybrid learning was proposed. We chose the teaching of a software engineering course and used starC as the teaching support tool for analysis. In our study, the teaching process was divided into several teaching units, and each teaching unit was further divided into several activity units. The content was organized in the form of topicalities, where students are allowed to choose the learning content according to their study plans and preferences. Through the questionnaire survey which includes the indicators of participation and satisfaction among the students on both traditional learning and hybrid learning, it is found that the students on hybrid learning have higher participation and satisfaction than that on traditional learning. This indicated that hybrid learning could effectively improve teaching effectiveness.

Keywords: StarC · Software engineering · Hybrid learning · Teaching innovation

1 Introduction

With the rapid development of information technology, a lot of changes have taken place, affecting the lifestyles of people. In the field of education, the state has paid more and more attention on the use of information technology to promote educational reform. Supports have been given to educational information technology, both in policy and finance. After the release of "The ten-year plan of Education Information Development (2011–2020)" by the Ministry of Education, many schools (from elementary education to higher education) in different provinces have been actively exploring the use of information technology in classes, aiming to improve the quality and effectiveness of teaching. In the course of this attempt, a hybrid teaching model which combined real classroom and virtual classroom has gradually become popular. The Central China Normal University has invested a lot of money and efforts in educational information technology, and has built an integrated teaching platform which used a cloud classroom (called starC) as the main tool. It provides services for teachers and students to carry out the virtual classroom.

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In recent years, the author has been engaged in teaching software engineering courses in real classroom, but the effect is not very satisfactory. Teaching problems mainly found in the following aspects:

(1) Complex student background at varied levels

The course is compulsory for non-computer science graduate students whose major are mainly computer application technology, educational information technology, and communications engineering from the National Engineering Research Center For E-learning, School of Physics and Educational Information Technology Institute. The software engineering course is both theoretical and practical. The course content are abstract. For students who do not have much experience in engineering projects or have little background knowledge, they often feel unable to start, and thus lose the passion to learn [1].

(2) Large gap between training objectives and teaching requirements

The teaching plan of the software engineering course is outdated, resulting in the disjoint of social needs and training. It is difficult for students to participate in the whole process of software development. They cannot apply what they have learnt into real practice [2]. The training objectives are to provide professional skills for IT workers, such as programmers who has programming experience in the development of programming and testing, designers with experience in project integration and development, and project managers with project management experience. Due to the complexity of the students' background, it is hard to accomplish the training objectives within a semester. It has to compromise the teaching expectations.

(3) Simplex evaluation methods

The traditional view of the quality of software engineering education is that the amount and depth of knowledge of the theory is the main evaluation criteria. But the purposes of the software engineering course are to enable students to master the basic knowledge and develop their thinking for program development, and more important, to develop their abilities to analyze and solve problem independently. In traditional learning, teaching evaluation of students is limited by time, place and means. It is hard to have effective multi-dimensional and multi-level evaluation of the students, for example, the students' learning experience throughout the learning process, the process of group discussions, and good design ideas from case studies. Teacher cannot give comments and feedback in a timely manner in the traditional classroom because of limitations of time and place.

(4) Shortage of teaching resource

In the traditional classroom, teachers cannot provide adequate resources for students, based on the students' interests.

(5) Personalized learning are confined by teaching model

In the traditional classroom learning where classes are lecture-based, students complete the assignments under the teacher's guidance. They are basically in a passive acceptance status. Due to the learning different among the students, it is difficult to meet the expectations of the curriculum for all students. As a result, the enthusiasm of learning is low. This also limits the students' personalized learning.

(6) Difficulty in tracking the learning process

In traditional classroom teaching, teachers cannot record the student performance at different stages and different aspects, and hence, cannot track students' learning process and conduct formative evaluation.

The problems mentioned above mainly due to the limitation of teaching time, space and supportive environment. To some certain extent, a virtual classroom can ease the problem of teaching time, space and supportive environment. In this paper, we propose to conduct hybrid teaching in teaching the software engineering course, using starC as a tool. It attains the benefits of real classroom and virtual classroom, where they complement each other in order to improve the teaching effectiveness.

2 Related Work

Wang Lei explored the hybrid teaching mode on blackboard from the perspectives of teaching behavior and teaching design [3]. Zheng Chunfang realized the effective combination of network resources and classroom teaching through "courseware download", "course video", "network test", "resource links", "recommended reading" and "discussion" [4]. An analysis was conducted, showing that students' satisfaction was closely related to e-learning adaptation, perceived usefulness, timely responses from teachers, and the perceived ease of use [5]. Liu Junliang studied the application of seamless learning strategies in the hybrid learning environment, where the impact of gender, disciplinary nature and points of interest are analyzed, and proposed some suggestions for learners to knowledge building [6].

Zhao Dongmei studied the teaching practice of university computer foundation courses in hybrid learning mode, where the learning activities and evaluation were carried out on Blackboard platform [7]. Zhao Yu explored the students' academic performance, learning interests and satisfaction in hybrid learning [8]. Jin Yi studied the design of teaching activities in hybrid learning mode for enhancing the teaching effectiveness [9]. Sun Dongdong explored the development and application of learning resources for hybrid learning, and reviewed the principles and teaching methods in the hybrid learning mode [10].

3 The Teaching Tool Model Supporting Hybrid Learning

To effectively support hybrid learning, a teaching tool or platform must provide the following functions:

(1) Supporting multiple devices

Teachers and students can make full use of tablets, smart phones and PCs to upload materials or learn resources through the Internet.

(2) Personal space for teacher

The platform should provide teachers with adequate storage for teaching resources. It should also support resource sharing so that teachers can produce, upload and release learning resources through various means anytime and anywhere.

(3) Granularity of resource organization

Learning resources should satisfy the fine-granular feature as much as possible. Not only that the students can make full use of their fragmented study time to digest the learning resources, the teacher can also utilize the fine-granular resources flexibly to adapt to the individualized learning needs.

(4) Supporting individualized assessment

Topical or comprehensive assessment can be carried out any time to test the student's understanding. The assessment can be initiated by the students, or organized by the teachers.

(5) Timely and active message service

The platform should provide timely and active message services, for example, notices, homework and teachers' feedbacks.

(6) Effective interaction

The platform should be able to support real-time interaction and asynchronous interaction. Real-time interaction makes the communication among a lot of people at the same time, such as chatting rooms. Asynchronous interaction allows teachers or students to leave a message at any time, such as forums.

(7) Supporting group work and diversified assignments

The platform should allow a group of students to submit assignments. The teacher would give each student an individual score. For team assignments, the same score would be given to each student within the group. The platform should allow students to give comments to others. Where appropriate, teachers' arbitration is allowed. The platform should support multimedia formats such as videos and audio images.

(8) Procedural tracking

The platform should be able to record the students' learning process and carry out formative assessment of students according to formative assessment gauges.

The Central China Normal University has developed an integrated platform for teaching, called starC. It is a cloud classroom with the above-mentioned functions. Figure 1 shows the conceptual model of service of starC.

StarC can support multiple devices, including the teacher's electronic whiteboard, tablets, smart phones, laptops and ordinary PCs. It also provides a web version. A typical screenshot of starC is shown in Fig. 2.

StarC provides the following functions: electronic archives of students, supervision of learning process, analysis of learning behavior, personal space, online evaluation, subject tools, stream media on demand, MOOC and forum. MOOC is mainly used as

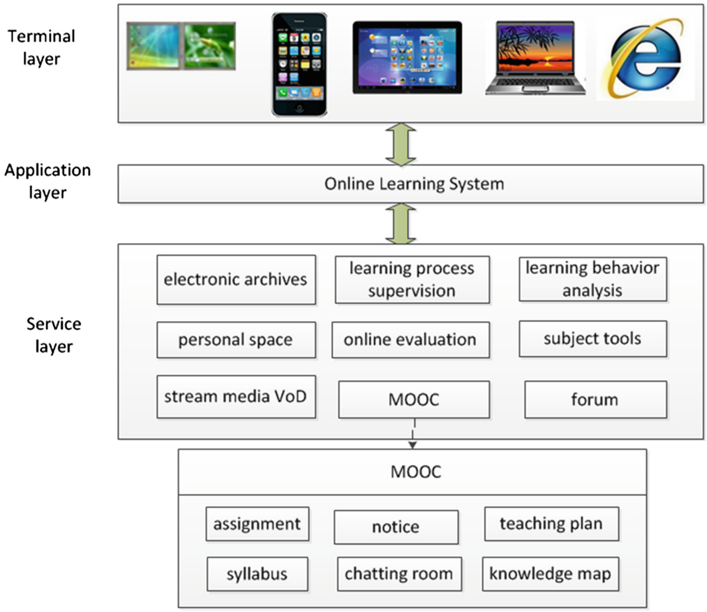

Fig. 1. Model of service of starC

Fig. 2. Screenshot of starC

teaching activities. Teaching plan, syllabus, knowledge maps, homework, notices and chatting rooms are supported.

4 Hybrid Teaching of Software Engineering

4.1 Teaching Process Model

The teaching process of software engineering is divided into several teaching units, and each teaching unit is divided into several activity units. Each activity unit covers a topic and the teaching mode can be the traditional classroom or online.

The hybrid teaching process model of the course of software engineering is shown in Fig. 3.

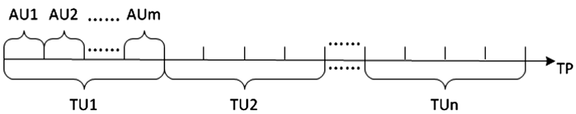

Fig. 3. Teaching process model

The formal description of the model is shown as follows:

$$TP = \sum_{i=1}^{N} TU_i \tag{1}$$

$$TU = \sum_{j=1}^{M} AU_j \tag{2}$$

$$AU = <\text{topic}, \text{mode}> \tag{3}$$

$$\text{model} = \{CI|OL\} \tag{4}$$

TP represents the teaching process. *TU* represents the teaching unit. *AU* represents the activity unit. *AU* is defined as a two dimensional array with topic and mode. There are two kinds of mode, *CI* (short for classroom instruction) and *OL* (short for online learning).

The model of students' participation in hybrid teaching in the course of software engineering is shown in Fig. 4.

It is shown that each student has its own learning process. Students' learning process is not controlled by a teacher. They can choose the topics according to their directions and preferences. The role of a teacher changed from leader to organizer. Students are not asked to attend every class and every activity. They would decide by themselves when to come to class and when to learning online.

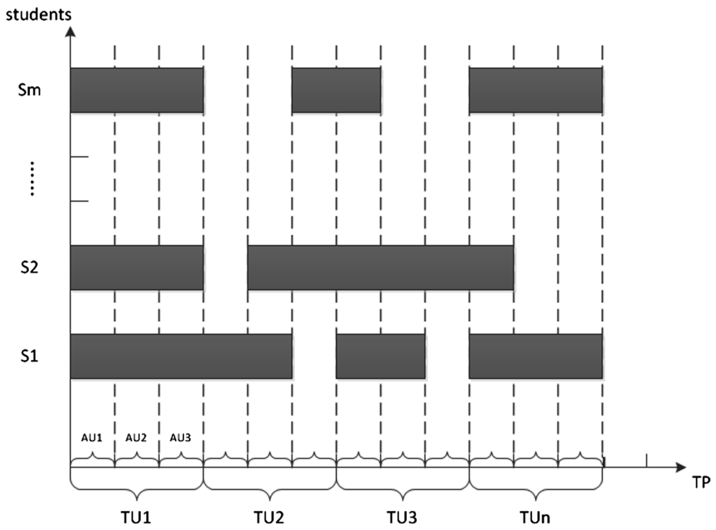

Fig. 4. Model of participation of students in teaching process

4.2 Teaching Practice

The starC has been used to support the hybrid teaching of software engineering course. Teacher uses starC to teach in class, set assignments, discuss or explain the concepts. Students use starC to learn, discuss, and submit assignments.

The teaching process would essentially cover resource development, assignment, discussion and evaluation.

(1) Resource development

Software engineering curriculum is characterized by various content, broad knowledge, and strong basic knowledge. It is difficult to cover everything in the limited teaching time. The advantage is that students can choose favorite fields to study according to their interests. Therefore, resources development is very important in order to take all the students into account. In starC, these resources include cases, such as project management case, videos for difficult point, such as path coverage in white-box testing, document template, such as for software requirement specification, test use case or test plan, etc.

(2) Assignment

There are two types of assignments: Compulsory assignments for all students are to complete as they have the ability to complete; Elective assignments for students to choose according to their own preferences and ability.

(3) Discussion

Special topics are organized for students to discuss such as on demands analysis, user experience design, and project management. The discussion is carried out in small groups. Comments and views are submitted using BBS and chat rooms in the virtual classroom.

(4) Evaluation

The comprehensive evaluation can be organized by teachers at the beginning of the term, during the semester and at the end of the term.

Comparing to the traditional classroom teaching, the hybrid teaching was extended in three aspects:

(1) Teaching Time

In hybrid learning, students have longer learning time, because the time covers both online learning and classroom teaching.

(2) Teaching Resources

With the help of starC, more teaching resources are provided as compared to traditional classroom teaching, for example, videos, pictures, e-books and other resources.

(3) Communication

In addition to face-to-face communication in the classroom, real-time online discussion and asynchronous can be made using starC.

5 Teaching Effectiveness

This paper is mainly based on the teaching of software engineering course from 2012 to 2014. Data are collected and analyzed on the teaching effectiveness, where the traditional classroom is compared with the hybrid classroom from the students' participation, students' satisfaction and students' gain.

We collected data from 53 students, 77 students and 105 students from the same course in 2012, 2013 and 2014, respectively. Traditional teaching is used in 2012 and 2013 while hybrid learning is used in 2014. The course has a total of 34 teaching hours. In the traditional teaching, there are 13 weeks of classroom teaching, and 4 weeks of project practice. In the hybrid classroom, there are 8 weeks of classroom teaching, 5 weeks of on-line learning, and 4 weeks of project practice.

(1) Students' participation

Class attendance is based on class-sign in and system access. Class discussion is based on BBS posts and replies and chatting room discussions. Class sign-in mainly aimed at reality classroom. The definition of class sign in is as follows:

$$RS = TS * W \tag{5}$$

$$AR = A/RS \tag{6}$$

RS represents number of required students. *TS* represents total number of students, *W* represents number of weeks. *AR* represents attendance rate, and *A* represents number of attendance.

The students' participation in 3 years is shown in Table 1.

Table 1. Students' participation

Mode	Year	Class attendance			Class discussion				
		Class sign in			System access	Classroom discussion	Forum	Chatting	Response papers
		RS	A	AR					
Traditional class	2012	689	516	75 %	n/a	68	n/a	n/a	n/a
	2013	1001	726	73 %	n/a	87	n/a	n/a	n/a
Hybrid class	2014	840	620	74 %	423	176	105	302	105

From the perspective of class attendance, there is little difference between traditional classroom and hybrid classroom in the last 3 years, both about 70 %. From the perspective of class discussion, the number of students in hybrid classroom was obviously higher than that of traditional classroom. It shows that students have more chance to interaction in hybrid classroom.

In addition, there are some activities only for the hybrid classroom, for example, discussion forums and chatting rooms. In summary, in the hybrid classroom, students have more chances to participate and get the feedback and express themselves.

(2) Students' satisfaction

Questionnaires are used to investigate students' satisfaction. The questionnaire provided three options, namely, very satisfied (S+), satisfied modestly (S), and not satisfied (S−). The results are shown in Table 2. A comparison of the results of the options is shown in Fig. 5. As can be seen from Table 2, the number of students that are not satisfied is 0, showing that students are basically satisfied with the software engineering course teaching. In the traditional classroom training in 2012 and 2013, the number of students that are very satisfied is less than that of satisfied modestly. But, in the hybrid class in 2014, situation is the opposite. This suggests that students' satisfaction in hybrid class teaching is higher than in traditional classroom teaching.

(3) Learning benefits

Learning benefits are investigated through questionnaires. The questionnaire provided three options, namely, gained greatly (G+), gained modestly (G), no gain (G−).

Table 2. Satisfaction survey results

Year	*S*+	*S*	*S*−
2012	21	32	0
2013	32	45	0
2014	52	49	0

S+ very satisfied, *S* satisfied modestly, *S*− not satisfied

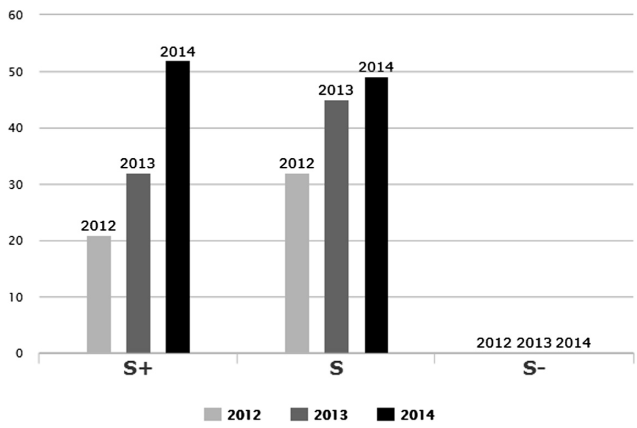

Fig. 5. Satisfaction survey

Table 3. Learning effectiveness survey results

Year	*G+*	*G*	*G−*
2012	12	35	6
2013	16	53	8
2014	20	79	2

G+ gained greatly, *G* gained modestly, *G−* no gain

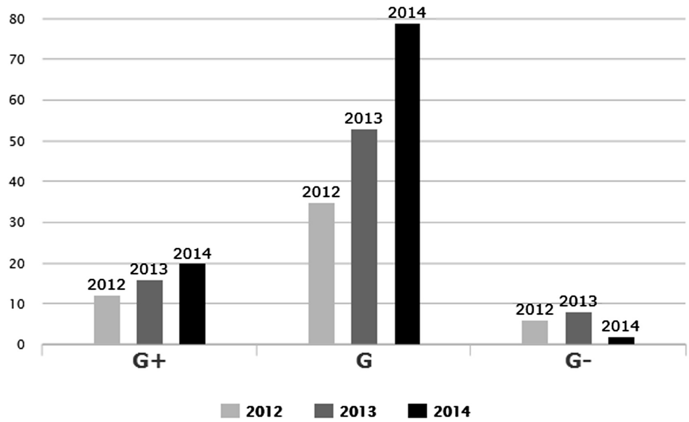

Fig. 6. Gains survey

The survey results are shown in Table 3, and comparison of the results of the options is shown in Fig. 6. As shown in Table 3, for hybrid learning, the proportion of students with the learning benefits increases year by year while the proportion of students with no gain declines year by year. For traditional classroom teaching, the proportion of students with learning benefits about 88 percent. These results show that the hybrid classroom can improve students' learning effectiveness to a greater extent than traditional classroom teaching.

6 Conclusion

Hybrid teaching is useful for teaching software engineering courses. It is found that the teaching support tools are important elements for hybrid teaching. Using starC for hybrid teaching, not only breaks through the limitation of time and space, but also improves the teaching from two dimensions: one is the depth, provides more learning and interaction opportunities for students, including the channel of accessing resource and achievement exhibition, the opportunity to discuss and assessment, and so on. Another is the breadth, the course can cover more students.

The hybrid teaching based on starC improves teaching effectiveness. It is however necessary to address two issues – how to determine the relationship between teaching objectives and teaching requirements, and how to adopt the personalized learning? Two modes in the personalized learning are suggested. The first mode is that the learning style and learning process are controlled, where teaching goals and teaching requirements are consistently maintained. The second mode is that students can plan the learning process according to their preferences. In this mode, there are differences between the personalized learning goals and the teaching goals. Further study should be done on how to make hybrid teaching adaptative to personalized learning.

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Feasibility Study of Hybrid Learning Strategy in Adult Correspondence Education

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Abstract. Adult correspondence education in mainland China started in the 1950 s and has been developed for over 60 years. The use of Information and Communications Technology (ICT) is one area of the development, but the progress is rather slow. It is undeniable that face to face teaching is the mainstream in adult education today. This paper analyzes the status and the problems of ICT development in adult correspondence education, and to propose a hybrid learning model for adult correspondence education, based on the experience on Network Education (Network education is a special education practice with internet in China. And online education and learning here is broader including Network education.) and the reconstruction of the teaching model.

Keywords: Correspondence education · Hybrid learning · Teaching model

1 Background

1.1 Challenges in Adult Correspondence Education

There are many study modes for adults in mainland China to pursue higher education, including the Correspondence Education, Evening University, Radio and Television University, Network Education and Self-study Examinations. Correspondence education was the oldest and largest one as it began early in the 1950s. Tens of millions students were trained and the teaching models were formed in a relatively stereotyped management approach later. For this management approach, the correspondence teaching stations were treated as a link to connect the host universities and students. These stations gave assistance to the host university in students' recursion, daily management, learning counseling, examination and other works with the authority of host Universities and Colleges. Learning was mainly based on the student's self-study, supplemented with short-term face to face teaching. This was the model for the first

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generation of distance education. The management approach and the teaching models ensured a basic quality in correspondence education by adapting the social development contexts.

However, with the development of society, these models do not suit the present needs for the following four reasons:

(1) Low attendance of face to face education for the conflict between working and learning. Most of the students were working adult. Though there were only a few days for face to face learning, it was still hard for them to participate aside from work.
(2) Low quality teachers. The correspondence education stations were usually scattered in different areas. There was always a conflict for teachers to arrange schedule for the host university and the stations. Teachers from the host university were occupied from their works in the university and did not have sufficient time for working in the stations. Therefore, the stations could only employ teachers from local. The face to face teaching's quality was then declined for the lack of good teachers.
(3) Inadequate monitoring and management from the host university. The hosting university could hardly play its role in teaching monitoring and management since the correspondence stations were not located in the same area. This was not the only significant reduction in face to face teaching time, but also the students' self-learning management. The student's learning support and teaching monitoring were also affected. Students had no chance to communicate with the teachers, so their questions and problems in learning could not be fixed on time.
(4) Other problems, such as the outdated learning contents and low quality learning resources which could not meet student's diverse learning needs. Teaching methods and mode of study were going backward and could not mobilize student's enthusiasm.

Above that, the correspondence education in China has reached its development bottlenecks. The "face to face plus self-learning" teaching model does not work well, and should be reformed to eliminate the above drawbacks. Constructing a new information-based distance education teaching mode is a new topic which is widely concerned by the correspondence education researcher and practitioners.

1.2 The Support Environment of Correspondence Education Informatization

With the rapid development of information technology and the improvements in network infrastructure, many different kinds of applications have been penetrated into people's daily lives and broadly used in various industries. This creates good conditions for the informatization development of correspondence education.

The number of Internet usersand mobile phone owners are increasing every year in mainland China. According to the report released by China Internet Network Information Center (CNNIC) in 2015, the number of Internet users has reached 649 million including 557 million mobile phone users. The coverage rate of internet has reached to

47.9 % which has raised 2.1 % compared with the end of 2013 [1]. At the same time, many kinds of new network applications have been developed rapidly. They have been penetrated into our economy, culture and everyday life. This means that the users can master the use of these information technologies easily, which provides a powerful support to the correspondence informatization.

The application of ICT in education also developed quickly these years. The Chinese Education Informatization Development Report (2013) pointed out that “our educational informatization has passed over the initial stage basically, and has been reaching the preliminary integration stage” [2]. Massive Open Online Courses (MOOC) got a lot of attention in educational field in 2013. Many famous universities have joined in MOOC research and development and proposed that MOOCs is a pushing hand (engine) of teaching reform in the future [3, 4]. This is also a powerful reason for expanding the education informatization.

1.3 The Lessons Learned from Network Education Pilot Practice

In fact, we earned experiences in integrating information technology into teaching in the field of adult education. The Ministry of Education launched a modern distance education project in 1999, and 68 colleges and universities were chosen to do a pilot study of network education. Network education is the most extensive, in-depth and successful forms of education that integrated technology into education in mainland China. It made considerable progress in many aspects, such as technology application, digital resource development and information management. This creates a strong impetus towards the information technology development in the pilot universities, and also promotes the reform and the innovative training model for teaching. This paper summarized the main teaching features of network education as follows.

(1) A variety of technical solutions formed with the application of the latest computer technology, network communication technology, multimedia technology and other information technologies. Three-dimensional information technology teaching environment has been built, and latest technologies have also been widely used in education, such as the next generation internet, mobile communications, artificial intelligence and virtual reality technology.
(2) Developed a number of digital education resources. The contents are rich, diversified, and highly interactive, which give students more choices in personalized self-learning. It is common to open and share the resources.
(3) New teaching approaches enhanced the teaching ideas and models. Internet-based teaching model has been formed and completed gradually; teaching content and curriculum system starts to adapt in-service staff’s diversity and individual’s needs; learning support services get a lot of attention; teaching teams gradually formed to adapt the characteristics of network education; flexible educational and teaching management models with credit system were widely used.
(4) Realized the digital teaching management and educational administration. These systems can support all management processes from registration to educational administration, teaching management, test management, tuition management, and

graduation management. Informatization management has been reached to a deep level of BPR (Business Process Reengineering) and improved the efficiency of management specification level.

Although online teaching has made certain progress, there were some obvious deficiencies of online teaching, as revealed in practices. These included issues on both the management perspective and teaching perspective. From the teaching perspective, the main problems are as follows:

(1) Adult learners cannot adapt online learning. This causes the problem of online learning disabilities.
(2) Some courses, especially the difficult courses such as science and engineering, are hard to be mastered only by online learning.
(3) The effect of practical training is not as good as expected. Although some practical courses can be learnt by simulation, the effect is greatly reduced. Let alone some practical courses which cannot be carried out by simulation.
(4) No interactions between students and teachers for pure online education which most of the teaching and learning process (except exam) are carried out online only. Interpersonal interaction is essential to both learning and personal development. For the lack of face to face interaction, the emotional interaction among students and teachers is hard to occur. It is not easy to eliminate the loneliness feeling of learners, to stimulate learners' motivation, to create excellent teaching context, and to promote the awareness of learners in the learning process.
(5) Web-based learning theory is not yet mature which has influenced the instructional design and the teaching organization. iResearch reported that though great attention had been paid by the government on online learning, admired by internet users, there was no fundamental change in educational model which resulted in blocking the development of online learning [5].

These problems gave a challenge to online education quality improvement and led to an adversely effect on the social reputation of online learning. The university engaged in online education should treat these problems seriously and response to them positively.

1.4 The Questions to Answer

There is no doubt that informatization will be the development direction of distance education. Sloan Consortium has released "Grade level: tracking online education in the united states" which is the twelfth annual report on the state of online learning in U.S. higher education in February 2015 [6]. "Is online learning strategic?" The answer in Sloan report is that the proportion of academic leaders who report that online learning is critical to their institution's long term strategy has grown from 48.8 % in 2002 to 70.8 % in 2014. The proportion of institutions reporting online education is not critical to their long-term strategy has dropped to a new low of 8.6 %, which is the lowest record in history. The question here it is: "are learning outcomes in online offerings comparable to face-to-face teaching?" There are different perspectives on it.

However, it is considered that the CAOs (Chief academic officers) focus more on the hybrid online education model which is to combine face to face education with online learning. They believe that the effect of hybrid learning "is better than" face to face teaching and online teaching. The majority of the academic leaders rated the outcomes of online and blended learning the "Same" as face-to-face learning (57.9 % for online and 56.6 % for hybrid) when the blended learning outcomes were more remarkable when comparing to the online teaching (32.8 % for hybrid versus 16.3 % for online).

Above all, the teaching method of adult correspondence education needs to be reformed. The informal learning environment has provided good conditions for correspondence education informatization development. The former experience of network education practice gave us some lessons to refer for the transformation. The remaining part of his paper is to discuss how to design the path of this kind of reform and is it feasible to adopt the hybrid learning strategy in correspondence education.

2 Adult Correspondence Education Informatization

Given the current situation of adult education, informatization is the fundamental in exploring the right strategy for adult correspondence education in mainland China. A survey was conducted in adult education colleges of higher education. An Adult Education Informatization Survey Questionnaire was sent out to 68 Universities and 65 valid questionnaires were collected. The investigation mainly covered the following perspectives: college basic information, informatization teaching, digital resources construction and sharing, investment in informatization (human, material and financial resources) and so on. Field research was also conducted at some adult education colleges and universities in Jiangsu Province and Shandong Province.

2.1 Current Status of the Adult Correspondence Education

The current status of adult correspondence education informatization could be concluded by the above questionnaires and surveys.

As we can see from the Table 1, although face to face teaching is still the main teaching method in correspondence education, the informatization teaching methods have been introduced and the online teaching has also been adopted.

Table 2 shows the level of acceptance for the necessary degree of correspondence education informatization. Universities participated in the survey agreed that it is substantial to integrate the ICT into correspondence education in order to avoid the elimination.

Table 1. Teaching methods in correspondent education

Without any digital learning resources	Without network, but use digital learning resources	Part online based teaching	Totally online teaching
14.7 %	35.3 %	50 %	0 %

Table 2. The acceptance degree of Correspondence education informatization

Very necessary	Necessary	Indifferent	Unnecessary
89 %	11 %	0	0

Table 3. The Multimedia classroom construction in university

Whether built multimedia classrooms		Whether connected to the Internet		Whether meets the need of daily informatization teaching	
Yes	No	Yes	No	Yes	No
97 %	3 %	92 %	8 %	79 %	21 %

Table 4. Multimedia classroom construction in station out of university

Whether built multimedia classrooms			Whether connected to the Internet		Whether meets the need of daily informatization teaching	
Yes	Partly	No	Yes	No	Yes	No
50 %	45 %	5 %	84 %	16 %	76 %	24 %

As we can see from both Tables 3 and 4, the internal and external networks and other conditions fulfilled the basic requirements to carry out informatization teaching.

Table 5 listed the current and expected way to build digital resources. Parts of the adult education digital resources were developed by themselves, but most of them were still in the learning imitate stages.

From the above several major research data, the importance of correspondence education informatization was recognized when the Informatization methods had been adopted. In order to remedy the drawbacks of “self-learning plus face to face teaching” model, most adult education institutions have tried to adopt digital resources in teaching. Some of them began to teach their courses completely online. Students’ learning method has been transformed to “self-learning plus learning online plus face to face teaching”. It is the horizon of hybrid learning approach.

2.2 The Bottlenecks of Correspondence Education

We found from the survey that although correspondence education informatization is highly concerned by correspondence education directors, correspondence education still faced its bottleneck.

Table 5. Curriculum resources construction methods

	Self-build	Corporative building	Buy	Sharing undergraduate resources in the university	Sharing undergraduate resources out of university	Sharing international open resources
Curriculum resources building approach	50 %	14 %	14 %	13 %	20 %	14 %
Expected curriculum resources building approach	42 %	50 %	35 %	35 %	22 %	37 %

(1) Lack of startup capital. Funding is indispensable for the infrastructure set up and support for informatization. However, no funding was available from the government on the correspondence education. The costs are unlikely to be absorbed by the tuition fees especially for those small sized universities.
(2) Lack of professionals and technical experts. The correspondence education is a traditional education model. There is a lack of informatization technology professional. Teachers and administrators are not required to possess any information technology skill. Once the informatization teaching starts, it is necessary to have the professionals to monitor the set-up of technical infrastructure as well as the continuous development of digital resources. The informatization literacy needs to be improved among all staff. The low ICT capability and literacy will only restrict informatization development. Teachers should enhance their level of information technology to support the online services and teaching activities.
(3) Lack of suitable digital resources. Integration of digital resources into education can accelerate informatization process, but the resources shared channel is insufficient because of information asymmetry. Teaching requirements of the schools are different. It is difficult to achieve the integration.

In addition, the teaching mode design is essential. Some School directors think that the correspondence education informatization is not complicated. The reality tells us that it is not as simple as a patchwork of several different teaching methods. A reform is required on the overall design for transforming the original structure and sequence to recycling processes. In the new model, the functions and requirements of all entities in the whole teaching and learning process should be imposed on teachers and students. All learning tools and learning resources will be different in the new model. New model design is important as the products mentioned above had a heavy reliance on it, and they should be changed with the design.

3 The Hybrid Model of Adult Correspondence Education

As mentioned earlier, traditional correspondence education was successful in the past, but it needs to be reformed for the change in the ecological environment [7]. There are many advantages of online education for the new context. Yet, online education also has shortcomings. It is not the best solution to replace the correspondence education. Many scholars in mainland China believe that hybrid learning is the best way to transform traditional correspondence education with information technology [8–10]. We also support this idea, based on our practical experience in network education for many years.

3.1 The Definition of Hybrid Learning

The definition of hybrid learning we adopted in this study is the one which focuses on optimizing the achievement of learning objectives by applying the "right" learning technologies to match "right" personal learning style to the "right" person at "right" time [11]. It has the following connotations: (1) focus on learning objectives rather than the technical delivery methods; (2) it should support a variety of different learning styles and to be adopted by more audience; (3) different knowledge backgrounds will get different learning experiences; (4) the most effective learning strategy is give what learners needed in time [12].

3.2 Hybrid Learning Model of Correspondence Education

As we can see from the Fig. 1, the teaching process of the correspondence education has the above features. It is a self-study based learning that teachers and students are isolated in the whole process. Though there is a short-term interaction between teachers and students; students with students, it is hard to interact and give feedback to students timely. There is no collaborative learning but only a single evaluation. Student can complete their experiments in the traditional correspondence mode. Figure 2 is a hybrid model in correspondence teaching.

The hybrid learning model for adult correspondence education has the following features:

(1) The internet support to the whole learning process. It is convenient for the interaction between teacher- student, student-student, and student - learning resource. It also supports different types of face to face teaching, teacher-student and student-student face to face interaction.

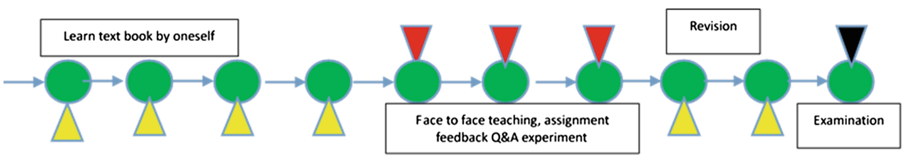

Fig. 1. Teaching process of correspondence education.

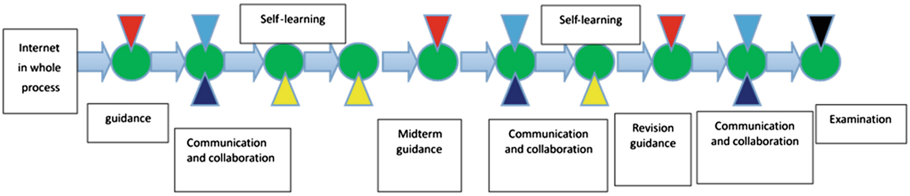

Fig. 2. Teaching model of hybrid learning

(2) Course chosen. In the past, with the restriction of inavailabilities of teachers in face to face teaching stations, all students in one programme had to learn the same courses. After using the Internet supported hybrid learning, learning is more flexible and open. Students can choose what they would like to learn form a certain range of courses based on their individual needs and interests.

(3) Course Learning. Learning guidance is provided. The main contents of the guidance include learning methods, introduction to online learning, and introduction of courses' academic requirements. Then students will complete the courses mainly by self-learning approach from both online and face to face. At the middle of the term, teachers will use the face to face model for guidance and feedback. There is a centralized guidance at the end of the course to help learners to revise and prepare their examination face to face. Compare to the traditional correspondence education model, the face-to-face contact hours can be reduced to one-third or less, and it will help learners to get a balance between working and learning. It is more flexible for learners to choose their learning time and station.

(4) Interaction and learning support. The interaction includes the access to learning resources, assignment, counseling, answering question and so on. The interaction can be made through the internet. High-quality and diverse online course resources are important for the foundation for hybrid learning. The uneven quality of teachers in correspondence station has been a major problem in teaching quality. Digital learning resources are easier to share and give learners a better experience. Teachers can give their feedbacks to students and mark their assignments online. Basically, the online tutoring can be done anytime. Students' questions can be answered more quickly. Face to face interaction and online interaction can be provided alternately to support each other. This can improve the learning effectively. The online learning support services throughout the teaching process can compensate the absence of learning support services in the correspondence education.

(5) Emotional exchange. There are three interaction stages in the learning process including not only teacher-student and learning interaction, but also student-student and emotion interactions. We found from the investigation that main purposes for students going to the correspondence stations were to overcome their loneliness by making friends and learning partners, and to get a sense of belonging, rather than listening to the lecture (this is the main task of teacher today, the class full with chalk and talk). Adults always have a basic learning ability to grasp the main learning contents by reading. If the primary function of

face to face teaching has been changed into Q&A and emotional communication, the number of students participated in face to face learning will be increased greatly. Therefore, the design of activities for students is the main task that we should prepare.

(6) Learning assessment. The final examination is the main evaluation method in traditional correspondence education. This kind of examination is serious, and formal. Testing the students' learning progress is just one of the purposes of examination. The more important thing is to encourage daily learning. It is generally believed that daily formative assessment plays an important role in promoting learning. The conflict of work, study and life for adult learners is critical. Students always put learning at the secondary position when they are busy. It is difficult to have a routine examination in traditional correspondence education. However, for online learning, it is easy to give assignments including daily assignment, quizzes, and online learning activities. Hybrid learning can combine the formative assessment and summative assessment together. It is a better solution for solving the problem of learning assessment.

(7) Practice. Students have chance to attend face to face learning. However, hybrid learning only provides some face-to-face learning experience.

(8) Teaching monitoring. In traditional correspondence education, teachers and students are separated. This adds difficulties in monitoring the teaching process. Teaching quality is hard to assure because the teaching requirements are hard to implement. Hybrid teaching makes the relationship closer as the teachers can track students' learning on time. Since the main process is completed online, teachers and administrators can spend more time in monitoring the teaching process.

4 Discussion and Conclusion

We have adopted the above hybrid learning into practice for several years and made some achievements. Our experience is summarized as follows.

There are two lines of correspondence education. One is the self-learning based on reading materials in paper form. The other one is the content-based course with face to face teaching. These two lines are parallel in a stage. Sometimes they may come together, but are usually separated. Hybrid learning combines them as one line. Core learning activities are conducted online, and the other activities play a supporting role. Nevertheless, it does not mean that these other activities are unimportant because they make online learning more thorough and sustainable.

Hybrid learning focuses on the learning objectives rather than the technology methods. There is no fixed proportion between face to face and online learning. Different proportions are used in different courses, depending on the course, teachers, and learners. Different people can have different options on the overall design. As different people have different learning styles, background, knowledge and learning experiences, learning strategies can be personalized.

Hybrid learning is not a patchwork of learning. The basic principle is to integrate different online learning tools into learning, instead of revising the traditional face to face learning. The integration process should be carried out gradually and cannot be hasty. The goal of hybrid learning is to combine the strengths of digital and traditional learning and to build a multi-dimensional distance learning space which can motivate learners. Hybrid learning is easier and better for learners but more complicated than the correspondence learning.

Online education has been breaking the boundaries of time and space. Students are having more autonomy in online education. It can meet the needs of working adults. Informatization can make a qualitative change in teaching method and teaching mode of correspondence education. It can improve the development of correspondence education.

There are still some limitations in online education, such as a lack of the feelings and emotions in real teaching context, dependence on student's participation, and self-control and time management. It is difficult to compare correspondence education with online education on the efficiency, openness and convenience. However, as compared to face-to-face learning, online learning does not have the advantage of the people-centered teaching and learning.

Correspondence education has been transformed from the traditional classroom teaching to online teaching, and then transformed back to the hybrid learning mode. This demonstrates that the correspondence model still has its clear advantages. Most researchers believe that hybrid learning model is the best distance education mode. Practice has proved that hybrid learning is an effective method to ensure learning quality. Informatization of correspondence education should be developed gradually. It should not be a duplicate of online education. An important factor to ensure the teaching quality is to strengthen the management.

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Learning with Video: The Digital Knowledge Representation and Digital Reading

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Abstract. Being a form of digital media in delivering knowledge, video has become one of the most important elements in online learning ecosystem. Some even claimed that these lecture video would replace the role of teachers. This paper introduces the features of video and explores how video can be applied to learning. The result of an experiment conducted by the researchers in this area is also discussed. Based on the collected statistical data, this paper further proposes an effective approach to designing "video reading" activities in four reading levels, namely, elementary reading, inspectional reading, analytical reading and syntopical reading.

Keywords: Representation of knowledge · Digital reading · Digital reading assignment design

1 The Role of Video in Online Learning Ecosystem

Video has become one of the most important elements in the Online Learning ecosystem. Video is indispensable for Massive Open Online Course (MOOC) or the Flipped Classroom. There are many examples. Khan Academy contributes many wonderful mini instructional videos for K-12 students. The teachers and students over the world can watch Khan's videos on the Internet. TED is another example for becoming a video-based encyclopedia more and more. With TED mini lecture videos, the audiences ("digital reader") can access to the innovative ideas from Khan, Gates, McCandless, Underkoffler, Sagmeister, and Johnson [1–4]. With the rapid development of wireless network, learners can access the mini videos by smart phone anytime and anywhere, realizing online learning ubiquitously.

Video has now become a research topic, and the e-learning researchers have the following research questions:

(1) Will the videos substitute teacher?
(2) What is the role of video in Online Learning ecosystem?
(3) How to integrate videos into learning process, and to engage the students accordingly?

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1.1 The Method to Inquire the Role of Video

With the purpose of observing and studying the role of video, a research course named "The Digital Representing and Digital Reading" was designed and offered to graduate students in a university. 11 graduate students enrolled and the main reading materials were videos. There were 9 sessions in this course and each session included watching the video guided by a worksheet, discussing in classroom, and writing a reflection note after class. The final essay studied the impact on students with a comparison on using video and textbook in learning, and analyzed the features of videos, with a discussion on how to integrate video in teaching.

1.2 The Basis Idea of Course Design: Video Is Just a Digital Textbook

The main tool to inquire the role of video was offering a research course in graduate level. Compared to other courses, no textbook or lecture were provided in this course. Over 90 % of the learning materials were videos.

The research course was proposed by a professor who established a framework to explore the relationship of education and media from oral chant, artificial press, printing press, radio and TV, to Internet, shown as Table 1 [5].

Based on this framework, the professor considered that the video was just a new digital textbook aligned with oral chant, the palimpsest, and the printing textbook to present and convey knowledge. The Lecture video of MOOC could not substitute the role of teacher. For the perspective of communication, course is an information system to convey knowledge and it includes 5 elements: student, teacher, content, social interaction setting, and learning activities (learning dialog). A video-based course consists of a content design (with selected videos), learning activity design, and the implementation process.

Content. The videos of the course are listed in Table 2. Several articles and 3 presentations were provided as supplementary learning material.

Learning activities. Subject to four reading levels, the teachers designed the "video" reading activities for graduated students, and developed learning tools like reading worksheet, discuss outline, reflection notes, and essay assignment.

Implementation. The course was taught in a hybrid model and the interactive setting included the set-up of classroom, the online learning classroom, email and after-class activities.

1.3 Data Collect and Analysis

At the end of the semester, a questionnaire was designed for a survey on the status of after-class "video" reading and to interview students about the differences of the learning experiences through video and textbook. Questionnaires were analyzed with statistical method while the interview data, the reflection notes and the final essay were analyzed with a word frequency analysis system. Based on the statistical data and the word frequency analysis, this paper introduces the features of video, and the effective teaching methods of "reading" videos.

Table 1. The outline of Media History and Education History

Time	Symbol system	Writing material	Duplicate tech	Education
Before BC 450: oral Chant	Oral syllable	People Brain	Speak and Memory	master
From BC 450 to 1450: artificial press	alphabetical language	Papyrus, Parchment paper, Manufactural paper	Transcribe by professional person	Old style school
From 1450s to now: Printing Press	alphabetical language	Manufactural paper	Print Machine	Modern School system
From 1830s to now: Analog E- Media - Radio and TV	Express symbol: oral, alphabet, picture, video and so on. Save and convey: analog e-signal.	Tape, CD etc.	Copy	Open University based on Radio and Television
From 1990s tonow: Digital E-Media, Internet	Express symbol: oral, alphabet, picture, video and so on. Save and convey: digital e-signal.	Internet	Download/ Upload	A whole new ecosystem for education

Table 2. The list of videos

No	Video
1	The Internet Age, Episode1 Time, CCTV
2	The Internet Age, Episode2 Tide, CCTV
3	Why Poverty, Episode 8, What does an education get you? Steps International
4	Greek Myths Tales of Travelling Heroes, BBC
5	The Power of Time off, TED Talks
6	Where Good Ideas Come From, TED Talks
7	Talk Show Friends, Xiangdong Zhang vs. Hang Zhou, Youku
8	Morning Call from Xiaosong Gao, Youku
9	Boss Town, an interview show, Shanghai Dragon TV
10	The Bang-bang Trio, guest Xiaobo Wu, Phoenix Satellite Television

2 Representing Knowledge with Video

2.1 The Elements of Knowledge Expression with Video

Knowledge is conveyed by means of symbolic system, such as oral syllable, alphabet, etc. With printing technology, knowledge is represented in text, numbers, and graphics. With the Internet, there is a variety of symbolic systems such as text, numbers, graphics, sound, moving pictures, and video, etc. To express knowledge, there is an intersection of sound, characters and pictures in video [6], shown as Fig. 1. They are all expression elements that play a different role in knowledge expression.

Characters: Concert with Picture and Sound, Highlight the Points. Characters are primarily used for text captions and only a few characters are shown in video. The basic expression element of video is the static picture although video is usually made by dynamic continuous pictures. Captions, sound and pictures help to deliver information nicely. The characters in the pictures highlight the main points. One of examples is public service advertising about the excessive drinking in Finland [7]. A one-minute story is told by a picture of scared eyes of kids with nearly no text and commentary. At the end, a caption appears: *How do our children see us when we've been drinking?* The audience was touched by the letters. The letters are the indispensable element of the video.

Sound and Pictures: Concrete vs. Imaginative. Video transfers knowledge through characters, sound and pictures. It has some other special features in delivering knowledge. The questionnaire designed with several questions to interview the students about the features of video. The high-frequency word analysis showed that learners recognized that the main feature of video was concrete vs. imaginative.

The sound and pictures make the knowledge expression more concrete and dynamic. A Video titled "*Do you know about heart stent surgery?*" [8] introduce the preoperative preparation of the surgery, the shape and usage of the heart stent, surgery course and the postoperative considerations. The main expressive elements are static pictures, animation, motion graphics and voice-over. The shape and the heart stent are

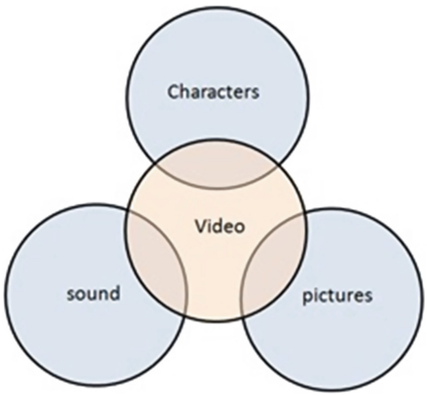

Fig. 1. The representation elements of video: characters, sound, pictures

showed with static images and the course of surgery is shown with motion graphics. The audience can "observe" the surgery, the tube insertion, and the status of blood flow etc. The contents of the heart stent surgery video is concrete and vivid which engages the audience to watch and to obtain (and read) the "knowledge". Yin responded: "*Watching video is more enjoyable. It can arouse my interest by listening, watching and reading*. Wang said: *Video can catch your attention easily because of the sound, color, picture* etc. *But reading text needs more patience*."

Some students think that "reading" the video may hurt the imagination. 8 out of the 11 students concerned that the video may go worse with the imagination. Li said: "*when reading the texts, the reader will imagine the outlook, shape of object, and dynamic process of operation, so called 'there are a thousand Hamlets in a thousand people's eyes'. While "reading" the video, the pictures directly defined the outlook and shape. It is discouraging for imagination training.*"

People: Special Element of Video Representation. The teacher, speaker or interviewer frequently appear in the video is defined as a special expression element. In videos, they are the story tellers. Tide, the episode 2 of The Internet Age, tells the story of the development of Internet and the Internet entrepreneurs, such as Marc Andreessen, Yang Zhiyuan, and Mark Elliot Zuckerberg etc. who are the actors to narrate the history of Netscape, Yahoo, Facebook, and so on. TED Talk is the one of speech which shows with the narrative style and the speaker is the first important representation element. For each TED talk, speaker takes charge of interacting with the pictures and text to convey the innovative ideas. Talk show usually has a host or hostess. He/She is the most important expression element of video for interviewing guests and managing the procedure.

The elements of characters, sound, pictures, people, and the lens, light and rhythm constitute the family of video language. Each element is not represented independently, but aligned with a story to present a piece of knowledge.

2.2 Rhetoric of Video

Rhetoric is a way of expressing meaning and conveying affection. In the process of text reading, the best way to make the expression appropriately is to use rhetoric such as metaphor, parallelism or exaggeration. Rhetoric also exists in video. The convey of knowledge can be presented in a better way by using rhetorical devices, and it also helps to express emotions and arouses empathy appealing to vision or auditory.

Rhetoric of Video: Metaphor and Metonymy. Video narrates story with consecutive frames of the authentic scenes and concrete objects, which brings obstacles in expressing abstract concepts with video. For example, the definition of "Internet" in textbook is stated as: "The Internet is a global system of interconnected computer networks that use the standard Internet protocol suite (TCP/IP) to link several billion devices worldwide." It is difficult to express this definition directly by video with the fact that "Internet" is not a concrete entity. Therefore, the rhetoric, such as metonymy, metaphor or other, should be used to comprehend the abstract concept in video.

The documentary, The Internet Age, employs metaphor and metonymy of the rhetoric to express the abstract concept of "age" and "Internet". Tide, the episode 2, represents the "The Agrarian Age" with seedling and wheat, "The Industrial Age" with gear, train and aero plane and "The Internet Age" with huge buildings and computer chips. Another rhetoric tool in this documentary is metaphor. The picture of Fig. 2 - waves in the ocean, traffic in the city and lights – is a visible metaphor of "The Internet tide". By using metaphor and metonymy, it is very clear to symbolize the abstract or invisible things. Rhetoric is an expressive tool of video to express and convey meaning.

Video Rhetoric: Exaggeration, Parallelism and Stretch Time. Exaggeration and parallelism are used in the video to express certain knowledge and arouse empathy. In Tide of The Internet Age, there is a series sentence to describe the big breakthrough in the Internet time:

These are distinctive "L" and "O";
These are unprecedented "L" and "O";
These are distributed and exchangeable "L" and "O";
These are breeding big data and cloud computing "L" and "O";
These are belonging to everybody "L" and "O".

This paragraph uses parallelism rhetoric and a repetition of "L" and "O", coordinating the strongly lyrical tone and the scenes of significant inventions in human history which achieves the exaggerated affection in emotions. In the questionnaire, Zhang said: "*This kind of exaggeration makes the documentary a little hypocritical, but you cannot deny you remember it and your emotion raise up to the top.*"

Another unique rhetoric in video is to stretch time, which is known as drawing out frames from a few seconds or even a few minutes in reality to tens of seconds. In video rhetoric, with the use of parallelism, exaggeration or other rhetoric assisted by background music, oral language or pictures, video arouses learner's emotions and empathy.

Fig. 2. The screenshot of *The Internet Age*

2.3 The Structure of Knowledge Expression with Video

The structure of knowledge expression is to illustrate how people organize evidences and study the interrelation between different knowledge. For educational communication, the most vital task is to establish a link between fragmented knowledge and to form a clear structure with a theoretical framework [9]. Therefore, structure is an important part of knowledge expression. The knowledge structured in video are always differed from the way organized in textbooks.

Tree Structure and Star Structure of Books. For textbooks, there are several common structural types, such as Tree Structure and Star Structure. Taking the book *How to Read A Book* and *Justice: What's the Right Thing to Do?* as an example, researchers has analyzed the knowledge structure of that textbook.

Tree Structure. Figure 3 show the tree structure of *How to Read A Book* [10]. The content of this book is organized into three parts. Each part focuses on a special aspect: dimension, approaches and goal of reading. All the knowledge is classified to three parts while the relations are weak between these 3 parts.

Star Structure. The star structure of *Justice: What's the Right Thing to Do?* [11] is shown in Fig. 4. The author explores the topic of Justice with different theories from different perspectives, and integrates several cases of justice dilemma into each session. The tension between the theoretical statement of justice and the complexity of justice dilemma makes the students think that the topic cannot be easily understood which fosters the critical thinking.

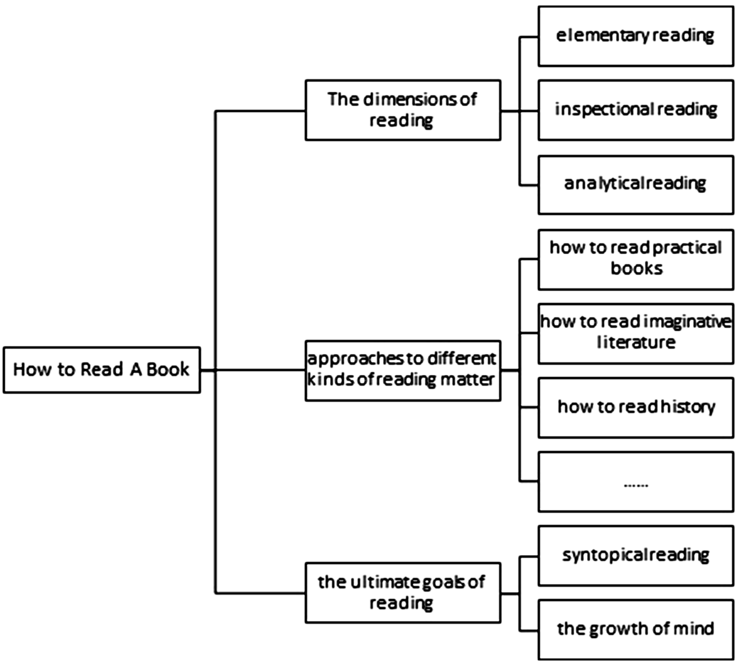

Fig. 3. The tree structure of *How to Read A Book?*

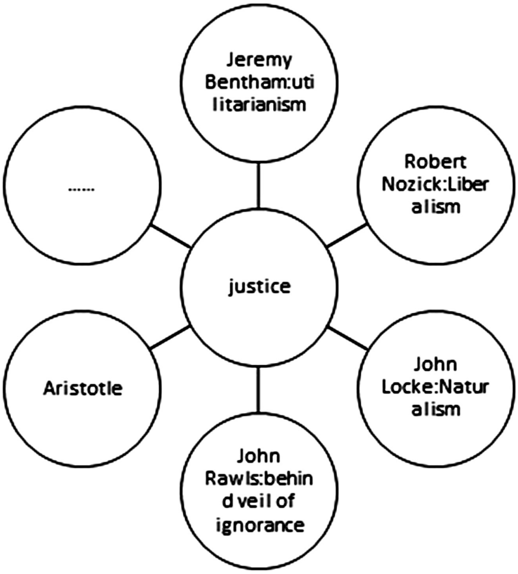

Fig. 4. The star structure of *Justice: What's the Right Thing to Do?*

Tree Structure and Star Structure succeeded in the structure of knowledge expression based on "Rumus Textbook Paradigm" [5]. Five hundred years ago, after the innovation of printing machine, a French philosopher named Peter Rumus figured out the paradigm of textbook and established Rumus Textbook Paradigm. According to this paradigm, a textbook began with several basic concepts, such as how to start reading; resolve concepts into sub-concepts, e.g. the dimensions, approaches and goals; and at last, all concepts are fully explained. When reading a textbook, the learners need not to read from first page to last page but to pick a sequence based on the knowledge structure. Otherwise, they may not be able to understand the concepts and contents.

The Structure of Knowledge Expression with Video. Different from the textbook, video cannot provide the table of contents and index. It arranges the evidence, statement, and theory with linear structure in chronological order. All the knowledge points are integrated to a consecutive order and these points are connected by time. The learners obtain the knowledge only when they have finished watching all the videos.

Without the table of contents and index, it is difficult for learners to grasp the video's knowledge structure. The question about "What do you think about the differences between reading books and watching the video?" 7 students pointed out the difference in knowledge structure. Liu said, "*Contents and index can help the learner to concentrate on the main points promptly, but videos cannot*." Zhang said, "*Video does not allow us to grasp the structure and establish a link between the knowledge points of video*."

The continuity of knowledge representation in video should be taken into consideration when establishing the links between facts or perspectives. Therefore, coordinate structure and linear structure are suggested.

Table 3. The three stories in documentary of *What Does an Education Get You?*

	People	Topics	Surroundings
Scenes in story 1	A schoolgirl who failed to the college entrance exam	Family conditions The purpose of going to college: getting rid of poverty	The girls home in the rural area
Scenes in story 2	A trainer who comes from a private education institutions	His work about propaganda of the institution(cheating the students actually)	The education institution; The trainer's apartment; The rural area;
Scenes in story 3	A graduate who is finding a job	The process of finding and changing jobs	Job market; company

Coordinate Structure. Video scene transitions to express several coordinated stories. The documentary, *What does an education get you? Episode 8 of Why Poverty* has three coordinated stories that are distinguished by people, topic and surroundings, shown as Table 3. The transition technology, such as fade-in, fade-out, dissolve etc., helps to build the video structure. The coordinate structure is clear. From the analysis of the after-class reflection notes, all the students can clearly tell the 3 stories and clues in this documentary. Li said, "*these 3 stories are connected when compared with others. The others cannot be linked up together.*" By transition technology, the documentary narrates 3 stories in different time and space.

Linear structure. Different from textbooks, most narrative structures of video is in linear structure. The evidence and the theory are presented by the host or narrator. For example, in the documentary of *BBC: Greek Myths Tales of Travelling Heroes*, the historian Robin Lane Fox narrates several Greek myth tales and finds the evidences to prove the history. Another case is *Morning Call: The Great Voyage*. Following the narration of Xiaosong Gao, the status of Europe in the end of 15th century, Christopher Columbus and the New World gradually appear on the screen in linear sequence.

2.4 Video: Explicating Tacit Knowledge by Presented the Process of Doing

Knowledge can be classified into explicit knowledge and tacit knowledge. Polanyi [12] has defined tacit knowledge as something that cannot be explained in text, charts and mathematical formulas which involves the action of doing something. Tacit knowledge is highly personalized and empirical and it is difficult to be coded, expressed and spread. As we know, the way to highlight and utilize the value of tacit knowledge is to make it explicit.

Internet changes the way of communication, and provides new expression tool to express and convey the tacit knowledge. Video is one of the knowledge representation tools.

By using the continuous dynamic pictures, video can express and convey the process of doing something. The learners can "observe" and learn between the pictures about the tacit knowledge. According to the existing research, tacit knowledge is a dynamic presence. The tacit knowledge of teaching is a complete, true and dynamic presence of the teaching space and context. Comparing the textbook, video has the advantage of representing the information about context, space, and the whole process of teaching to convey the tacit knowledge [13]. Therefore, some long history tacit knowledge in printing era can be represented and conveyed through video.

Video provides more information than the textbook. Different from the textbook, video acquires hidden context that influences the understanding and explicating the tacit knowledge. For example, the documentary *Greek Myths Tales of Travelling Heroes of BBC* brings the myths back to its birthplace, the cultural relics and remains. The true scenes of the remains carried the mysterious cipher to help the audience to reproduce the scene of the birth of Greek Myths Tales, and to experience the development and the formation of the tales. A student Li said: "*Natural scenery in the video shocks me. If Professor Fox talks about the origins of Greek mythology in a classroom, students may find it difficult to understand how the nature gives its impact to the myths.*"

3 Video Reading: Learning with Video

Video has become the most favorite digital media among the readers, especially the young readers. Thousands of people access to video contents with tablet, smart phone and PC every day. Nonetheless, when the video is integrated into the formal teaching, the problem appears that the completion rate of lecture video of MOOC is very low. K12 schools have applied flipped classroom method, but the teachers do not know how to engage students to learn video content.

How to design a course plan that is able to engage students in learning with videos more frequently?

According to the analysis of the role of video in the beginning of this paper, video is just a digital textbook. The course of video "reading" can be designed by referring to the model of book reading, selection of the appropriate videos and the assignment of the learning activities of "reading" video.

3.1 Four Levels of Reading

Mortimer J. Adler, the author of How to Read A Book [10], states that there are four levels of reading, namely, elementary reading, inspectional reading, analytical reading and syntopical Reading. The four levels are cumulative, meaning that "the first level is not lost in the second, the second in the third, the third in the fourth" [10]. The fourth and highest level of reading, syntopical reading, includes all the other levels.

The first level of reading is called Elementary Reading or Basic Reading. When one masters this level, one could "pass from the illiteracy to at least beginning literacy" [10]. Children always encounter this level first, in which they learn to recognize individual words and grasp the meaning of the sentences on the page. Although adults have memorized so many vocabularies, they continue to have difficulties at this level especially when reading the foreign language books.

Inspectional Reading is skimming, which is characterized by reading more as quick as possible. After this level, readers are able to answer the questions: “What is the book about?”, “What is the structure of the book?” and “what are the parts?”.

Analytical Reading is a complete reading. It emphasizes on the best reading within unlimited time. The analytical readers have to read a book by chewing and digesting the contents repeatedly for the sake of understanding. Reading analytically is the best reading method.

Syntopically Reading, or comparative reading, is the highest level in reading. In mastering this level, one picks up a series of books about one topic, by not just one. After comparing with the books, the readers could “construct an analysis of the subject that may not appear in any of the books” [10]. This level of reading is the most complex one and doing an academic research is similar to syntopical reading.

3.2 Instructional Design for the Course of “The Digital Representing and Digital Reading”

Based on the four levels of reading put forward by Adler, we believe that there are also the same four levels for learning with videos. However, learning with a video is a little bit different from reading a book in each level. We design a process of instruction according to these four levels.

Instructional Design for Elementary Reading. The level of Elementary Reading includes four steps. First is to get prepared for learning by video physically and mentally. For example, children usually hear well and have good sightedness for watching video. The other three steps are distinguishing sounds, identifying images and knowing the meaning of words. Normally, kids learn to listen and discriminate different sounds before identifying various images. Finally, they begin to recognize the individual words which involve higher skills.

In fact, elementary reading is talking about the development of cognitive competence. In accordance with this rule, we take the cognitive competence of learners into account when selecting learning videos. Learners in our research are those 11 graduate students who are mature physically and mentally and they have the ability to learn with video. Totally, we selected ten videos for them. These ten videos are listed in Table 2.

Instructional Design for Inspectional Reading. Inspectional reading emphasizes on time. It means that the learners develop a general sense of a book’s contents within limited time. Studying the table of contents is a good way to master this level. When learning with video at this level, it is required to have other supporting materials like written introduction.

Written introduction is very important at this level. To keep pace with this rule, we chose three ways to introduce a video to students in brief.

First, guide them to study “the table of contents” if available. For instance, the documentary *Greek Myths Tales of Travelling Heroes* has a brief introduction at the beginning, so the learners can watch the first minute of the video before learning.

Second, provide them with some written materials. Apart from *Greek Myths Tales of Travelling Heroes*, there is no introduction in other videos. Written materials are indispensable for students to get a rough idea of the video. An example of the written introduction used in the documentary *The Internet Age: Time* is given below.

After agricultural age and industrial age, Human has entered the era of the Internet at the end of twentieth Century. This video is about when the Internet is invented and how it establishes the connection between people under multiple factors such as culture, regime, economy and so on…

Third, introduce the video orally. If the video is familiar to students, we do not have to provide the written introduction. For example, Morning Call from Xiaosong Gao is a very popular talk show in mainland China and an oral introduction is enough.

Instructional Design for Analytical Reading. Adler claims that one reads analytically from three points of view: outline, content and criticism. Learning with video has the same three points. First, give an outline of a video by enumerating major parts of the video in order to give a relation. Then, interpret the video's contents by reaching a consensus with the "author" on key words, important sentences and main arguments. Finally, criticize the video as a communication of knowledge with the some rules, for instance, the criticism does not begin until you have completed your outline and interpretation of the video.

In harmony with these rules, we arrange three activities to help students reading analytically in class. First, outline a video with a blank table of contents. Before watching a video, we always hand out a blank table or sheet to students so that they could outline the major parts or to take some notes when watching a video.

Second, complete a task sheet. After watching the video, every student is given a task sheet to work on the assigned tasks. The tasks are designed to assist students to understand the contents of the video deeply. An example of tasks used in *The Internet Age: Time* is as below:

This video introduces how WWW develops from ARPA Net. With its development, many fathers of Internet made great contributions. Please show the process of development of Internet with a timeline and your timeline should focus on the key time, important new innovations and great inventors.

Third, discuss in class and write a video report after class. Criticizing a video is an important part in analytical reading. Discussion and video report are designed to help students criticize. If the class duration is allowed, we will discuss the video on its contents, production and so on. After class, students are asked to write a video report about what impresses them. Students can learn to foster their own critical thinking.

Instructional Design for Syntopical Reading. Syntopical Reading is the highest level which is mixture of other three levels. When reading a book at this level, readers are expected to select some books in relation to one subject and to read them analytically and comparatively for generating their own new ideas about the subjects. However, for learning with video, "readers" should do more. Pictures are the most important parts in video, and it is supposed that readers to "read" the pictures syntopically as well. "Reading" pictures means analyzing how the pictures are used to convey a video's theme.

In order to achieve Syntopical Reading, we designed a case study with term paper. Students were asked to hand in a paper at the end of the semester. We hope that students could construct their own arguments of the video reading based on all these chosen videos. The requirements of the paper are as below:

Term paper:

1. *Your paper is about the topic of The Digital Representing and Digital Reading and the subject is determined by yourself.*
2. *Some contents should be included in your paper:*
   (1) *Analyze the rhetoric style of videos referring to all videos of this course listed in Table 2.*
   (2) *From the aspects of investigation, academic research, fact and conclusion, what is offered by these video?*
   (3) *What is the difference between learning with book and learning with video?*
3. *Represent your opinion with multi digital writing signal system, such as charts, figures and videos.*
4. *The total pages of your paper is limited from 3 to 5 pages.*

In conclusion, our instructional design contains six elements. The whole teaching process is as shown in the Fig. 5. Selecting videos is done before learning with video. In every class, students are introduced with the selected video and jot notes with blank tables of contents. They also have to complete the task sheets, and to discuss in class. After class, they will have to write a video report. In fact, we put the introduction, blank table of contents, task sheet and discussion contents into the same worksheet. When the term is over, students are asked to submit a term paper.

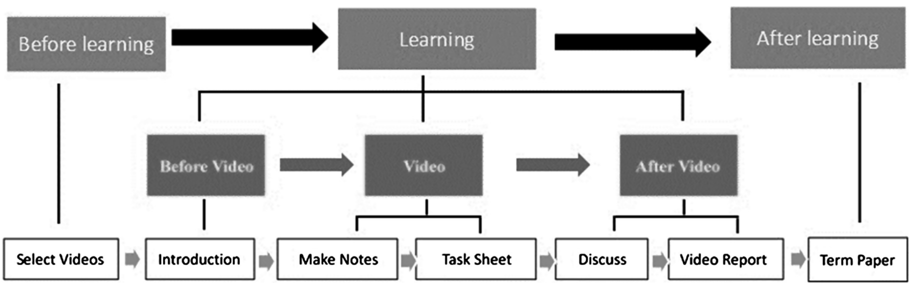

Fig. 5. The whole process of video reading

3.3 The Effect of the Instructional Design

When this research course was completed, we conducted a survey on all the activities and materials used in class. There were five open questions in the questionnaire, including "sort all materials including videos and other supporting materials", "what is the role of the worksheet? And what do you think of it?" and so on.

Eleven questionnaires were sent out and all of them regained. Word frequency analysis and three-level coding are done with all questionnaires. Some findings are as follows:

The Contents, Style, Persons of the Video Are the Three Dimensions Which Students Value Most. The first question, "Sort all materials including videos and other supporting materials", is to investigate whether the students like the videos or not, and what kinds of videos attract them most. The top three videos students like are:

1. *The Power of Time off, presented by Stefan Sagmeister, TED Talks*
2. *What does an education get you? The Episode 8 of Why Poverty, produced by Steps International*
3. *The talk Show: Morning Call, hosted by Xiaosong Gao, produced by Youku Company.*

For seeking the reasons why they liked these three videos, six out of eleven answered. All of the six students used "Contents","Style"and "Person" directly or indirectly to explain the reasons. Four out of six students mentioned the person Gao Xiaosong whowas the host of *Moring Call*.

For example, students Gao said: *Both the contents and the style of "The Power of Time off" attract me. "What does an education get you?" explains this topic with 3 real stories. And, l like the style of narrative of Gao XiaoSong.* Another students Liu said: *I like the contents and style of "What does an education get you?"* Student Li stated that *The reason why I like "Education, Education", "The Power of Time off" and "Moring Call" is that the contents of "What does an education get you?" is very real which lets me think a lot about education, the content of "The Power of Time off" is amazing and the host of Morning Call, Gao XiaoSong, is very humorous and talented.*

Worksheet Plays Three Roles When Students Learn with Video, Including the Guiding Role, Supporting Role and Supervisory Role. The second question is "What is the role of the worksheet? And what do you think of it?". Among eleven students, nine of them thought that the worksheet was an effective tool and helped them to catch the important information from the videos. By coding the answers, we found that the worksheet played a role in supporting the students to learn.

The first one is the guiding role. Students concluded that the introduction, blank tables of contents and tasks on the worksheet were helpful to provide a rough idea of the videos and assisted them to understand the learning objectives. It guided them to pay attention to the important parts of the video. As students Li said, "*Worksheet is a guide to the video and tells us the concrete learning objectives*".

The second is the supporting role. We added the blank table of contents to the worksheet to support students to outline the video. Student Ma emphasized that "*The blank table of contents is like an outline. It is very convenient to us to organize the video effectively, which is very beneficial to grasp the contents of the videos*."

The third is the supervisory role. Actually, if watching a video was the only activity in class, it could distract the students' attention. Worksheet was a kind of homework which reminded the students that there were some tasks to complete and they must concentrate in to watching the videos. Student Qin claimed that "*Worksheet supervises me to watch the videos carefully. I must be concentrated and can't pay attention to other things*".

Writing Video Reports Is Helpful to Watch the Video Again after Class. Mastering the four levels of video reading mentioned above requires watching the video again and again for beginners. How to make sure that students could learn with videos after class? We assigned them a video report as their regular homework.

By analyzing the regained questionnaires, we found that ten of the eleven students thought that this indispensable homework urged them to watch the videos repeatedly after class. Students Yang explained that "*Actually, the ultimate goal of video report is to analyze the techniques used in the video. However, I can't achieve this goal by watching the video once in class. I have to watching more videos.*"

4 Conclusion

This study is to explore the video as a new means of transferring knowledge and learning. Video delivers knowledge with the elements of characters, sound and pictures, people such as host and interviewer, the rhetoric such as metaphor, metonymy, exaggeration, parallelism and stretch time, and the structure of Coordinate Structure Linear structure.

Video can express and convey the process of doing something. Tacit knowledge in printing era can be represented and conveyed in video.

For video, a kind of new digital reading material, teachers could design the "video reading" activities by referring to the four reading levels stated in *How to Read a Book* to help students to engage in "video reading".

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Computer Supported Collaborative Learning

Potential of Social Media Not Only in Collaborative Learning: Expectations and Reality Case Study

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Abstract. There have been endless expectations in the potential of social media among academicians when this currently natural phenomenon entered and settled in our professional and private lives. The goal of this paper is to provide readers with an insight into the current trendy issue of social applications in university teaching/learning environment where aspect of real proven collaboration is highlighted. Students' perspective forms another key aspect of the explored issue. The sub-goal is to compare the results of real active cooperation of students in the social media space with students' perception of social media potential in the process of education. The paper brings both deep literature reviews on this issue and tangible results gained from series of conducted surveys and follow up semi directed discussions. Findings from the survey do not correspond to great expectations and stressed features of new virtual space and possibilities brought by Web 2.0 phenomenon that would fruitfully foster the process of education.

Keywords: Communication · Collaboration · Education · LMS · Potential · Social software applications

1 Introduction

Two key actors dominate, mingle and influence each other in the worlds of social media; those are social and technical aspects that both constantly develop and influence our lives as they clearly reflect and significantly affect current epoch. Technical innovations possess substantive drive in young people; their strength lies in enabling users participate and interact in web-space which represents a valuable contribution for educational purposes as well. When the social aspect is taken into consideration other distinctive strengths get revealed we mean the development of one's identity within the framework of social network self-presentation, communication and interpersonal relations in virtual space.

Social media are predominantly perceived as channels enabling new ways of communication among participants where cooperation and interaction are highlighted.

The issue of social nets in the process of education has been analysed and discussed by academicians for fifteen years; to be precise the history goes back to 1999 when

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Web 2.0 phenomenon started to write its history. Positive outcomes prevail and endless potential is highlighted. Implementation of social applications into the process of education widens the vast sphere of ICT in education; it brings new opportunities, expectations in their potential [1] but pitfalls as well.

The organization of the paper is as follows: firstly a theoretical background with a review of the literature is provided, then research methodology is described, the key part brings comparison of results from the survey which was conducted with two groups of students of present form of study from the Faculty of Informatics and Management, University of Hradec Kralove. Examined areas related to general use of social applications for everyday life and for study purposes, students' active involvement into contributing into virtual space either on the basis of tutor's instructions or purely voluntarily, last section was focused on student's opinion on potential of social applications in the process of education. Graphs visualize the findings. Conclusion summarizes the findings and raises questions calling for further discussion.

2 Theoretical Background

This part brings excerpts from the literature review on Information and communication technologies (ICT) in education narrowed to social media phenomenon in education.

ICT is a topic which never stagnates; information and communication technologies form a natural part of our lives where education is no exclusion. Their importance has been worked out in numerous academic works covering a wide span of grasping the issue with positive expectations or uncritically optimistic approaches via sober, realistic concept [2] to the sceptical view of the computer technologies potential. This paper on social media also claims to contribute into the field of implementation of information and communication technologies into the process of education.

Researchers approach the issue of social applications in higher education from various perspectives. Just a limited number of them is enumerated with respect to various approaches. Deep insight into the issue of Web 2.0 and practice of teachers in Higher Education was done by Greener; she reviewed peer-reviewed journal articles since 2006 [3]. Net generation and potential of social software for study purposes is discussed in the paper of Valtonen [1]. Tess focuses on the potential role for social media as a facilitator and enhancer of learning, his literature review explores social media in higher education [4]. Real educational activities and their modelling in an on-line setting are worked out by Balogh, Turcani, and Burianova [5]. As for the last example of a different perspective a widely discussed issue of learning styles has been selected; Poulova, Simonova and Janecka present in their paper design, creation and application of a software application supporting individual learning styles in e-learning [6].

As for characteristics of Web 2.0 and its appropriateness for teaching learning purposes it encourages sharing and construction of information; it is participative [3]. She states that faculties are supposed to stay up to day to benefit from tools like social networking, blogging, learning management systems, publishing, etc. The most underlined potential is seen in cooperation and collaboration. As an example of inhere presented enthusiasm can be blogs, Agosto brings a deep review into collaboration and knowledge sharing fields [7] and explains how to stimulate even maximize students collaboration on the fundaments of framework of factors, see more Zach and Agosto [8].

Findings gained from the review prove strong belief in real active cooperation and sharing knowledge via social media. But our findings from previous surveys where mapping of awareness and utilization of selected social applications in higher education didn't indicate students' willingness to contribute to the virtual space in terms of educational purposes [9]. No boundless enthusiasm and persuasion in "painless" or voluntary cooperation was revealed in the following survey as well.

3 Research Methodology

This chapter covers following areas: defining of the study problem of the research and its objective together with description of the research tool, the accessible sample and a way data processing.

3.1 Study Problem and Research Goal

This paper is a logical continuation of the research dealing with social media landscape [2] which concerned individual types of social software applications selected on the basis of their various missions fitting various goals. This time the aspect of real cooperation is examined. The study problem is again social media in higher education but now with focus on active effort of students.

- *The goal of this paper is to map real situation relating to utilization of social applications with focus on students' active cooperation, sharing, creating and developing materials in them.*
- *The sub-goal aims at potential of selected applications perceived entirely by students.*

The paper is based on the survey followed by semi-directed discussions which were conducted with two groups of students at the Faculty of Informatics, University of Hradec Kralove in 2014. The survey stems from a long term survey on utilization of software apps; this one is based on a short list of 8 relevant applications.

3.2 Research Sample

The research accessible sample consisted of two groups of full-time students from the second year of their studies. In the first group there were 71 students of subject General Finance, from the Financial Management Bachelor programme, the other group was made of 42 students of Professional English, from Information Management and Applied Information Bachelor programmes. The gender issue was not examined.

3.3 Research Tool

A modified questionnaire from previous research was applied. Five key areas were examined; first two sections related to general use of social applications for everyday life and for study purposes, the following two sections dealt with students' active involvement into contributing into virtual space either placing their own contributions based on tutor's requirements and demands or placing them voluntarily without tutor's instructions, last section was focused on student's opinion on potential of social applications in the process of education.

113 questionnaires were distributed and collected bringing data encompassing the core areas plus one extra area for students of Professional English so that their tutor could gain up-to-date technical data:

- personal utilization of social applications,
- their utilization for study purposes,
- utilization of social applications for studying languages
- placing own contributions based on tutor's instructions and demands,
- placing contributions voluntarily
- and finally student's opinion on potential of SA in education.

As mentioned above the questionnaire was based on questionnaire that was used in previous surveys, but it was modified heavily. Out of 17 applications only 8 appropriate ones were selected to fit the focus of the survey.

- Out of the wide scale of social nets only Google +, Facebook were selected, as Twitter and other social nets still are not frequently visited by our students [9].
- YouTube has always been popular with our students; it has been widely utilized for both study and leisure purposes. YouTube is an application enabling sharing predominantly music recordings as well as presentations and instructions from various areas. It might be expected that students will contribute into this space.
- Wiki platform is a social application that is one of essential apps for cooperation purposes, as it enables sharing knowledge, it enables developing common knowledge [10]. It is popular with students, they drain materials from it nearly daily [2]. But what is their active contribution into it? Aren't they only passive users?
- Skype as exclusively social communication application has been selected as well, but ICQ has been excluded as an archaic not utilized media any more.
- Blog as a form of online reflective diaries must have been listed, as literature review has proved its potential in spite of the fact that there was quite a high scepticism with researchers in utilization of this application by our students on our local scene.
- Completely the same reasoning was for selection of social–bookmarking. Great fruitful potential of this specific application for study purposes is described in literature [10]. But we were aware of the fact that this app doesn't belong to the menu of our students' applications. Social-bookmarking is used for storing and sharing web-links, so it is a promising tool for cooperation.
- As for learning management systems (LMS) no one was specified, neither commercial nor open one was named. In the questionnaire there was just stated LMS. Our students are familiar with this system as it has been embedded at our faculty

since 2001 and its utilization forms a standard way of learning teaching process mostly in the blended way of learning/teaching. Currently Blackboard is used.

This time no electronic form of questionnaire was applied but hard copies of questionnaires were distributed which might sound as a rather old fashioned style. It took about 3 min to complete the questionnaires by respondents then the follow-up discussion came and lasted about 20 min. So the whole process of distributing and collecting data was short. Rate of questionnaires' return was 100 % as researcher personally distributed the questionnaires and discussed the issue with respondents. Positive about the version of hard copies was the moment that during the follow up discussion respondents could follow the read thread of the issue and also add comments in written form. Then the process of processing all quantitative and qualitative data came; it was time consuming as it was necessary to insert the quantitative data into spreadsheets. Gained findings were enriched with graphs so that the readers could visualize the findings.

4 Results and Discussion

Both groups that formed the research sample had the same background; they were from the Faculty of Informatics and Management. There was a presumption that both groups were comparable and that it would be possible to put them together and create only one group. But there were such discrepancies in findings that it was necessary to work with each group separately and consequently compare findings relating to individual categories and applications between these two groups of General Finance and Professional English.

Figures 1 and 2 provide readers with a general view of all five examined categories in utilization of individual apps. These comprehensive graphs contain large amounts of

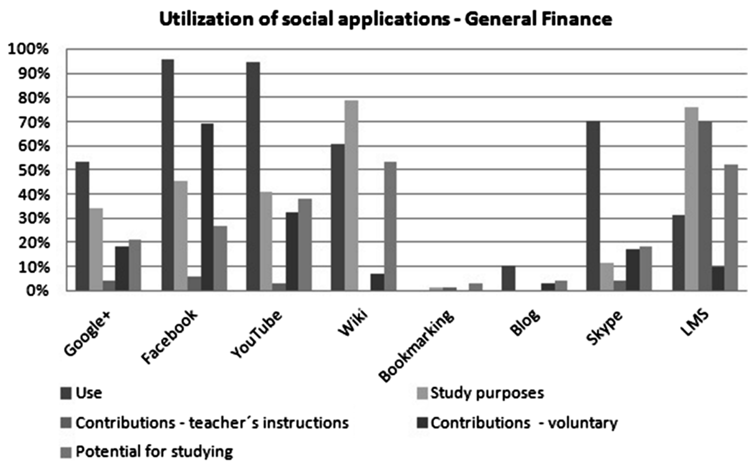

Fig. 1. Utilization of applications by group 1 (General Finance)

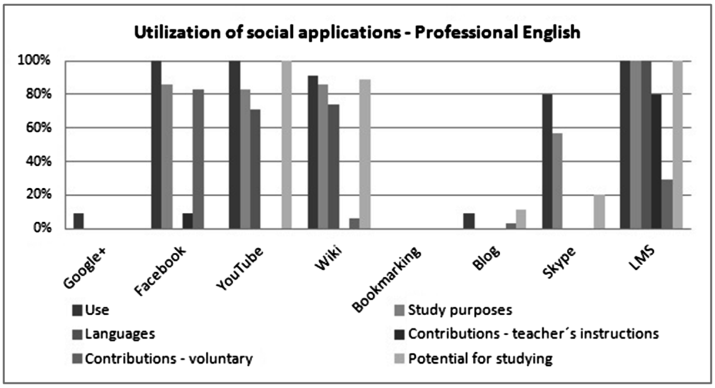

Fig. 2. Utilization of applications by group 2 (Professional English)

data, which are below elaborated according to the categories in question into further graphs for clearer visualization and explanation of findings.

The first bar in Figs. 1 and 2 shows whether the application is used. This category is shown and described in detail below in Fig. 3 – Utilization of applications by both groups. The second bar in comprehensive graphs Figs. 1 and 2 shows how many respondents use the app for study purposes. The third bar in the Fig. 1 and the fourth bar in the Fig. 2 represent key findings related to placing contributions into app on the basis of teacher's instructions. See more Fig. 4 where the category is shown and commented. The fourth bar of Fig. 1 and fifth bar of Fig. 2 illustrate the other core issue; they illustrate number of contributions that are placed by students voluntarily. See more Fig. 5 and its comment.

The last bar in both introductory figures reflects *students' view of the potential of discussed applications*. This "thrilling" category of apps potential is demonstrated on the comparison of utilization of SA and their perceived potential of students on the final Fig. 7.

Figure 2 has extra category 'Use for studying languages' which is represented by the third bar. One of the researchers was a language teacher and so was inquisitive what the situation is like in her field so that she could get inspiration and modify her teaching activities accordingly. The highest results were reached in LMS, YouTube and Wiki:

- All students use Blackboard platform and
- astonishing three quarters of students use YouTube and Wiki in studying languages.

The fourth bar shows percentage of students who place *contributions* as assignments on the basis of teacher's instructions, the fifth one reflects *voluntary activity* in apps and the last sixth one shows the *perceived potential* of discussed applications *in the process of education*.

Three more graphs are used to illustrate examined areas. As a starting point a comparison of utilization of applications is provided, see Fig. 3.

At first glance the differences appear striking, but in reality there two key discrepancies.

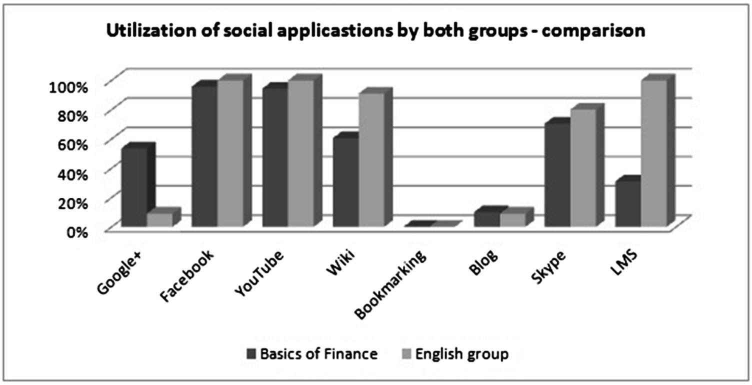

Fig. 3. Comparison of utilization of applications by both groups

- Utilization of Facebook and YouTube is nearly identical, it reaches astonishing 100 % and Skype 70 % to 80 %.
- Blog is utilized by comparable but limited number of respondents reaching only 10 % and 9 %. Findings are the same as in previous survey [2].
- Key discrepancy from the point of view of learning/teaching is seen in utilization of Blackboard learning management system (LMS), everybody from the group 2 uses it but as for group of Financial management only one third uses it.
- Surprisingly the first group uses Wiki platform much less than the other group; to be precise it is 61 % to 91 %.
- As for Bookmarking which is considered to be a beneficial tool for cooperation, for sharing materials [11], our sceptical expectations have been right. None out of 113 students uses this application.

Two more graphs deal with the core issue of this paper. Figures 4 and 5 depict real active contributions that enable developing materials, their editing and enriching from various sources. Reality doesn't correspond to great expectations and literature review, to promised opportunities and challenges to cooperate even collaborate [1, 7].

- As for contributions and cooperation that are run in accordance with teacher's instruction only LMS is worth mentioning, see Fig. 4. LMS is used by 70 % of respondents in the first group and 80 % by the other group of students. It proves both students' and teachers' involvement and established practise.
- Only 6 % and 9 % enter social nets to cooperate.

These findings clearly show that implementation of social applications into the process of education basically depends on teachers' involvement.

Significant findings relating to cooperation and active involvement into developing materials in social media can be seen in Fig. 5.

- \`Finance group\` contributes into all apps except bookmarking and reaches higher results in Google +, YouTube, Blog and Skype.

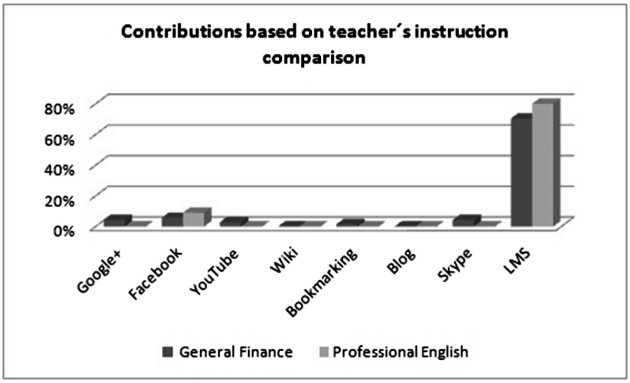

Fig. 4. Contributions based on teacher´s instruction

- 69 % from the first group and 83 % from the other group of students actively contribute to Facebook.
- *Exceptional findings relate to YouTube. 32 % from `Finance` group contribute to YouTube which is praiseworthy and represents a positive not usual trend in our settings.*
- Positive is that students are used to contribute freely into LMS.

The last findings relate to potential seen by students.

- The more active `Finance group` is little bit more open to utilization of applications in education on wide scale covering all selected application: more important role play Google + 21 %, FB 27 %, YouTube 38 %, 18 % Skype, only Wiki and LMS outreach 50 %.
- As for the `English group` students believe in YouTube and LMS in astonishing 100 % and in Wiki in 89 %.
- No potential is seen in Bookmarking and Blog. Students don't use them, they say that currently plenty of applications merge and one application can serve several roles.

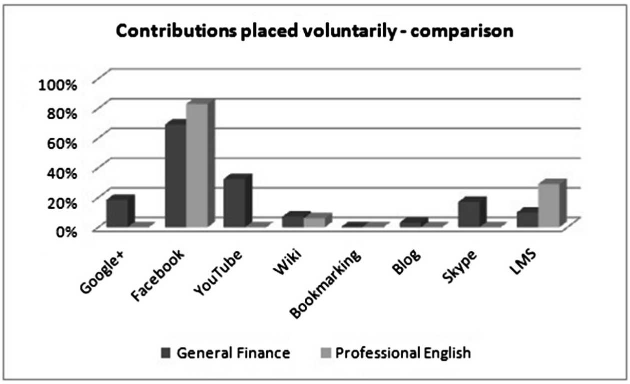

Fig. 5. Contributions placed voluntarily

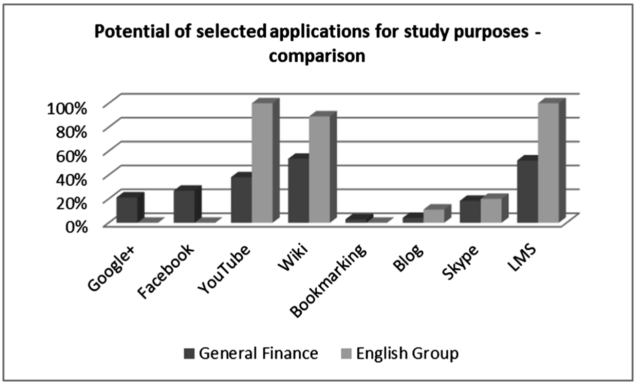

Fig. 6. Potential of social applications for study purposes

Surprise arises when categories of current utilization of applications for study purposes are compared to category of seen potential for study purposes see Fig. 7 (Figure 6).

As for the more active Financial group:

- the only category where there is at least small increase between used app and its potential is Skype, everywhere else the numbers are smaller,
- only 50 % of students can see potential in LMS when now three quarters of them use it for study purposes,
- Facebook for study purposes is used by 45 % respondents from the Finance group and potential can see 27 %,
- YouTube is utilized in 41 % and potential can be seen in 38 % of students.

As for the other group:

- they don't use Google + and they don't see any potential in it,
- the most striking finding relates to Facebook which is used by 86 % of respondents from the other group for study purposes in 86 % but none of them can see any potential.

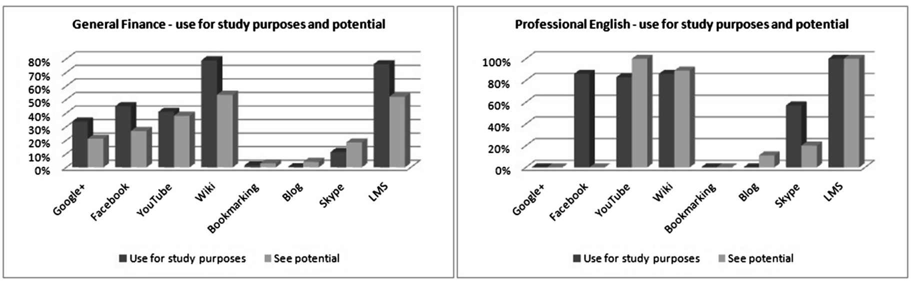

Fig. 7. Use and potential

Why students do not find bigger potential educational benefits of latest achievements of social applications which they widely utilize in their life?

When it comes to qualitative findings, they were gained during a follow up discussion. The discussion was run immediately after collecting the questionnaires, positive was that students were involved in the issue and ready to talk and share their experience but limiting was that the researchers couldn't target questions at the issues which arose later after data processing. Prepared topics of discussion stemmed from previous surveys. The first one dealt with Bookmarking, why it wasn't common to use this app at our university setting. Students stated that they didn't need narrowly specialised tools like Bookmarking as this service can be provided by "multifunctional" Facebook. The other topic was Blogs because in previous surveys there had been big differences in using them, e.g. students of Tourism management were not only visiting blog pages but there was a significant number of students keeping own blogs but as for students of Applied Informatics there was zero interest in them. Students of current sample from Financial and Information Management and Applied Information bachelor programme showed that Blogs are not in field of interest at all. The core topic was active involvement into cooperation and enriching study material in applications enumerated in the questionnaire. Even if most of the students are computer wizards as it is their branch of study, they are able to use sources but just on scale of gathering and processing materials but resist to collaborative work. And here comes the jewel in findings, students finally revealed us and discussed a local purely student application which was not on the questionnaire list. They widely use and even contribute to *old fashioned Forum "Python"*. There is one determining factor – they highlighted that contributions on e.g. Facebook have short life and serve to current purposes and needs, they come and go. But in Forum which represents unofficial university student pages without teacher's access for more than ten years there are stable, long-life categories of individual faculties with numerous sub-categories like subjects, tricks and tips, tests, etc. making students life easier. One quote is given as a bright example: "If there wasn't Python we all would have been dropped out".

5 Conclusion

In spite of the fact that research sample consisted of students from the same faculty there were few discrepancies in utilization, active development of study materials and seen potential in social applications. One group was formed by students of General Finance subject from the Financial Management bachelor programme and the other group consisted from students of Professional English from Information Management and Applied Information bachelor programme.

There were nearly identical findings reaching 100 % utilization of Facebook and YouTube in both groups, comparable results related to Skype 70 % to 80 % in favour of English group.

Key discrepancy from the point of view of learning/teaching was in utilization of Blackboard learning management system (LMS), everybody from the English group used it but as for group of Financial Management only one third used it. *The answer for active utilization of LMS by the English group can be found in systematic work* *and in motivation; students are encouraged to contribute and cooperate in this platform.*

The other discrepancy was found in utilization of Wiki platform 61 % to 91 % in favour of English group. As for editing in Wiki, findings were marginal in both groups.

Our students are mostly passive users. But when they are instructed how and where to place contribution, they don't find it difficult or bothering as was proved in the English group.

Main trend can be seen in a great increase in utilization of YouTube for study purposes.

There can be seen *no increase in active developing materials* in the examined apps. There is complete ignoring of Bookmarking. Blog is of minor importance, to be precise 10 % to 9 % as well as Wiki 7 % to 6 % in slight favour of Finance group.

So there is a key topic calling for discussion – should teachers take an active role and utilize the promising features of social applications in the educational process themselves?

This paper is just a modest contribution, bit of a mosaic of the global phenomenon. The intention is to provide readers with a local perspective based on actual observation, survey and discussion with students of regional university. Startling finding worth exploring is *students' willingness to true cooperation and sharing study materials and information in their local "territory" in a more than 10 years old exclusively student Forum where teachers 'access is prohibited.*

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Effectiveness of Collaborative Learning with Complex Tasks Under Different Learning Group Formations: A Cognitive Load Perspective

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Abstract. This paper reports the results of an experiment designed to investigate the effectiveness of different collaborative group formations (homogeneous vs. heterogeneous in terms of prior knowledge levels) for learning complex materials in a blending learning environment from the perspective of cognitive load theory. The results of the experiment demonstrated overall benefits of the heterogeneous composition of the collaborative groups. The results also indicated that levels of learners' prior knowledge might influence the effectiveness of collaborative conditions. For learners with lower levels of prior knowledge, the heterogeneous collaborative group was more effective than homogeneous condition while there were no differences between the conditions for more advanced learners. Reported lower ratings of cognitive load for the heterogeneous condition supported the cognitive load explanation of the results.

Keywords: Cognitive load · Collaborative learning · Group formations · Blend learning · Expertise reversal effect

1 Introduction

Collaborative learning as a pedagogical strategy has been encouraged in classrooms at various levels for promoting students learning. It commonly refers to a setting of learning environment in which students work in a small group to achieve a specific learning goal, for example, to accomplish a group product or complete individual problem solving tasks by helping each other (Slavin 1995; Johnson and Johnson 2000). Gamoran (1987) argued that the instructional process in a small group setting could be an essential mechanism through which group learning might achieve its effects. It was suggested that under peer group learning condition and given an equal opportunity to participate, group members could share cognitive resources, exchange ideas, foster explanations and elaborations that would facilitate conceptual understanding and acquisition of underlying principles for problem solving (e.g., Webb 1991; Hatano and

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Inagaki 1991). Therefore, due to the higher order thinking activities involved in group discussions, collaborative learning might facilitate constructing flexible knowledge structures by individual learners that could transfer across different tasks.

However, it was noted that a discrepancy existed in group performance and knowledge acquisition at an individual level (Webb 1992; Webb and Farivar 1999). Effective individual learning outcomes might not be achieved if group interaction does not occur (Webb 1992; Webb and Farivar 1999) or learners do not apply the problem solving guidance provided by other members of the group when they work independently (Lainema and Nurmi 2006; Murphy and Alexander 2005). Cognitive load factors may also influence conditions under which collaborative learning environments are effective. The following section describes the main assumptions of cognitive load theory and introduces a cognitive load perspective on collaborative learning.

Cognitive load theory investigates instructional consequences of fundamental features of human cognitive architecture (see Sweller et al. 2011 for a recent overview). This architecture includes working memory and long-term memory as its major components. Working memory is involved in short-term maintenance, construction and integration of mental representation. It is usually associated with conscious controlled information processing. Working memory is extremely limited in capacity and duration when dealing with unfamiliar information: no more than several items of information could be processed simultaneously and for no longer than a few seconds (Baddeley 1986; Miller 1956). If many related unfamiliar elements of information are processed concurrently, working memory capacity could be easily exceeded resulting in a cognitive overload. Cognitive load theory distinguishes intrinsic cognitive load that is imposed by processing the elements of information that are essential for achieving specific learning goals, and extraneous cognitive load that is imposed by processes that are irrelevant to achieving the learning goals (Kalyuga 2011; Sweller 2010).

Long-term memory contains our organized knowledge structures and is virtually unlimited both in capacity and duration. These organized knowledge structures (schemas) allow us to encapsulate many familiar elements of information into larger units (chunks) and treat them as single elements in working memory thus effectively preventing cognitive overload and facilitating acquisition of new knowledge working memory. Thus the characteristics of working memory information processing change significantly as information becomes more familiar because of the acquired knowledge structures in long-term memory that effectively reduce or eliminate severe processing limitations of our cognitive system (Sweller 2003). For example expertise, we can easily comprehend complex written language as our reading proficiency increases and common combinations of lower-level components can be chunked and processed as whole higher-level units (e.g., letters instead of separate strokes; words instead of separate letters; phrases instead of separate words) without a cognitive overload. Therefore, levels of learner prior knowledge represent an essential factor in determining the magnitude of cognitive load experienced by the learner.

Within a cognitive load framework, collaborative learning has been conceptualized by considering a group of interacting learners as an information processing system that may have an expanded processing capacity due to sharing the cognitive load intrinsic cognitive load caused by a learning task across a number of cooperating working memories (Kirschner et al. 2011). However, sharing and coordinating information between members of the group (transaction costs) involves additional working memory resources (Kirschner et al. 2009a). Such additional cognitive load may potentially override any benefits of off-loading some of the interacting elements of information to other members of the group if the transaction costs are relatively high. Kirschner et al. (2009a) suggested that this could be the case for relatively simple tasks that involve a small number of interactive elements of information. In this case, the benefits of sharing already low number of interacting elements may be exceeded by the transaction costs. On the other hand, for complex tasks, the reduction in cognitive load achieved by dividing the resources involved in processing a large number of elements among group members could significantly surpass the involved transaction cost.

Kirschner et al. (2009a) compared collaborative and individual learning formats and demonstrated that individual learners were more efficient on retention posttests, but group members were more efficient in dealing with transfer tasks. Kirschner et al. (2011) investigated the impact of problem complexity on the effectiveness of collaborative learning. They demonstrated an interaction between the complexity of learning tasks and learning conditions (individual vs. group learning) for mental effort scores. Mental effort was lower for individual learners than group students when dealing with low complexity tasks, but higher for high complexity tasks. The same interaction was also found for solution times, but not for raw performance scores. Thus, individual learning from low complexity tasks was more efficient because these learners invested less mental effort than group learners. However, for more complex learning tasks, individual learning was less efficient than group learning because individual learners had to invest more mental effort. These results are consistent with other research findings indicating that collaboration is best suited to more complex learning tasks (Laughlin et al. 2006), but individual learning is superior on less complex tasks (Andersson and Rönnberg 1995, Meudell et al. 1992).

Zhang et al. (2011) also demonstrated that collaborative learning of complex webpage design tasks was significantly better (with less mental effort required) than an individual approach if students were allowed some choice in the content of the webpage. In another study that investigated cognitive load aspects of collaborative learning, Retnowati et al. (2010) demonstrated that groups of novice learners benefited more from worked examples than from problem solving thus extending the worked example effect in cognitive load theory to these learning conditions problem solving. Research in other cognitive load aspects of collaborative learning is still very limited. In particular, the role of prior knowledge of group members and accordingly, the effect of different group formations in relation to participant levels of prior knowledge, have not yet been investigated from a cognitive load perspective.

Based on cognitive load considerations, it was predicted that the formation of groups (homogeneous vs. heterogeneous in terms of prior knowledge levels) might influence the effectiveness of collaborative learning. Specifically, a heterogeneous composition of a collaborative learning group could be beneficial for learners with lower levels of prior knowledge who would receive guidance in solving problems from more experienced learners thus preventing their unguided random search for answers that could cause high levels of cognitive load Alternatively, in a homogeneous collaborative learning condition, novice learners, in the absence of guidance, would need to be involved in cognitively taxing search-based problem solving. For learners with higher levels of prior knowledge, the homogeneous group composition may also be of no benefit since these learners can presumably deal with the problems using their available knowledge base. Any unnecessary collaborative activities could be redundant and potentially detrimental for learning.

2 Method

2.1 Participants

One hundred and eighteen Year 10 high school students (average age 15 years) enrolled in three different classes at a Macau public co-educational school participated in the experiment. These three classes were selected randomly from seven Year 10 classes at the school. Four participants were subsequently excluded from the analysis because they did not complete the tests.

2.2 Experimental Groups

A quasi-experimental design was employed with intact classes randomly allocated to three experimental conditions. Since students were placed in different classes after they had completed Year 9 based on their average scores in Chinese, English, Mathematics and Integrated Science (in order to have similar distributions of students with different abilities in a class), the three classes were presumed to be similar in terms of general abilities. Levels of students' prior knowledge in computer studies were used in this study to form two types of collaborative learning conditions. The computer studies scores that students obtained in the last semester of Year 9 were arranged in an ascending order and the top 27 % of students were allocated to the higher prior knowledge group while the bottom 27 % of students were allocated to the lower prior knowledge group. The remaining 46 % of students belonged to the medium prior knowledge group. One of the participating experimental classes (n = 41, 16 males and 25 females) was allocated to a collaborative learning condition in which the members of each learning group were at the same prior knowledge level in computer studies (*Homogeneous Collaboration Group*). Eight learning groups were formed (see Table 1 for the numbers of students and the mean scores in Year 9 computer studies for each learning group). Another participating experimental class (n = 39, 23 males and 16 females, modified group n = 35) was allocated to a collaborative learning condition in which the members in each learning group were at different prior knowledge levels in computer studies (*Heterogeneous Collaboration Group*). Eight learning groups were formed (Table 1). The third participating experimental class (n = 38, 20 males and 18 females) was allocated to an individual learning condition as a control condition (*Individual Learning Group*).

Table 1. Mean scores and standard deviations for prior knowledge in computer studies for each learning group in the homogeneous collaboration condition and the heterogeneous collaboration condition

Learning Groups	1	2	3	4	5	6	7	8
Homogeneous Collaboration (n = 41)								
Number of Group Members	5	5	5	6	5	5	5	5
M	72.4	76.2	86.3	75.8	81.9	77.2	70.7	76.6
SD	4.59	7.25	5.06	7.15	4.69	1.88	8.21	6.42
Heterogeneous Collaboration (n = 39)								
Number of Group Members	5	5	5	4	5	5	5	5
M	77.9	78.2	77.3	77.8	78.0	76.3	75.2	78.9
SD	6.78	4.58	2.66	4.19	5.94	4.31	7.11	7.37

2.3 Materials and Procedure

The computer studies course offered in the participating school consisted of 18 lessons in the first semester for all Year 10 students. Each lesson included two 45-minute sessions each week with a 10-minute break between the sessions. The present study involved a pre-training session, a pretest session, five learning sessions and four test sessions. The learning materials were related to programming using Visual Basic (VB) as a computer programming language. The materials were designed by the teacher who taught the computer studies course and were used across the seven Year 10 classes. Teacher lectures formed the basis of the learning phases of this study. Following the lectures, students practiced either collaboratively in small learning groups (about five participants in a group) or worked individually depending on the experimental condition. In the collaborative learning conditions, students in each group were instructed to help each other in solving task problems.

Pre-training. The study started at the third week of the semester. Students in the participating classes were pre-trained with basic concepts about programming as a language of communication between human and computers. The pre-training was focused on the purposes and method of writing a program and conducted in a normal classroom setting in two 45-minute sessions for each class.

Pretest. A pretest was conducted in the fourth week to ensure that the participants did not have advanced prior knowledge of VB programming. The results of the pretest were used as a covariate in the subsequent analyses of posttest performance. The pretest was conducted in a computer laboratory for each participating class. Each participant was requested to solve a mathematical problem using a VB program on the computer that was allocated to her/him. Participants had previously learned the problem during their mathematics classes. There was no time limit set for the test.

Learning phase. There were five learning tasks, and each task was introduced in a single 45-minute learning session over five weeks. Each learning task started with an introductory lecture by the teacher followed by few practice exercises using tasks with the same surface features. Students practiced either individually or in a group depending on the learning condition they had been assigned to. The feedback during the practice tasks was provided by the teacher to the whole class and was identical in all three experimental classes. Posttest tasks followed the learning tasks 2, 3, 4 and 5.

Posttest. Participants were requested to complete a test after each learning task starting from the second task. Students worked individually on all the posttests. There was no time limit set for the posttests. The scores for the four posttest tasks were summed up to obtain the final posttest score.

Ratings of cognitive load. After completing the fifth learning task, participants were required to rate mental workload associated with the learning tasks and completing all the posttests. Each participant was asked to rate two items ("How hard did you find learning this unit?" and "How hard did you find completing all the tests for this unit?") on a five-point scale from 1 (very low) to 5 (very high).

3 Results

3.1 Variables

The dependent variables under analysis were Year 9 computer studies scores, posttest performance scores, mental workload ratings, and instructional efficiency scores. Independent variables were learning conditions (homogeneous collaborative learning condition, heterogeneous collaborative learning condition, and individual learning condition). The pretest scores were used as a covariate to take into account any initial differences in knowledge that participants might have because of the familiarity with the learning materials. All effects were considered as significant at $p < .05$ and marginally significant at $p < .10$.

3.2 Experimental Groups

It is a general policy of participating schools to place students in Year 10 classes based on their average Year 9 scores so that all classes have similar distributions of students with different abilities, In accordance with this policy, the results of one-way analysis of variance (ANOVA) for the Year 9 computer studies scores indicated a highly non-significant difference between the three experimental groups, F (2,111) = 0.12, MSE = 48.21 (M = 77.11, SD = 7.17 for the *Homogeneous Collaboration Group*; M = 77.44, SD = 5.44 for the *Heterogeneous Collaboration Group;* M = 76.66, SD = 7.87 for the *Individual Learning Group*). Thus, the three experimental groups were considered as having the same levels of prior knowledge in terms of general computer studies.

3.3 Collaborative Learning Groups

Results of one-way ANOVA for the Year 9 computer studies scores indicated a highly significant difference between the eight learning groups in the *Homogeneous*

Collaboration condition, F (7,33) = 3.43, MSE = 36.04, $p < .01$, $\eta_p^2 = 0.42$, confirming that these learning groups were at different levels of prior knowledge in computer studies. ANOVA for the Year 9 computer studies scores indicated a highly non-significant difference between the eight learning groups in the *Heterogeneous Collaboration* condition, F (7,27) = 0.256, MSE = 34.93, confirming that the eight learning groups were at a similar level of prior knowledge in computer studies. Means and standard deviations are provided in Table 1.

3.4 Posttest Results

One-way analysis of covariance (ANCOVA) for the total retention scores using the pretest scores as a covariate indicated a highly significant difference between the experimental conditions, F (2,110) = 9.38, MSE = 602.71, $p < .001$, $\eta_p^2 = 0.15$. (M = 286.39, SD = 30.24 for the Homogeneous Collaboration Group; M = 293.37, SD = 24.92 for the Heterogeneous Collaboration Group; M = 291.71, SD = 32.07 for the Individual Learning Group). In regards to differences between pairs of conditions, separate ANCOVAs indicated that the Heterogeneous Collaboration Group outperformed the Homogeneous Collaboration Group, F (1,73) = 17.34, MSE = 482.38, $p < .001$, $\eta_p^2 = 0.19$; and the Individual Learning Group outperformed the Homogeneous Collaboration Group, F (1,76) = 12.61, MSE = 618.47, $p < .01$, $\eta_p^2 = 0.14$. No significant differences were found between the Individual Learning Group and the Heterogeneous Collaboration Group, F (1,70) = 0.22, MSE = 699.56 (Table 2).

For evaluating the effect of learner expertise on the effectiveness of different learning conditions, learners with the median prior knowledge level were excluded from the analysis (N = 61) in order to obtain two distinct levels of prior knowledge (low and high). The eliminated part was about 46 % of the original sample (without breaking students with identical cut-off scores into different categories). Two-way ANCOVAs for the total retention scores using the pretest scores as a covariate indicated a significant main effect of instructional conditions, F (2, 54) = 3.21, MSE = 495.30, $p < .05$, $\eta_p^2 = 0.11$. Expectedly, there was a significant main effect for expertise, F (1, 54) = 12.03, MSE = 495.30, $p < .005$, $\eta_p^2 = 0.18$. There was a significant interaction between the experimental conditions and levels of learner expertise, F (2, 54) = 3.96, MSE = 495.30, $p < .05$, $\eta_p^2 = 0.13$ (see Fig. 1). Means and standard deviations are provided in Table 3.

In regards to differences between pairs of conditions, there was a significant interaction between the Homogeneous Collaboration Group and the Individual Learning group and levels of learner expertise, F (1, 42) = 4.76, MSE = 490.08, $p < .05$, $\eta_p^2 = 0.10$. There was also a significant interaction between the Heterogeneous Collaboration Group and the Individual Learning Group and levels of learner expertise, F (1, 31) = 5.63, MSE = 577.15, $p < .05$, $\eta_p^2 = 0.15$. There was no significant interaction between the Homogeneous Collaboration Group and the Heterogeneous Collaboration Group, F (1, 34) = 0.63, MSE = 441.37. In regards to simple effects, ANCOVA indicated no significant differences between the three experimental conditions for the lower knowledge level learners, F (2, 27) = 2.00, MSE = 619.81. However, a marginally significant difference was found between the Homogeneous Collaboration

Table 2. Means and standard deviations for posttest scores for different experimental conditions and levels of learner prior knowledge

Expertise Level	Lower prior knowledge level n = 31		
Experimental Condition	Homogeneous Collaboration n = 12	Heterogeneous Collaboration n = 7	Individual Learning n = 12
M	280.58	290.43	271.75
SD	34.35	24.18	25.55
Expertise Level	Higher prior knowledge level n = 30		
Experimental Condition	Homogeneous Collaboration n = 13	Heterogeneous Collaboration n = 7	Individual Learning n = 10
M	3.85	3.43	3.60
SD	0.90	0.79	0.84

Group and the Heterogeneous Collaboration Group, F (1, 16) = 3.85, MSE = 597.16, p < .10, η_p^2 = 0.19 favoring the Heterogeneous Collaboration Group. For the higher level learners, there was a significant difference between the three learning conditions, F (2, 26) = 6.22, MSE = 364.59, p < .01, η_p^2 = 0.32. The Individual Learning Group marginally outperformed the Heterogeneous Collaboration Group, F (1, 14) = 3.31, MSE = 514.55, p < .10, η_p^2 = 0.19, and significantly outperformed the Homogeneous

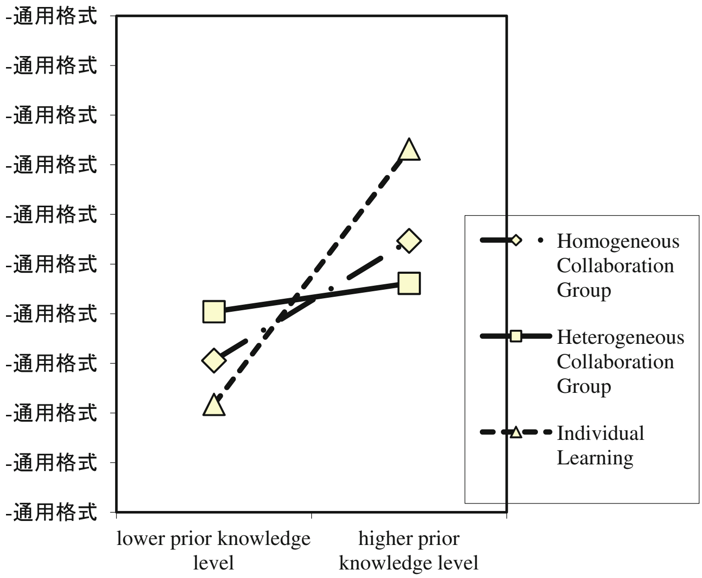

Fig. 1. Interaction between learning conditions and levels of learner expertise for the retention posttest scores.

Table 3. Means and standard deviations for ratings of cognitive load for different experimental conditions and levels of learner prior knowledge

Expertise Level	Lower prior knowledge level *n* = 31		
Experimental Condition	Homogeneous Collaboration *n* = 12	Heterogeneous Collaboration *n* = 7	Individual Learning *n* = 12
Ratings associated with Learning			
M	3.92	3.43	3.75
SD	0.79	0.54	0.75
Ratings associated with Performance			
M	3.75	3.00	3.50
SD	0.75	0.82	0.67
Expertise Level	Higher prior knowledge level *n* = 30		
Experimental Condition	Homogeneous Collaboration *n* = 13	Heterogeneous Collaboration *n* = 7	Individual Learning *n* = 10
Ratings associated with Learning			
M	3.85	3.43	3.60
SD	0.90	0.79	0.84
Ratings associated with Performance			
M	3.77	3.43	3.50
SD	0.73	1.27	1.08

Collaboration Group, F (1, 20) = 12.24, MSE = 342.65, $p < .01$, $\eta_p^2 = 0.38$. There was no significant difference between the Homogeneous Collaboration Group and the Heterogeneous Collaboration Group, F (1, 17) = 0.45, MSE = 286.82.

In summary, the above results indicated that overall a collaborative learning environment characterized by a homogeneous group formation was a less effective learning condition than a heterogeneous group formation. The homogeneous group formation was also less effective when compared with the individual learning environment. The results also indicated that levels of learner prior knowledge influenced the effectiveness of different learning conditions (an expertise reversal effect). Heterogeneous collaborative learning could be more beneficial than homogeneous collaborative learning for less experienced learners on both retention and transfer tasks, while no differences were found between these two learning conditions for more advanced learners.

3.5 Ratings of Cognitive Load

One-way ANCOVAs using the pretest scores as a covariate revealed that there was a significant effect of the experimental conditions for the mental effort ratings associated with learning, F (2,110) = 4.56, MSE = 0.62, $p < .05$, $\eta_p^2 = 0.08$ (M = 3.63, SD = 0.92 for the Homogeneous Collaboration Group; M = 3.29, SD = 0.71 for the

Heterogeneous Collaboration Group; M = 3.68, SD = 0.78 for the Individual Learning Group). In regards to differences between pairs of conditions, separate ANCOVA indicated a significant difference between the Homogeneous Collaboration Group and the Heterogeneous Collaboration Group, F (1,73) = 8.00, MSE = 0.64, $p < .01$, $\eta_p^2 = 0.10$. The Homogeneous Collaboration Group reported higher ratings of cognitive load than the Heterogeneous Collaboration Group. There was also a significant difference between the Heterogeneous Collaboration Group and the Individual Learning Group, F (1, 70) = 5.58, MSE = 0.55, $p < .05$, $\eta_p^2 = 0.07$. The Individual Learning Group reported higher ratings of cognitive load than the Heterogeneous Collaboration Group. There was no significant difference between the Homogeneous Collaboration Group and the Individual Learning Group, F (1, 76) = 0.57, MSE = 0.68.

After excluding learners in the median range of prior knowledge for investigating the effects of learner expertise, a two-way ANCOVA (N = 61) using the pretest scores as a covariate indicated a significant main effect for instructional conditions, F (2, 54) = 3.75, MSE = 0.57, $p < .05$, $\eta_p^2 = 0.12$. There was no significant main effect for expertise, F (1, 54) = 0.04, MSE = 0.57. There was also no significant interaction between the three experimental conditions and levels of learner expertise, F (2, 54) = 0.03, MSE = 0.57. Means and standard deviations are provided in Table 3.

4 Conclusion

Research in collaborative learning environments has usually been approached from motivational or social constructivist perspectives. There have been only a few studies that investigated cognitive load aspects of collaborative learning. Characteristics of human cognitive architecture are essential for understanding cognitive processes that occur during collaborative learning. This paper extends this line of research by considering the effect of group composition in respect of levels of learner prior knowledge.

According to the collective working memory effect in cognitive load theory, the collaborative learning. Collaboration could be more effective than individual learning in case of complex learning tasks that involve high levels of element interactivity. The learning tasks used in this study were exactly such tasks. The study demonstrated that the formation of groups (homogeneous vs. heterogeneous in terms of participants' prior knowledge levels) influenced the effectiveness of collaborative learning. In general, the heterogeneous composition of a collaborative learning group was more effective than both homogeneous group composition and individual learning conditions, especially for learners with lower levels of prior knowledge. The guidance in solving problems these learners might have received from more experienced learners presumably reduced their involvement in unguided search processes that usually cause high levels of cognitive load.

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Knowledge Trade and Sharing in Knowledge Management System

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Abstract. The importance of knowledge management (KM) leads many companies to use a knowledge management system (KMS); however, users frequently do not make good use of KMS. There is a new view that knowledge market can be helpful to promote knowledge transfer by knowledge trade. Knowledge transfer could be activated through the items of knowledge organization, knowledge strategy, KMS, and knowledge reward via knowledge sharing culture and knowledge trade market. We have proposed that the framework be organically related to above factors in the prior research. This article examined various cases to analyse the effect of knowledge trade market and knowledge culture for knowledge transfer. We then considered real case researches of the Korean organizations and global firms in order to discuss each factor on how to activate knowledge transfer. This discussion suggests that organizations harmonize both knowledge culture and knowledge trade market for knowledge transfer.

Keywords: Knowledge trade market · Knowledge transfer · Knowledge management (KM) · Knowledge management system (KMS) · Case analysis

1 Introduction

Changes in the knowledge-based economy have highlighted the importance of knowledge management (KM) for sustainability and corporate competitiveness (Davenport and Prusak 1998). As more firms recognize the importance of invisible knowledge assets, they have conducted KM. KM is defined as, "a systemic and organizationally specified process for acquiring, organizing, and communicating both tacit and explicit knowledge of employees so that other employees may make use of it to be more effective and productive in their work (Alavi and Leidner 1999)". Firms expect to maximize the utilization and, hence, value creation of knowledge being accumulated in the firm (Nonaka 1994). A Knowledge management system (KMS) is defined as "IT-based systems developed to support and enhance the organizational process of knowledge creation, storage/retrieval, transfer, and application (Alavi and Leidner 2001)".

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In traditional KMS, however, there was a tendency that a little knowledge could be transferred to users. Because users were passive being who accepts knowledge (Parent et al. 2007). A discrepancy between the complexity of accumulated data and the intention of users who want to find the latest knowledge causes poor KMS use. Users want to find the latest knowledge easily. For this reason, users tend to have difficulty finding high quality knowledge within their company.

Recently, there is a new view that knowledge trade takes a good advantage of knowledge transfer (Benbya and Van Alstyne 2011). Knowledge trade market based KMS can be good substitute for traditional KMSs. We think that knowledge trading can help transfer knowledge and grow an organization effectively. Jeong and Ahn empirically proved that knowledge transfer can be activated through knowledge trade in knowledge markets. This study explores how a knowledge transfer mechanism interacts organically in real cases. The framework for knowledge transfer activation is based on: (a) knowledge organization, (b) knowledge strategy, (c) KMS, (d) knowledge rewards, and (e) knowledge sharing culture and knowledge trade market. We want to examine potential gaps between evidence and practice in knowledge transfer framework (Jeong et al. 2013).

In the next section of this paper, we will review traditional KMSs and knowledge-trading KMSs. We then provide an overview of our research methodology and analyse it with qualitative data. Multiple case analyses of various organizations provide implications supporting our systematic framework. Lastly, we outline discussions for readers and future research.

2 KMS Review

2.1 Supplementations of KMS in Traditional KM

Generally, scholars have regarded KMSs as a key enabler for KM. KMSs support the creation, transfer, and application of knowledge in organizations (Alavi and Leidner 2001). IT is an important enabler for supporting knowledge transfer. KMSs have three common applications: (a) the coding and sharing of best practices, (b) the creation of corporate knowledge directories, and (c) the creation of knowledge networks (Alavi and Leidner 2001).

There has been some criticism of traditional technology-push KM models.

> Workers may not know if the available data, information, and decision models are indeed up to speed with the radical discontinuous changes in the business environment. In this model, incomplete and often outdated data, information, and decision models drive the realization of the strategic execution, but with diminishing effectiveness (Wiig, K.M.: New generation knowledge management: What may we expect? Knowledge Research Institute 2002, Malhotra 2005).

Current KMSs represent mainly centralized repositories, organized and structured around pre-defined company functions and workflow (Antonova and Nikolov 2014). Many efforts are necessary for maintenance of the latest knowledge and good quality knowledge in current KMS (Wiig 2002). The balance between rewards and assessment is very important for a user's participation in knowledge transfer, because users want to obtain recognition and reputation through their contribution to knowledge transfer. Appropriate KM strategies for maintaining KMS require: (a) the balance between competition and collaboration, (b) the balance between social (intrinsic) rewards and economic (extrinsic) rewards (Bock et al. 2005), and (c) knowledge diffusion strategies that meet organizational goals (Yu 2007). If only competition is emphasized uploading knowledge in KMS, individuals may hoard information for personal advantage (Benbya and Van Alstyne 2011). In the early stage KM, there was tendency firms give only economic rewards to individuals. Though economic rewards are helpful to share knowledge, they are not primary motivators within knowledge sharing initiatives (Bock et al. 2005). The KM objectives and strategy need to concur with the company's/business unit's objectives (Greiner et al. 2007). According to Saito et al. (2007), appropriate KM strategies for maintaining KMS require: (a) senior management support with strategy and business requirements, (b) consideration of organizational dynamics and culture, (c) a series of KM initiatives designed to support knowledge process. A culture of trust and collaboration improves knowledge sharing and organizational effectiveness (Sveiby and Simons 2002). We should emphasize knowledge culture, organizations structure, technology, and management as key elements for successful KM (Yu et al. 2007).

2.2 Supplementary Mechanism for Traditional KMS: Knowledge Trade Perspective

Knowledge trade can address the difficulties in managing the hesitation of knowledge transfer in traditional KMSs. Traditional KMSs are repository systems to manage and accumulate knowledge. KMSs established from a knowledge trade perspective, however, support the process to connect people seeking answers with people that have the answer.

The architecture of a traditionally centralized IT system is designed with a top-down approach; that of a knowledge market, by contrast, is designed as a way of connecting peer-to-peer. The peer-to-peer approach can connect directly knowledge producers (possessors) to knowledge consumers (seekers) (Benbya and Van Alstyne 2011). On the other hand, centralized management of a top-down approach cannot manage all the information; it is also difficult to maintain the latest information. As old knowledge is accumulated in the KMS, users tend to ignore it. Figure 1 explains the differences between traditional knowledge management and knowledge trade market.

3 Research Method

The prior research conducted by survey and structured equation model (with partial least squares) empirically proved that knowledge transfer could be activated through knowledge sharing culture and trade in knowledge markets. As prior research has shown, knowledge-sharing culture and knowledge trade markets are supporting

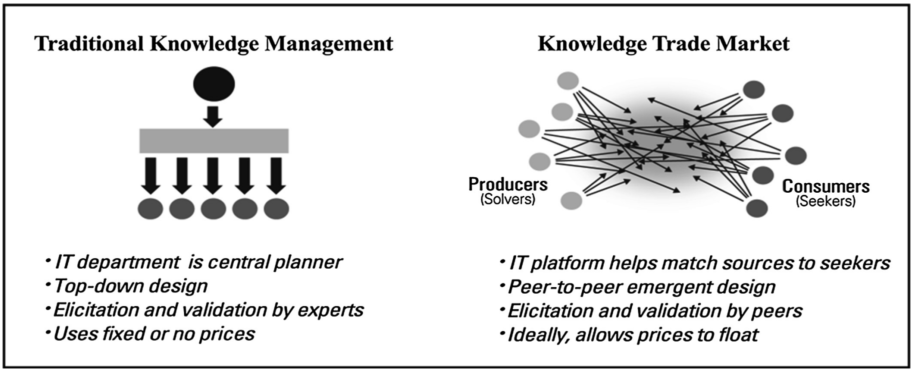

Fig. 1. Differences between traditional knowledge management and knowledge trade market (Source: Benbya and Van Alstyne 2011)

mechanisms for knowledge transfer activation. Knowledge organization and strategy are positive factors for knowledge sharing; KMSs and knowledge rewards are positive factors for knowledge trade markets (Jeong et al. 2013). Figure 2 shows how factors affect the empirically proved knowledge transfer platform (See Fig. 2).

To investigate how knowledge transfer factors are activated in real cases, we did multiple researches on the knowledge-transfer activation factors: knowledge organization, knowledge strategy, KMS, knowledge rewards, knowledge sharing culture, and knowledge trade market. We did collect real-case evidences that substantiate each latent variable to knowledge transfer framework. Especially, we do want to introduce the best practices of the utilization of knowledge trade mechanism in real cases. In the next section, we will introduce how each factor activates knowledge transfer mechanism through real cases.

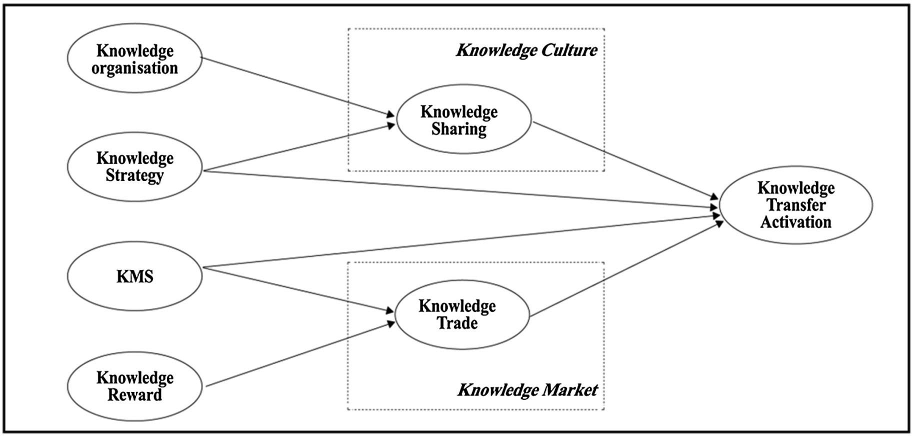

Fig. 2. Knowledge transfer activation mechanism (*source: Jeong et al. 2013)

4 Case Analysis

Case study is commensurate with investigating research question related 'how' and 'why'. The qualitative data are particularly useful for understanding why or why not emergent relationships hold (Eisenhardt 1989). Construction strategy of case study needs analytic generalization method, which compares developed theory and empirical results of case research (Yin 2002). This paper attempts to test how the latent variables of logical model (knowledge transfer framework) are supported in real cases. We researched real cases of KM organizations that successfully organize knowledge transfer from various literatures.

In this section, we analyze how factors including knowledge trade market for knowledge transfer operate in real cases. We investigated the real cases for the combination practice with the framework of the prior research and showed the best practice of each latent variable from literatures. Especially, we interviewed five persons who work for Samsung SDS that knowledge trade market is active for the in-depth analysis in July 2014.

4.1 Knowledge Trade in Knowledge Market-Based KMS

Internal knowledge markets are protected environments where users trade their knowledge via price mechanisms. They facilitate reuse of existing information, cause new information to be created when needed, and efficiently regulate use of resources, including people's time (Benbya and Van Alstyne 2011). Knowledge trade interacts with knowledge sharing culture to raise the value of knowledge assets.

Infosys Technologies, a global India software services company, has received both the Asian and the Global Most Admired Knowledge Enterprise (MAKE) awards. Infosys has launched a central knowledge portal, KShop, in 2000. A knowledge currency units (KCU) incentive scheme was launched to jumpstart contributions to KShop. "Under the scheme, Infosys employees who contributed or reviewed contributions to KShop would be awarded KCUs, which they could accumulate and exchange for monetary rewards or prizes. Additionally, employees' cumulative KCU scores world is displayed on a scoreboard on KShop, thereby is increased the visibility and standing of prolific contributors (Garud 2005)".

Samsung SDS is the largest Korean company that provides SI and IT consulting with US$ 6.4 billion revenue and 10,000 employees in 2014. Samsung SDS is a representative KM enterprise that has held MAKE (most admired knowledge enterprise) in Asia for nine years straight and received MAKE in Global in 2010. More than 60 % of their 10,000 workers possess IT professional certificates. Samsung SDS has operated a knowledge portal named 'Arisaem' since 2000. Samsung SDS encourages knowledge trade through an internal knowledge market by paying virtual currency. Colleagues evaluate the quality of knowledge traded and there are three degrees of being satisfied: strong satisfaction, satisfaction, normal. The price level from the evaluation of colleagues is differentially graded by a dedicated team and there are differential rates of virtual currency for knowledge sharing contribution. The following example is a real case in which Samsung SDS used virtual currency. "Some manager in Samsung SDS had a difficulty finding a solution during the project. He had to change a computer operating system from UNIX to Windows, but he did not know where to start. He immediately threw a question to 'Arisaem' and finished his work within two days. That would be four work-weeks if he had to work alone. He, of course, gave 'Aar' (virtual currency) to solution finders (Kim 2002)". The person concerned KM(S) of Samsung SDS evaluates that they could save nearly 50 h on every knowledge trade event.

Since market flow could control prices, the floating exchange rate (currency) is helpful to control effectively a knowledge trade market (Benbya and Van Alstyne 2011). Samsung SDS applies the floating exchange rate to control an internal knowledge trade market. According to a quarterly KM budget, the more knowledge being shared, the more the exchange rates fall and vice versa. This corresponds to the characteristics of demand-supply curves in markets. The utilization of virtual currency could be the opportunity to use rewards for knowledge sharing and measure indirectly the value of knowledge being shared.

4.2 KMS

Accenture is one of the leading global management-consulting firms. It is the largest of the pure consultancies with 246,000 consultants in 120 countries. Accenture has been a pioneer in KM (Paik and Choi 2005). The KMS of Accenture is an essential asset for maintaining virtual teams and various projects in many countries. Formerly known as Anderson Consulting, Accenture proposed the strategies for prevention of degradation using KMS as follows: (a) efficient categorization of information, (b) continual supply of valuable knowledge, (c) maintenance of repository cleanness by professionals. The Anderson Consulting KMS maintained continuously valuable knowledge and managed by more than 400 professionals (Jarrar and Zairi 2010). It is very difficult to maintain knowledge effectively.

We need developing platforms by users' participation rather than managing knowledge. Fjeldstad et al. (2012) proposed that we need actor-oriented organizational structures and architecture for collaboration. Actor-oriented architecture is composed of three main elements: (a) actors who have the capability and values to self-organize; (b) commons where actors can accumulate and share resources; and (c) protocols, processes, and infrastructures that enable multi-actor collaboration. Knowledge trade could be self-organizing system that maintain the latest knowledge and establish relationships (collaboration) by users' participation (Benbya and Van Alstyne 2011).

4.3 Knowledge Rewards

Rewards systems offer people fairness in relation to their contribution and the value they add to the organization (Armstrong 2006). Social, i.e. intrinsic rewards are viewed as more effective than economic, i.e. extrinsic rewards (Bock et al. 2005; Huff 2006). Recognition is the representative variable of social rewards and encourages people to promote individual and organizational knowledge sharing rather than individual knowing (Riege 2007).

IDEO has been ranked in the top 25 most innovative companies. IDEO shares their employees' profiles containing capability and outcomes. The profile is classified with tags; the number of tags with profiles acknowledges who is the professional in the concerned project. The company easily finds out the professionals who lead new projects. Profiles work on raising employees' reputation in the company and are helpful to spread knowledge sharing to all members. Employees gain recognition and reputation from colleagues and grow as professionals. Profile sharing lets the company dig out hidden talents and motivate employees to share their knowledge (Brown 2008). Balancing between company's recognition and personal reputation as proper knowledge rewards, IDEO kills two birds with one stone: training professionals, and sharing knowledge. The right social recognition program leverages an organization's people and their knowledge to share the corporate culture.

Kelly Services is a Fortune 500 company offering services that include temporary staffing, outsourcing, and vendor on-site and full-time placement. Kelly has been recognized for its quality processes, management practices, supplier diversity, and community involvement (Jenero and Mark 1995). Kelly operates a reward program named Kudos for increasing an individual's productivity and encouraging participation. Whenever employees get recognition from customers or managers, the company present 10 $\sim$ 100 Kudos points with the level of contributions. Each Kudos point is equal to US$ 1. Employees' contributions are classified into three categories. First, "individual records" (when employees receive recognition from managers or customers): manager recognition, customer recognition, building their learning record, record breaker, improving their record, and submitting an idea for productivity. Second, "making someone better" (when employees refer their colleagues or participate in an activity): referral bonus, making a difference, peer recognition. Third, "bang your dream" (when employees write articles): newsletter recognition. Employees who contribute to the company are also in the spotlight in their newsletter. Kelly's Kudos program is a good example that balances between individual effort to obtain social and economic rewards and the recommendation of colleagues. It is possible to enhance the divergence of knowledge through the balance between social rewards and economic rewards.

4.4 Knowledge Sharing Culture

Culture acts as a social control mechanism that manages community members and sanctions those who deviate from norms (Lee and Cole 2003). Organizational culture can be defined as the shared, basic assumptions that an organization learned while coping with the environment and solving problems of external adaptation and internal integration that are taught to new members as the correct way to solve those problems (Park et al. 2004). Al-Alawi et al. (2007) classified the relationships between organization culture and knowledge sharing as follows: trust, communication between staffs, information systems, reward system, and organization structure.

LEGO Mindstorms NXT is now being developed with consumers every year. It is a programmable robotics kit developed by LEGO and MIT. The LEGO

Mindstorm series of kits contain software and hardware to create small, customizable, and programmable robots. Currently, there are a number of YouTube video clips about creative and customizable robots. The early version of Mindstorms had been hacked. LEGO considered litigation; however, they accepted this situation as a reflection of the customer's point of view. There is a strong community of professionals and hobbyists of all ages involved in the sharing of designs, programming techniques, creating third-party software and hardware, and contributing of other ideas associated with LEGO Mindstorms (Vallance et al. 2009). Its system/website is organized much like a wiki, harnessing the creative potential and collaborative efforts of participants. LEGO also encourages sharing and peering by making software code available for downloading and by holding various contests and events. In addition, LEGO invite outside specialists who give directions besides inside experts from strong communities. Though LEGO currently has a culture that respects its customers, LEGO previously had a vertical closed structure. If LEGO had not been able to adapt its culture with customers' communications, then there would be no LEGO.

4.5 Knowledge Organization

Information is a flow of messages, while knowledge is created and is organized by the very flow of information (Nonaka 1994). Knowledge creation is the wide-scoped process of cooperative relationships among members within organization. A horizontal organization structure is suitable for knowledge transfer by making cooperative relationships. That is why horizontal organization activates teamwork-based communications among members (Goh 2002). A horizontal organizational structure not only implies enhanced communication but also the decentralization of the decision-making process (Claver-Cortés et al. 2007).

Recently, organizations use actively social network services (SNS) to ensure horizontal in-company communications. There are two types of companies using SNS: companies that use commercial SNS and companies that use self-developed SNS. LG electronics and Daumkakao use commercial SNS. LG Electronics is a Korean multinational electronics company with sales of US$ 54 billion and 91,000 employees in 2014. Daumkakao is an internet services company in Korea, which has sales of US$ 0.6 billion and 1,600 employees in 2014. The HRD team of LG uses social media 'Yammer' to collect ideas and to discuss opinions. Daumkakao uses Yammer more specifically; it is composed of a community for company-wide communications and 48 in-house communities. Communities are composed of teams, services, concerns, and clubs. People talk and discuss opinions in their communities. Daumkakao evaluates Yammer use as a movement to initiate in-house horizontal communication.

Though SNS promote an organization for supporting horizontal communication, companies block outside SNS messages because of security issues. Shinsegae and Lotte Data Communication Company (LDCC) use closed-end and self-developed SNS. Shinsegae is a Korean department store franchise with sales of US$ 4.5 billion and 16,000 employees in 2014. LDCC is a Korean IT-service company with sales of US$ 5.4 billion and 1,200 employees in 2014. Shinsegae has developed intra-social system named ‘Blossom’ to strengthen communications between people. In Blossom, people can check all posting messages from all members in real time and use most of the features as SNS. All messages from outside flow into LDCC SNS, but messages from inside to outside are blocked. Key features are as follows: micro blog (Twitter) operation, searchable personal profiles with personal career goals and projects, proposed ideas evaluated with comments and surveys, and places for storing content.

4.6 Knowledge Strategy

KM should be tightly related to objectives and business strategies of the organization or sub-unit. The strategic direction of the organization should determine the direction of the KM activity (Greiner et al. 2007). Based on the strategy, KM will determine the processes for managing knowledge. KM processes define methods for managing knowledge at a macro (organizational) and micro (individual and group) level (Sherif, 2006). According to Lettieri et al. (2004), “A KM strategy must be coherent and integrated with a comprehensive strategy whose goal is to pursue excellence”.

Samsung Life Insurance is the largest Korean insurance company with US$ 22 billion in revenue and 6,500 employees and is a Fortune global 500 company. The company makes the best use of a two-track strategy for knowledge transfer. Insurance companies need both actuaries and life insurance planners. Professional knowledge is actively shared in the forum in their KMS. People share and adopt their ‘Learning and Growth’ knowledge in the ‘Infor YOU’ team room. Knowledge sharing site in Infor YOU is composed of field CoP and an essential certificate-learning club. Knowledge capable of being shared and transferred includes business operation materials, learning materials, club activities, and headquarters materials. In addition, Samsung Life Insurance efficiently transfers its knowledge assets (lessons learned and information from field, best practices) to life insurance planners through a satellite broadcast. Knowledge strategies have to be appropriately adapted to organizational structures and business strategies like Samsung Life Insurance.

Doosan E&C is global infra-solutions company that provides civil works, architecture and plants with US$ 1.9 billion revenue and 1,700 employees. Doosan E&C has successfully modified their knowledge strategy to suit the construction industry. Though in general KM tries to transfer best practices, conversely Doosan E&C shares failures. In the construction industry, delays raise costs. The company allows voluntary posting of failures to spread lessons, and eventually influence production growth. Doosan E&C have changed their knowledge strategy to optimize organization structures within industry category.

Table 1 describes briefly the characteristics of the above cases. Characteristics of constructs from case organizations present main points for knowledge transfer activation.

Table 1. Characteristics of case organizations

Construct	Case Organizations	Characteristics
Knowledge Trade (in Knowledge Market)	Infosys Technologies,	Virtual currency based knowledge trade market affected external mechanism for knowledge transfer
	Samsung SDS	Knowledge trade by price led to autonomous dispersal of knowledge
KMS	Accenture	Traditional KMS needed a lot of effort for maintenance Autonomous development of knowledge market in KMS by knowledge trade
Knowledge Reward	IDEO, Kelly Services	Knowledge rewards balanced between economic reward and social reward (recognition, reputation)
Knowledge Sharing (in Knowledge Culture)	LEGO	Trust based knowledge culture affected internal mechanism for knowledge transfer Knowledge culture derived a sharing environment from user participation
Knowledge Organization	LG electronics, Daumkakao, LDCC	Horizontal and flexible organization structure Animated communication in knowledge organization
Knowledge Strategy	Samsung Life Insurance, Doosan E&C	Aligned knowledge strategy with organization target Knowledge strategy modified within environment around organization (industrial category)

5 Discussion

Our study explains how knowledge transfer mechanisms could be activated through knowledge trade markets by the multiple case researches. There are many enterprises that operate KM. There are, however, a few enterprises that increase productivity with KM. KM is a real, complex ecosystem organized by a number of factors; knowledge organization, knowledge strategy, KMS, knowledge rewards, knowledge sharing culture, and knowledge trade in markets. Why is knowledge market a useful mechanism for knowledge transfer activation? Market mechanisms can control the cycle of knowledge creation and extinction in the knowledge market. Knowledge trade in markets can be controlled autonomously by flexible prices. Currency liquidity can vitalize the knowledge market. Though some companies utilize virtual currency policy, the exchange of real goods can manage the market appropriately as with Samsung SDS.

Companies and organizations have to develop KMSs that users can promote autonomously by active adoption of trade in knowledge market mechanism. We need to adjust market mechanisms on KMSs via flexible prices and balance economic rewards and social rewards rather than favoring only economic rewards.

Firms or organizations should consider various aspects for the placement of a knowledge market within the organization. First, KMSs should provide a way to improve and sustain the relations among communities. Second, firms need to change their organizational structure to be flexible. Flexible organizational structure can improve the social relations of the members. Decentralization and social interaction are particularly important on encouraging knowledge flows among organizational units that compete with each other in the marketplace (Tsai 2002). Third, we should harmonize the economic and social rewards for the balance between competition and cooperation. Though economic rewards can be helpful for the quantitative growth of knowledge creation, it is important to improve the quality of knowledge by reputation and social rewards. Fourth, compensation should be accompanied by a fair assessment. Evaluation methods need to leave a uniform measurement and they should be promoted and managed so employees feel judgments of their knowledge transfer are fair.

We hope that our results can give a stage as theoretical and empirical framework for future research on the knowledge trade KMS (in knowledge market), which enhance KM initiative with the other accelerator: knowledge organization, knowledge strategy, and knowledge sharing culture.

In particular, a consideration of limitation in the current study suggests that further studies be made by in-depth case studies for knowledge trade market. Though we investigated multiple cases across different conditions for knowledge transfer, we do not explain deeply how each factor harmonize organically with the knowledge transfer of knowledge market in real case. We could also obtain more generalized research results if we do study deeply one or two cases through a traditional case-study methodology (Yin 2002).

For future work, we suggest that a knowledge market analysis based on SNS be added by setting the framework of a knowledge market and knowledge sharing culture for knowledge transfer activation.

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Toward a Highly Interactive Model of Flipped Learning

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Abstract. This study proposes a highly interactive model with the new technology of wireless projector to provide an ideal environment for presenting and discussing by multiple users including the teacher and students during lecture hour of flipped classroom. This model can definitely reduce the transition time and the presentation burden switching among a variety of learning activities to achieve a seamless learning. The TAM statistical analysis method is then exploited in the assessment for ease of use and usefulness for the proposed model. Finally, the experimental results demonstrated that the proposed model could readily support highly interactive learning activities for the flipped learning and have high acceptance of intent of use and usage behavior.

Keywords: Wireless projector · Flipped learning · Seamless learning · TAM

1 Introduction

The effective use of modern technology can let teachers easily organize their instructional materials and teaching activities simultaneously to enrich the classroom in full of the interesting and aggressive situation [1]. With the advantage of new functions of projector including the high resolution and wireless projection, the visual display by the teacher and students have more attractive and vivid such that the traditional PPT presentation can be improved [2, 3]. In addition, teachers can use a digital broadcast teaching system on their classroom to deliver teacher-side visual information to their students' PCs, notebooks or mobile devices [4]. This typical system highly focuses on delivering information from teacher side to student side. In order to achieve remarkable result to increase students' presentation capability, the delivering function from student

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side to teacher side is needed. That is, students can easily deliver their visual information to the classroom projector. Recently, the fast progress of wireless projection hints us to improve the function of digital broadcast teaching system so that students can directly send their content to projector instead of finding VGA cable to connect their PC or notebook to the input port of projector [5, 6].

As we know, the flipped classroom more emphasizes on interactive activities. This student-centered learning model allows students having more opportunities to present their opinions. Moreover, in a collaborative group, each member perhaps scramble to raise his/her voice. In this case, one presenting channel is not enough to satisfy their highly requirement. This motivates us to integrate the standards of wireless presentation including Airplay and Miracast together to let students who can hold different device to show their visual information to the classroom projector at same time and on their own seat position. In this researcher, we proposed a wireless projector server, called Airboard, to realize the above requirement [7–10].

In cognitive apprenticeship teaching, the interaction between a teacher and students is also considered as one of important activities applied in the flipped classroom. The teacher can handle the Airboard to invite or reject students' visual information to the classroom projector. Therefore, the teacher-led strategies can be realized more easily.

Finally, we apply the method of TAM statistical analysis to evaluate the contribution of highly interactive environment assisted by Airboard for realizing cooperative learning and seamless learning. The experimental results demonstrated that the proposed model could readily support highly interactive learning activities for the flipped learning and have high acceptance of intent of use and usage behavior. We believe we catch the developing trend to establish the highly interactive model that still has more fruitful research issues to deal with in the future.

2 Related Concept

2.1 Flipped Learning

Flipped classroom is a form of blended learning in which students learn content online by watching video lectures usually at home and do homework in class with teachers and students discussing and solving questions. The teacher interacting with students is more personalized with guiding instead of lecturing [11, 12].

Flipped learning strongly excludes to read videos inside lessons that is a self-learning model. It emphasizes about how to best use in-class time with students that is a student-centered model. Actually, flipped learning helps teachers move away from direct instruction as their primary teaching approach toward a more student-centered approach [13, 14].

2.2 Collaboration Learning

Students are collaborating with each other through a media to learn more about specific subjects, to test out ideas and theories, to learn facts, and to gauge each other's opinions [15–17]. In most cases, the collaboration process boosts everyone's interactive frequency.

According to Jones and Issroff (2005) research on collaborative learning and educational technologies, some key concepts is needed to take into account the interaction between cognitive, social and affective/emotional factors [15, 16]. Some highlights are summarized as follows:

- Social affinity between partners: some studies suggest that friend relationships facilitate the communication processes and interaction regulation that in turn increase motivation and collaboration.
- Actual and perceived cognitive abilities of the partners: this factor draws the attention to possible difficulties managing asymmetries in collaboration.
- Distribution of control: the way about the different members of a learning group are able to control their learning pace and how available tools enable this process during collaboration.
- Nature of the task: the nature of the task also influences the way a group 'decides' to collaborate. The difficulties of being able to collaborate synchronously might lead to losses in the activities, which increase the chance of demotivation towards group work.
- Time: socio-affective relationships evolve in time. Thus, it is important to conduct longitudinal studies in order to reveal how the different elements of a group are able to appropriate the technologies at their disposal.

2.3 Seamless Learning

Seamless learning refers to the seamless integration of the learning experiences across various dimensions including formal and informal learning contexts, individual and social learning, and physical world and cyberspace [18].

A ubiquitous learning environment is a pervasive and persistent setting allowing students to access learning materials flexibly and seamlessly in any location at any time, both from the physical environment and from the Internet [19]. All echelons will integrate the collectors, thus creating a seamless collaborative environment [18].

In e-Learning or c-Learning (classroom-Learning), we need more efficiency and to focus on teaching and learning activities or peer perform interactive learning. From the seamless-learning perspective, learners are given the opportunity to collaborate and interact in new ways within their peers and the physical world, as well as the physical world can be augmented through the using of digital technologies.

Learners would be encouraged to externalize their learning experiences and increase their awareness of the underlying connections between abstract representations and concrete experiences.

Inspired by the discussions by Chan et al. (2006) on the seamless learning model supported by the setting of one mobile device or more per learner, Looi et al. (2009) propose that seamless learning can be framed according to the guiding principles of distributed cognition theory [20, 21].

Through a thorough review of recent academic paper on seamless learning, Wong & Looi (2011) identify ten dimensions that characterize seamless learning as follows [21]:

- (MSL1) Encompassing formal and informal learning;
- (MSL2) Encompassing personalized and social learning;
- (MSL3) Across time;
- (MSL4) Across locations;
- (MSL5) Ubiquitous knowledge access (a combination of context-aware learning, augmented reality learning, and ubiquitous Internet access);
- (MSL6) Encompassing physical and digital worlds;
- (MSL7) Combined use of multiple device types (including "stable" technologies such as desktop computers, interactive whiteboards);
- (MSL8) Seamless switching between multiple learning tasks (such as data collection t analysis t communication);
- (MSL9) Knowledge synthesis (a combination of prior + new knowledge, multiple levels of thinking skills, and multi-disciplinary learning);
- (MSL10) Encompassing multiple pedagogical or learning activity models.

2.4 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is a statistic method based on information systems theory to collect and analyze users' acceptance and use of a technology. This model suggests that when users are trying to use a new technology, at least two factors, perceived usefulness and perceived ease of use, to influence their decision:

1. Perceived usefulness (PU) - Fred Davis defined it as "the degree to which a person believes that using a particular system would enhance his or her job performance".
2. Perceived ease of use (PEOU) - Davis defined it as "the degree to which a person believes that using a particular system would be free from effort" [22].

3 Implementation of Flipped Learning

3.1 Instructional Design

We selected the lecture of distant learning, "I-Number Logic", to implement this experiment. This lecture supported by the MOOCs project of Taiwan Ministry of Education during 5/2014 $\sim$ 4/2015 was run by two styles of course. One was on TaiwanLife which is a MOOCs web platform during 10/27/2014 $\sim$ 01/18/2015 as 18 h lecture of pure distant learnng. Another was on CyberCCU which is the distant learning platform of National Chung Cheng University in Taiwan during 9/2014 $\sim$ 1/2015 as 36 h blended learning lecture. Both lectures used the same 18-hour high quality e-Learnng content with full HD resolution and mp4 media format.

Based on the Bishop and Verleger (2013) analysis, "an ability to communicate effectively," "an ability to identify, formulate, and solve engineering problems," and "an ability to function on multidisciplinary teams" are important training outcomes of an engineering unversity student [14]. Many of these criterion for better outcome are generally difficult to teach and assess effectively with informative lectures and closed form questions. The lecture offered in TaiwanLife was a 100 % self-learning and informative lecture. Even we tried to design more attractive problems, we were hard to face our students to let problem more open. Therefore, the second style lecture offered in our university was increased 18 h to run the flipped learning.

This lecture is related to the I-Ching so called the Book of Changes, a mystery kwonledge from ancient china. It is very difficult to fully comprehend the knowledge base and inference rules of the core book. Therefore, we rewrite the part of prediction as the main content of our lecture to satisfy the modern lecture format. We translate the old concept of knowledge to be a knowlege rule base. Students can learn the specific rule to understand the deep idea instead of ambiguous concept of original I-Ching. Also, we apply the inference structure of fuzzy system to rewrite the prediction rule as a well-form inference mechanism. Students can understand how to manipulate a set of rules picked up from knowledge rule base to progress a sequence of inference steps and finally give a perfect consultation.

There were 33 students whose majors are in Engineering or Managment to take the I-Number Logic in our university. Mathematical Logic is one of the key foundations related to their major areas. Therefore, we design two kinds of open form questions to let students construct their I-Ching knowledge and prediction inference abiliy.

Type I Problem: Ask students to explain an old phrase or several correlated old phrases with a new knowledge rule. For example,請以生尅之法則解釋“兄動刻財,子動能解”。(Fig. 1).

A lot of phrases can be found from old books. This kind of treasure knowledge can be appropriately selected to let students discuss outside the classroom and then present their opinion inside the classroom.

Type II Problem: Ask students to rewrite old predication cases with new inference mechanism (Fig. 2).

Aslo, a lot of old cases are avaliable without worrying about the copyright. Most of the old cases were concept-based writing style with uncertainty conclusion. Let each completely discuss the assigned cases outside the classroom and then present their new results inside the classroom.

In this class, 33 students are divided into 11 groups. Each student can discuss the problem in their group, but must return the answer and result by oneself. In this study,

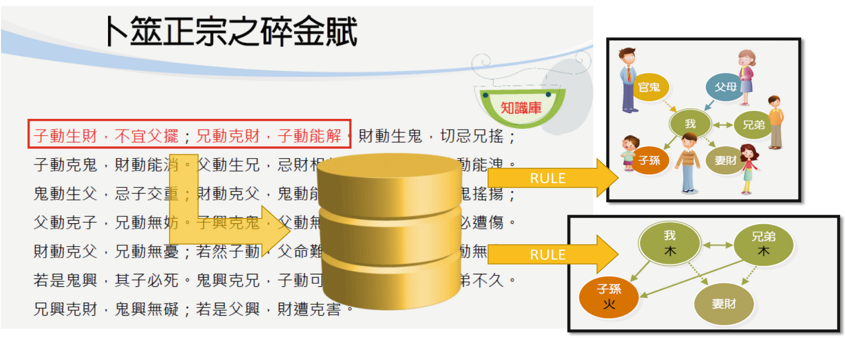

Fig. 1. A new knowledge rule

Fig. 2. Some new inference mechanisms

we just concentrated on analyzing the final report of each group on their activity gap and technology acceptance. Each group was assigned a project with two Type II problems and one self-design problem. Each problem has one member in charge of it. This member is called as the major member and another two members are called minor members. Each one has a chance as the major member and two chances as minor members. The mission of major member was in charge of preparing the PPT and reporting the main result. Another two were to assist the major member to report the supplementary data from knowlege rule base and inference mechanism while the major member mentioned them.

Inside the flipped classroom, each group has three times to report their final project. Students not in the active group were encouraged to discuss with the reporting group for realizing the concept of peer learning.

3.2 Multiple Channel Presentation

At most, four persons want to present including one teacher and three students. In Fig. 3, the traditional projector configuration was suggested. The teacher handled the VGA switch box to decide whose content can be shown on the screen. At same time, only one person can display his/her content under this solution. This style of presentation is called

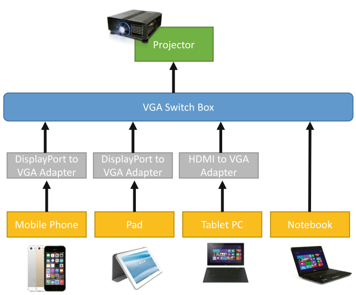

Fig. 3. Switching presentation

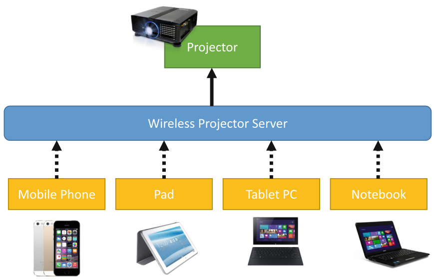

Fig. 4. Parallel presentation

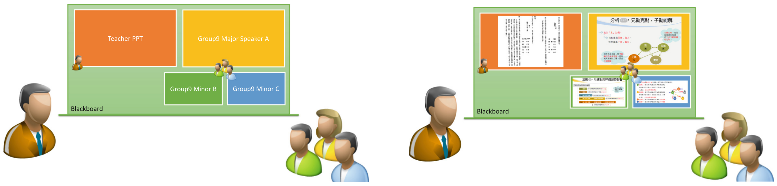

Fig. 5. A highly interactive scenario

as switching or sequential presentation. In Fig. 4, the wireless projector server was proposed. The wireless projector server allows four contents display on screen at same time. The teacher and students can use the wireless environment to connect to wireless projector server. This server can receive four inputs and then display them on one screen. This style of presentation is called as parallel presentation. Under this presentation style, the highly interactive scenario can be easily realized as shown in Fig. 5.

4 Analysis of Seamless Learning

This experiment is to test whether the parallel presentation can reduce the activity gap in contrast to the switching presentation. The first run of 11 groups was asked to use the approach of switching presentaton to present their first Type II problem. Then, the second

Fig. 6. The scenario of parallel presentation

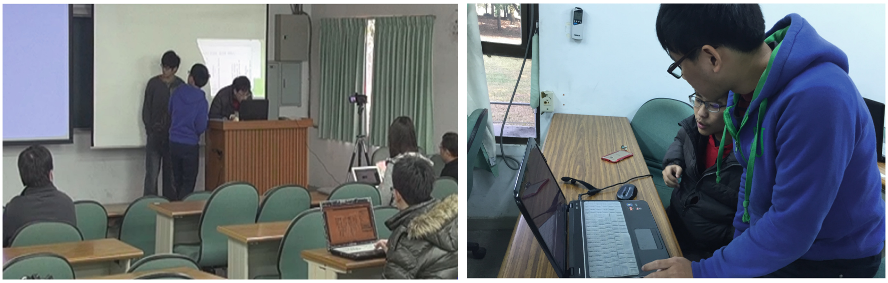

Fig. 7. The difference scenario bewteen squential and parallel presentations

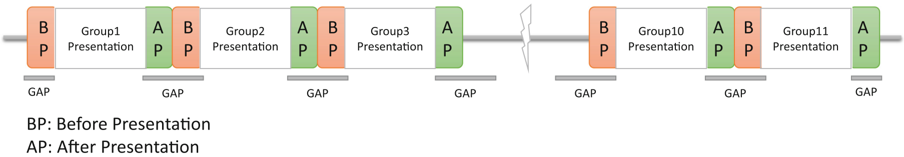

Fig. 8. A learning gap bewteen two consecutive presentations

run was asked to use the approach of parallel presentation to present their second Type II problem. The presentation time of each problem is not over 10 min (Figs. 6 and 7).

We used two digital video recorders to record the whole learning activities occured inside the classroom. We found that the activity gap occurred between two consecutive presenations. In Fig. 8, we can find that before and after 11 presentations totally have 12 gaps.

Basically, the duration time before presentation probably was occured by

(1) walking from seat position to presentation position;
(2) setting up the VGA connection to project;
(3) setting up the resolution and mirror projection.

Also, the duration time after presentation probably was occured by

(1) taking off the VGA connection;
(2) picking up their notebook and handout and going back to their seat.

With the ideal consideration of seamless learning, we should spend whole lecture time on presentation. Actually, it is impossible to reach this ideal goal. The only effort is to reduce the gap. From our statistical data, we found that average time spent on each group on the 1st and 2nd runs were 15.81 and 10.03 min, respectively.

In Table 1, we can find a significant differences of presentation time spent by each group in the 1st and 2nd runs. By switching presentation, each member probably used different brands of notebook to connect to projector so that it always caused a connection failure. The Groups 5 and 11 in the 1st run can not connect to projector, and tried a couple of times finally to conncet to the projector. This caused a big gap before their presentation.

Table 1. The presentation time tabulation

Group	Before presentation(min)		In presentation (min)		After presentation(min)		Overall(min)	
	1st run	2nd run	1st run	2nd run	1st run	2nd run	1st run	2nd run
01	4.5	2	6.2	7	2	0.5	12.7	9.5
02	5	1.2	8	7.8	2	0.4	15	9.4
03	5.2	1	7.5	7.6	2.2	0.5	14.9	9.1
04	4	1	9	9.2	1.5	0.4	17.5	10.6
05	13	1.2	10	9	2	0.5	25	10.7
06	4	1.1	8	8.5	1.5	0.5	13.5	10.1
07	3	1	7	8.5	1.6	0.4	11.6	9.9
08	4	2	7.5	8	1.4	0.5	12.9	10.5
09	5	1	8.2	9	1.5	0.5	14.7	10.5
10	6	1	8	8.2	1.5	0.4	15.5	9.6
11	12	1.4	7.2	8.5	1.4	0.5	20.6	10.4
Average	5.97	1.26	8.15	8.30	1.69	0.46	15.81	10.03
Percentage	37.78 %	12.60 %	51.52 %	82.77 %	10.70 %	4.62 %	100 %	100 %

In the 2nd run, students didn't need to walk to platform or inforamtion desk. They can present their result on their seats, and cooperate with another members via Wi-Fi by using the wireless projector APP to show their reports on the projector screen. Therefore, they had more time to explain his/her study report with comfortable mood. In the 1st run, each group almost wasted almost half time (48.28 %) in preparing for presentation. However, in the 2nd run, the preparation time was highly reduced and students spent 82.77 % time on their presentation.

5 TAM Analysis of Highly Interactive Environment

Although much research supports the Technology Acceptance Model (TAM) as an excellent model to explain the acceptance of IS/IT, it is questionable whether the model can be applied to analyze every instance of IS/IT adoption and implementation [23].

Many empirical studies recommend integrating TAM with other theories (e.g. IDT, or DeLone & McLean's IS success model) to cope with rapid changes in IS/IT, and improve specificity and explanatory power (Carter & Be´langer, 2005; Legris, Ingham, & Colerette, 2003) [24, 25].

According to the TAM, it is derived to apply to any specific domain of human–computer interactions (Davis et al., 1989) [22]. The TAM attitude toward using, in turn, is a function of two major beliefs: perceived usefulness and perceived ease of use. Perceived ease of use has a causal effect on perceived usefulness. Design features directly influence perceived usefulness and perceived ease of use [26].

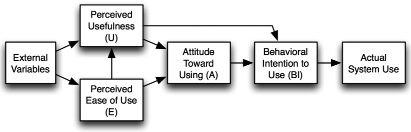

Fig. 9. The Technology Acceptance Model, version 1. (Davis 1989)

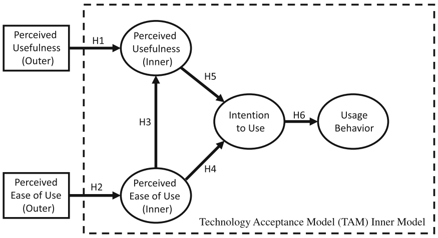

Fig. 10. The Highly Interactive TAM Model

5.1 Research Model and Hypotheses

Study Architecture: This study is based on Davis (1989) the Technology Acceptance Model (TAM), which follows the original mode of "perceived usefulness, perceived ease of use, the intention to use and the usage behavior" as facets of inner model variables [22]. On the external variables, we selected the Venkatesh, V. and H. Bala, (2008) proposed Technology Acceptance Model as an external variables and design questionnaires for the outer model of TAM. The outer model questionnaires require to explore usage intention of students' acceptance to use the system in perceived usefulness and perceived ease of use [23] as shown in Fig. 9.

This study was based on Fig. 10 that delimits the relationship in the various facets of TAM architecture. According to this model, we proposed six hypothesis to investigate the effects of TAM. The definition and rationale for each of research hypothesis variables are detailed below:

"The External factors" (In SmartPLS known as "Outer Model") refers to the quality of their information systems function measure. It contains the system's reliability, usefulness, ease of use, friendly and reaction time [27]. This study was based on the above theory and hence we developed following research hypothesis:

H1: External factors will positively influence perceived usefulness.
H2: External factors will positively influence perceived ease forward.

According to the Davis (1993) and Igbaria et al. (1997) pointed out, the Perceived ease of use will positively affect the perceived usefulness and intention to use [26, 28].

The perceived usefulness follows the above theory document to develop the H4 and H5 research hypothesis. In addition, according to the Sørebø and Eikebrokk (2008) point out, if information technology can allow the user spend less time to learn how to use, in a better way it can be easily intuitional to use, so that it will indirectly improve user interaction with the application of information technology [29]. Therefore, we designed hypothesis as follows:

H4: perceived ease of use will positively influence perceived usefulness.

About "Perceived usefulness", Davis (1993) and Igbaria et al. (1997) found that if the user thinks the information system can effectively improve work efficiency, the user will have a higher intention to use this system. This study was based on the theory of this document, the following research hypothesis [26, 28].

H5: The cognitive using perceive usefulness will positively influence the system.

"Interaction with the system" refers to the interaction between users and information systems. If the user more frequent to use the system, which represents that a user will have a higher intention to use the system [26, 28]. The following research hypothesis is based on the theory of this document:

H6: interactive with the system will positively affect the willingness to use the system.

5.2 Questionnaire Design and Operational Definition

This study used questionnaires to predict and investigate the system of student acceptance the ease of use and usefulness. All the questionnaires were designed by refering to some research experts [18, 30]. In this study, the questionnaire content was: Perceived Usefulness Outer model, Perceived Ease of Use Outer model, Perceived Usefulness Inner mode, Perceived Easy of Use Inner model, Intention to Use and Usage Behavior. A totally is 36 ask items.

5.3 Development of Instruments

Data Collection: The samples were collected from the lecture, I-Number Logic, in our university, Chung Cheng Univrsity. Therefore, this study actually used the college students to carry out a questionnaire administer test. We used the concept of TAM, and designed 70 questions for questionnaire. After that, we discussed with seven professors and doctoral students and left 36 questions for final experiment. It was enough to reveal both inner and outer model of TAM dimensions. The questionnaire experimented from January 5, 2014 to January 15, 2014. Total investigations sent out were 80 questionnaires and took back 65 samples. After the deduction of 13 invalid questionnaires, 52 valid questionnaires were obtained. The effective rate was 65 % for reflecting this study results for the wireless projector environment.

5.4 Reliability Validity Analysis

This study analyzed the results of the program in accordance with SmartPLS. It was determined where the reliability index factor loading and a Composite Reliability (CR) and Average Variance Extracted (AVE). If the CR higher values can be measured, the latent variables (Bagozzi 1981) would show the recommended value of 0.6 or more [31].

The Average Variance Extracted (AVE) values were calculated for each potential variables. If the average variance was extracted the higher amount of potential variables, it showed that there were more potential variables. Concerning about high

Table 2. Test results of each facet

	Composite Reliability (CR)	AVE	Cronbach's Alpha
Perceived usefulness (Outer)	0.932	0.505	0.919
Perceived ease of use (Outer)	0.914	0.545	0.895
Perceived usefulness (Inner)	0.891	0.673	0.836
Perceived ease of use (Inner)	0.958	0.852	0.942
Intention to use	0.878	0.705	0.793
Usage behavior	0.888	0.727	0.809

convergent validity and discriminant validity, Fornell and Larcker (1981) suggested that the average variance extracted should be greater than 0.5. The table shown below reflected the average variance extracted from all constructs of all amounts greater than 0.5. Thus, this study confirmed the measurement of this experiment and had some convergent validity [32].

The reliabilities of each variable were shown in Table 2. In this study, Cronbach's Alpha coefficient value on reliability analysis tested the internal variables to measure each of the question items from the table consistency between Cronbach's Alpha value of each variable between 0.793 to 0.942. According that Cronbach's Alpha value was greater than 0.6 and the CA value was greater than 0.7, the reliability of the questionnaire can meet the eligibility criteria and then the use of this research scale had good reliability. In Table 2, Composite Reliability and Cronbach Alpha were higher than the recommended value. It explained that the internal consistency of this study indicated that all facets of the project were good.

Overall for the questionnaire, most of users who used Airboard in flipped classroom learning activities were perceived and interesting. Some of them expressed the hope that can continue and will recommend it to other students to use. Not only that, some of students hoped to using courses in the future, but also to apply relevant information technology for learning activities.

6 Conclusion

In this study, we have employed the technique of wireless projector to improve the interactive ability of a group of students while they are presenting simultaneously. This improvement can make more freedom of interaction inside the flipped classroom so that students can present on their seat instead of working to the platform or information desk.

We found that the *t* values collected from the hypothesis of H1, H2, H3, H4, H5, and H6 all reached the standard level of significant. This shows that the Wireless Projector Server System possesses high satisfaction and positive effect.

Therefore, the experimental results demonstrated that the proposed model could readily support highly interactive learning activities for the flipped learning and have high acceptance of intent of use and usage behavior. We believe we catch the developing trend to establish the highly interactive model that still has more fruitful research issues to deal with in the future.

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Collaborative Learning Using Social Media Tools in a Blended Learning Course

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Abstract. The concept of collaboration is rooted in social constructivist theories. With social theories as the theoretical base, collaborative learning is extended to online collaborative learning with the support of new technologies. In blended learning, students learn in collaborative situations using online tools to support inquiry and discovery learning. The Community of Inquiry (CoI) framework is a popular framework for blended learning from a socio-constructivist perspective where teaching, cognitive and social presence are required in collaborative constructivist learning. With the continued advances in technology, online collaborative learning via social media initiates new learning experiences. The purpose of this paper is to explore the student experience in collaborative learning using social media tools in a blended learning course. In this study, in-depth semi-structured interviews were conducted in a blended learning course. The results show the students engaged in learning through use of WhatsApp, Skype and Facebook to transfer, share and construct knowledge among peers in asynchronous and synchronous modes. Relationships of the collaboration with learning outcomes, engagement and other influential factors were also found. The collaboration was found to be initiated independently by the students and was a non-prescribed activity as it was not designed in the course nor instructed by the teachers. This study asserts that the element of autonomy could be considered in the Community of Inquiry in reflecting the learning experience without a teaching presence in blended learning.

Keywords: Online collaborative learning · Social constructivist theories · Community of inquiry (CoI)

1 Introduction

In the blended learning environment, it is important to coordinate face-to-face mode and online mode of communication to better support collaboration [1]. Collaboration is not a new concept in blended learning as it is rooted in social constructivist theories that students can perform at higher intellectual levels in collaborative situations [2]. Al-Ani [3] stresses social constructivist theories underpin much of the theoretical work on blended learning and these theories focus on how the tools are used in on-line environments to support inquiry and discovery learning. In higher

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education, cooperative and collaborative learning have a role at both undergraduate and postgraduate levels [4]. The basis of both cooperative learning and collaborative learning in constructivism is that knowledge is constructed and transformed by students [5]. Collaborative learning and cooperative learning have similarities but still have differences in that in collaborative learning, students are believed to have social skills already, can organise and negotiate efforts themselves, and are guided but not directed by instructors [6]. Collaborative learning is a way in which individuals work closely together towards a common goal, adopting expertise and experiences and emphasizing co-creation and contributions from each member of the group [7]. Collaboration enhances and promotes learning which is an important factor in academic achievement, personal development and student satisfaction [8]. Situations, interactions, processes and impacts are four fundamental criteria influencing collaboration [9]. Collaborative learning occurs when small groups of students help each other to learn [10]. Under these circumstances, the collaboration is carried out coordinately and synchronously by mutual efforts in problem solving, value creation and skill set leverage among all participants [11, 12].

1.1 Theoretical Concept

Constructivism suggests that learners 'create knowledge as they attempt to understand their experiences' [13]. In constructivism, real-life learning is complex and learners actively attempt to pursue learning. As an extension from constructivist theories, social learning theories advocate the construction of knowledge via social interaction whereby students can learn through interacting and communicating with peers, teachers and other experts [14]. We learn from culture, which is a primary determining factor for knowledge construction, using learning communities, collaborative learning, group work and discussion-based learning. Vygotsky's theory asserts the themes on social interaction, 'more knowledgeable others' and the 'zone of proximal development' [15]. Zone of proximal development refers to the 'distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more knowledgeable others' [2, p.86]. Although the zone of proximal development concept is developed through observing children, it provides an underlying framework of social learning in adult education [16]. Contributing from the constructivists, social theories gave fundamentals for the development of later collaborative and cooperative practices in modern society [17]. Social theories can be used to provide a theoretical base from which to understand cooperative learning [18].

A number of frameworks and models are related to blended learning. The community of inquiry framework is a popular framework for blended learning from a socio-constructivist perspective [19]. The model identifies that teaching, cognitive and social presence are required in a collaborative constructivist learning environment and suggests that cognitive presence can be created and supported in a computer-conference environment with appropriate teaching and social presence [20].

1.2 Online Collaborative Learning

In the context of online collaborative learning, constructivism is also considered as a theoretical foundation for technology and social studies integration in which learning occurs in the network environment and the mediation of technology facilitate learner-to-learner interaction [21] and online learning provides an environment for social constructivist learning [22]. Stacey [16] studies on using computer-mediated communication (CMC) as a means of small group and large group communication in a distance learning programme and finds that Vygotsky's theory can apply to online communication. She describes the way that CMC provides an environment for social construction of knowledge through collaborative learning and explicitly states that'the notion of construction of knowledge in a group context, which is derived from the work of Vygotsky and neo-Vygotskian researchers, could provide a framework for understanding how the study's participants learned' [14].

Online collaborative learning is facilitated by new technologies. Klemm [23] considers Moodle as an online platform based on a socio-constructivist learning approach and offers a number of interactions and tools for collaboration and exploration learning. In a research on classroom innovation, a collaborative knowledge forum was built for students' implementation of social learning [24]. The research showed that schools encouraged collaboration between students, group projects and peer tutoring. Through learning and sharing with each other, students could build knowledge by learning from others. In a study regarding the use of mobile tools for students' learning, social learning spaces are set up in both in-class formal learning and out-of-class informal settings [25]. Teachers use media forums to assess students' work and also set tasks that specifically measure students' interactions and co-operative skills [26]. Mobile-assisted classroom-based tools are used to facilitate the students' online social learning in-class and out-of-class. The results show that social learning activities supported by the mobile devices can facilitate students' learning and these devices can be the students' personal 'learning hubs' to enhance formal and informal learning spaces.

Online learning via social media has drawn attention from researchers recently and the new concept of e-learning 2.0 is defined as the adoption of social media in learning or education [27]. A study on collaborative learning using social media in higher education shows that more introvert students perceive social media as more helpful for increasing their collaborative learning performance and self-confidence [28]. Learning through social media places the control of learning into the learners' hands [29]. Another study on the use of WhatsApp mobile social learning with structural teacher-guidance shows a positive impact in the achievements and attitudes of the students when compared to the face to face learning students [30]. However, Li, Helou and Gillet [31] argue that higher education institutions are still primarily relying on traditional learning management systems (LMS) that do not fully capitalize on the potential of social media for enabling participation in global learning networks, collaboration and social networking.

2 Methodology

As part of the study of a research on understanding students' experiences in a blended learning course with a research sub-question 'how does collaboration facilitate students' study in blended learning', the purpose of this paper is to explore the student experience in collaborative learning using social media tools in a blended learning course. It aims at finding out the reasons, the ways and the experiences of students which involve their relations with each other. Since interpretivism has the goal of 'understanding the complex world of lived experience from the point of view of those who live it' [32, p.118], it suits this research purpose of understanding student experience. This interpretive research, in understanding the social realities (learning experience) for those experiencing them (student), conforms to subjectivism and is appropriate to a qualitative research approach. In this study, individual interviews were designed to obtain in-depth data from the students. Before the research, consent was received from the school and the course leader. In the first week of the course, research consent was obtained from the students in the classes.

The study was conducted with the 2013 cohort of the Management Accounting course of a full-time Higher Diploma programme. In the cohort, there were four classes of students and the total number of students was 160. The unit of analysis was two classes within the four classes. Based on a prior study on online participation in this research, the students were categorized into four types of online-learners. Self-directed Learners are students who can direct their own learning by spending time to learn in the online platform and participating in many online learning activities. Guided Learners are students who follow the teacher's guidance in participating in assigned activities and they are willing to spend time to learn in these particular activities. Window-shopping Learners are students who try to look at different kinds of learning activities but do not spend much time in any of the activities. Passive Learners are students who do not spend much time in the online platform and just mainly participate in activities assigned by teachers. The individual interviews were conducted in early 2014. Two students in each of the four learner categories were randomly selected and invited to participate in the individual interviews. Among the eight students, half of them were from each of the two classes.

The interview was designed in a semi-structured way. In the interview, two questions were related to online communication using social media. Students were asked to describe by an example how they learnt via the social media in the course and how the tools enhanced their learning experience. To allow the students express their views with appropriate wordings and expression, the interviews were conducted with the students' mother tongue, Chinese. The interviews were tape-recorded and the transcripts were then prepared. The transcripts were translated into English for study and recurring ideas or themes were identified and illustrative quotations selected. Qualitative analysis software, Nvivo 10, for labeling and sorting segments of text into categories was used for data analysis. For assuring reliability and validity of the interviews, the recordings and translation were reviewed by a local expert. Thematic Analysis of Braun and Clarke [33] was used in data analysis of the research.

3 Findings

Students were found to be actively involved in non-prescribed online collaboration in this course. Social media applications were used for their communication. Among the 8 interviewed students, all of them had used social media applications to learn. The numbers of these students using the tools WhatsApp, Facebook and Skype were 7, 5 and 3 respectively. The main reason that they used several tools to communicate was that the tools had different special functions to facilitate their communication and learning. Through communicating via these tools, they learnt from collaborative learning. The following provides the findings about why and how they used the tools, their engagement in collaborative learning, and the relationship of such collaborative learning with other influential factors.

3.1 Online Collaborative Learning in WhatsApp

Most of the students used WhatsApp to communicate for blended learning in the course. Among the 7 students who had used WhatsApp to communicate, 5 mentioned that they communicated in groups. In their communication, they mainly asked questions when they had problems in learning for the peers to answer and they discussed learning contents related to examination. A student explicitly said that she used WhatsApp to ask questions to her classmates whenever she 'did not understand any learning contents'. WhatsApp, as the most commonly used tool for non-prescribed asynchronous online collaborative learning in this course, was used ad hoc in asking and answering questions when students had problems in study, for instance, doing calculation exercises.

Besides sending the contents in text, students made use of the audio and photo feature to send the questions and answers in formats that facilitated the convenience of communication. Three students described in detail how they learnt through collaboration using text, audio and photo messages. After they sent out their questions using text or photo, others replied to them via text, audio or photo messages. One of them found using text or photo to show her questions was better than describing them to the peers by talking on the phone. Another student found text messages were more convenient to use than voice messages. The student further explained that the advantages of WhatsApp were that it allowed her to make voice recordings, type text and upload photos, at a relatively fast and convenient speed; she could add many people for chatting in a group; and it was free of charge. Another student preferred using WhatsApp audio to communicate to using the phone because of the merits of its asynchronous feature.

The group size of the non-prescribed online collaboration using WhatsApp varied from 2 to over 10. In this study, one group had 4-5 students and another group had more than 10 students with the WhatsApp's asynchronous feature.

3.2 Online Collaborative Learning in Skype

With the group audio feature provided in Skype, the 5 students who used Skype in communication in the MA course had audio group discussion with peers via Skype.

The reason for using Skype was that it enables real-time audio group communication as the students explained. While having real-time communication, students could have discussions on learning activities that were more complex, for example, questions with a case and open-ended questions.

Unlike the communication in WhatsApp which was asynchronous, the students either scheduled a time or had ad hoc communication in Skype when they had questions. One student used Skype in his personal computer instead of his mobile phone for communication. He mainly had one-to-one communications and occasionally had a discussion in groups. He typed text, uploaded photos and printed the screens with graphics and passed them into Skype for discussion. He explained how he used Skype to discuss difficulties he was having in doing exercise questions.

For group size in Skype, one group had 4-5 students but not all of them joined the discussion every time and only 2-3 of them discussed together more. On the other hand, another Skype group has 5-6 students and they were the same peers as in their WhatsApp group. The Skype group size ranges from 2 to 6 in this study.

3.3 Online Collaborative Learning in Facebook

The collaboration among students in Facebook was knowledge sharing and discussion. Among the 3 students who had used Facebook, they mainly used it as file sharing. One of them mentioned that the students posted the questions which were worth doing or for discussing into Facebook. They wanted to encourage others to do the questions and they solved the problem together.

The sharing of files for discussion was asynchronous. The sharing of files not only facilitated the sharing of knowledge but also encouraged learning in a collaborative way by allowing them to do the shared questions and solve the shared problem together.

3.4 Online Collaborative Learning for Achieving Learning Outcomes

Students studied in blended learning for achieving learning outcomes, obtaining good results and acquiring knowledge. It is found that students' engagement in non-prescribed online communication was related to their intended learning outcomes in relation to preparing for the examination, which contributes most of marks in overall assessment in this course, and solving problems during studies.

All the 8 students said they used the social media when they had problems in study and asked questions of peers. Social media were used when the students were doing exercises, doing revision and studying for examination as 4 students explicitly stated in the interview. Besides, social media were more frequently used before examination and a student explained the reason was that they could ask for help immediately if they found any problem. Three students stated the frequencies of usage, which varied from every 1-2 days to every 2-3 weeks during the whole study period.

Although the frequencies of using social media in collaboration in the course are varied, the reasons for using the tools are the same. It is found that students are actively involved in non-prescribed online communication for achieving learning outcomes in relation to preparing for the examination and solving problems during studies. While this sub-section shows the findings on why and when they had the collaboration, engagement is the most important part in their non-prescribed online collaboration.

3.5 Engagement in Online Collaborative Learning

All 8 students interviewed were engaged in communication via social media with their peers as they got help conveniently with timely support from others in this additional communication channel. The students found learning via online collaboration was helpful, effective and time-saving. Students engaged in online collaboration via social media as they could learn from peers who had more knowledge. Two students said they sought help from others with better results or knew more on how to do the questions.

Such non-prescribed collaborative learning realized Vygotsky's theory [14] of zone of proximal development in learning through social interaction from the more knowledgeable others. It also confirmed Dooly's [5] basis of collaborative learning that through communication, knowledge is constructed and transformed by students as the students found they learnt from collaboration.

The students learning from online collaboration using social media relates to both traditional and online learning activities. Students used WhatsApp to seek for help when they had problems during study. The flexibility and convenience of the tools enabled students' engagement in learning. It was found that a student even made use of WhatsApp to ask peer questions in the class.

Three students found the problem of isolation in online learning was remedied by the collaboration in social media. One student found that by studying together via the social media, they were encouraged to learn and could get help from others effectively.

The following student's view best summarized the reason for students' engagement in collaborative learning via social media was facilitating communication and idea exchange, learning and giving feedback with others, comparing the study progress, solving problems together, and studying without the feeling of loneliness. He said,

> *'They mainly helped us to facilitate communications and exchange ideas. We learnt and gave feedback to each other. By comparing our study progress, I could understand if I was lagging behind. We could discuss and exchange ideas when doing assignment. When problems came up, they could be dealt immediately. I did not need to study alone.'*

It was found that students' experiences were enhanced by engaging in non-prescribed online learning using social media, with their perceived advantages of helpfulness, convenience, an alternative option, being effective and time-saving. Students' engagement was learning from a 'more knowledgeable other' in the zone of proximal development (Vygotsky, 1962). They also exchanged ideas and compared progress during learning via the tools. The online collaboration happened both inside and outside the class and it helped lessen the isolation feeling of the students.

3.6 Other Factors Influencing Non-prescribed Online Collaborative Learning

Other factors influencing non-prescribed online collaborative learning were found to be barriers and the need of a teaching presence. Among the 8 interviewed students, 7 were using mobile devices for online collaboration with social media. However, one student 'did not have data plan' and therefore he only 'use[d] Skype to communicate with his personal computer'. The difference of this student to others was that he could not participate in the communication as conveniently as the other students. As a result, limitation of the device was a barrier for him to extend online collaboration when he was not accessing his computer.

A student explained the reason for having online collaboration was that it was not easy to gather face-to-face to have discussion. However, she found the screen of her mobile phone was too small. She used online collaboration because she found it was the only choice to her to have discussion. She further expressed her wish on having online collaboration in the learning platform of the school with the whole class set into a group.

The same student also preferred to have the teacher's response in online collaboration. In the interviews, the students mentioned teachers in expressing their views. One of the students actually said that his teacher was in his WhatsApp group but the teacher rarely replied and communication between them was not related to learning. However, it was found the teacher in another class did answer students' questions related to learning in WhatsApp. If the question was difficult, she would stay after the next class to explain the answer to the student. However, she only collaborated with some students in the class as it was a non-prescribed learning activity. It was found that some students needed the teacher's support during non-prescribed online collaboration.

However, the support from the teacher was not always required in online collaboration. One student felt 'pressure if he had to ask the teacher question'. He felt happier to learn from his good friend using Skype then asking the teacher a question, in which he found he could already learn from peers via collaboration in Skype. Online collaboration was not an isolated learning activity. A student said that she would consult the teacher, though not in the way of online communication, if the peers could not answer her questions. In such case, teaching support was closely related to online collaboration as an extension of learning in the course.

It was found that educational experience in non-prescribed collaborative learning occurred in most of the situations without a teaching presence and learning occurred in such activities initiated by individuals independently with autonomy. The collaboration was not designed, instructed or involved teachers. The teaching presence occurred occasionally in learning via social media and was needed sometimes by the students. However, in this study, the individuals experienced learning and engaged in learning most of the time without the teaching presence in non-prescribed online learning.

4 Discussion

In this study, non-prescribed online collaborative learning using social media tools was active among students. The reason that they used several tools to communicate was that the tools had different special functions to facilitate their communication and learning. Through these tools, they engaged in collaborative learning.

In their daily learning and especially before examination, the students made use of the asynchronous text, audio and photo features of WhatsApp to ask and answer questions for learning from the peers who knew more than they did. The results agree with Stacey [16] that Vygotsky's theory can apply to online communication as students learnt from more knowledgeable others through online collaboration in the blended learning course.

The students used both asynchronous and synchronous mode to learn from each other in Skype. The students had audio meetings in small groups in Skype to have discussions. The discussion contents related to some questions which presented problems or needed their deep thinking. Furthermore, they shared their found knowledge with others by file sharing and discussion in Facebook. The results affirm online learning provides an environment for social constructivist learning [22].

Online collaborative learning using social media is associated with learning outcomes and engagement. The frequencies of such collaboration were higher before examination, which contributed most of the marks to an overall assessment of the course. The questions they asked and discussed in their daily studies were related to the examination, such as calculation questions. They learnt in the zone of proximal development by learning through social interaction [14]. The students engaged in learning as they found online collaboration via social media helpful, effective, convenient, an additional communication channel and time saving. Through the communication, knowledge was constructed and transformed by the students [5].

Other influential factors in the non-prescribed online collaborative learning include barriers and teachers. The size and availability of network connection affected students' learning experience via social media. Although some students found they wanted participation of teachers, it was found in this study that the teacher's role had less influence, or even no influence in the students' learning from collaboration via social media. The students initiated and controlled their learning via discussion, knowledge transfer and knowledge sharing via the social media without instruction or teaching support.

The results confirm, as another example, that learning through social media places the control of learning into the learners' hands [29]. In online collaborative learning, learners achieve the desired learning outcomes through the learning experience with their intrinsic drive and without the process of design, facilitation and direction from teaching. Such elements interact with 'social presence' and 'cognitive presence' in the non-prescribed collaborative learning. The Community of Inquiry [20] should also consider the independence or autonomy element as the discourse is extended.

5 Conclusion

This paper explores the student experience in collaborative learning using social media tools in a blended learning course. In this study, in-depth semi-structured interviews were conducted and the results show how students engaged in learning through use of WhatsApp, Skype and Facebook to transfer, share and construct knowledge among peers in asynchronous and synchronous modes. Learning outcomes, engagement and other influential factors like barriers and teaching presence are related to students' experience in non-prescribed online collaborative learning with social media.

'Teaching presence' is an element in having educational experience in the Community of Inquiry [20]. However, it was found in this study that the educational experience in non-prescribed collaborative learning occurred in some situations without the teaching presence which occurred only occasionally in learning via social media. The collaboration was initiated independently by the students and was a non-prescribed activity as it was not designed in the course nor instructed by the teachers. With the importance of individuals in non-prescribed online collaboration in blended learning, the element of independence could be considered in the Community of Inquiry (CoI) in reflecting on the learning experience without a teaching presence in blended learning.

The limitation of this study is that only the individual interview method was used as this paper reports the interim results of a 4 year case study research. Method triangulation and data triangulation will be used for the entire research to enhance the validity and reliability. Further studies on other issues on blended learning should be conducted to have the holistic understanding of the students' experience in blended learning for considering the reflection of independence or autonomy in the Community of Inquiry as proposed in this paper.

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The Impact of Online Discussion Platform on Students' Academic Performance

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Abstract. This paper reports on research investigating student experiences of learning through face to face and online discussions in business and marketing courses in a local self-finance institution. Using methodologies from relational research into university student learning, the study investigates associations between key aspects of student learning focusing on conceptions of what students learn, approaches to learning and learning outcomes. The students' views on using online discussion platform and the difference in learning performance between students who did use online discussion platform and who did not will be compared in this study. Furthermore, it was expected to find that these differences were reflected in the learning outcomes, that is, student approaches would be linked to more complete conceptions of learning and to better academic performance. In other words, the existence of causal relationships between the using of online discussion platform and academic performance was also explored. Data on students' conceptions and approaches was collected through group interviews and final marks were used as an indicator of the quality of learning in terms of students' academic performance.

Keywords: Online discussion platform · Online learning · Online forum · Learning performance · Academic performance · Moodle

1 Introduction

In recent years, online discussion platform has been rapidly becoming a significant part of the learning experience at the institution not only in distance education but also in campus based settings. An increasing number of predominantly campus-based higher education institutions are now making online learning platform a major part of the student experience through including a range of online activities such as online discussions, interactive case studies, quizzes, inquiry and self-assessment [12]. If the online part of the student experience is not integrated with the rest of the students' course, it will be meaningless at best and impede learning in more serious cases [17]. Integrating the online discussion experience with the whole student learning experience to promote meaningful learning is a key challenge for educators and course designers.

This paper presents research addressing specifically the issue of how students integrate online discussion and face to face learning. In particular, students' experiences of learning through both face-to-face and online discussions in a marketing course at a self-finance institution were explored. Our focus was the associations

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between the way students conceive of learning through discussions (conceptions of learning – what students think they are learning about), the way they go about their learning through discussions (their approaches to learning) in both face-to-face and online contexts and academic performance. The objective of the study was to investigate the relationships between students' learning approaches to learning through face-to-face and online discussions and their academic performance in the two particular course contexts, Introduction to Marketing and International Business.

Academic performance assessed at the end of the courses was used as an indicator of the quality of learning. By looking at the relationship, we hope to achieve a better understanding of the ways students make sense of their face-to-face and online learning experiences thus help in designing the learning programmes that promote understanding.

2 Online Discussion in Higher Education

Online discussion has been becoming common in higher education. In the following literature review, the trend of online discussion in higher education, perceptual and psychological factors affecting online discussions, approaches to learning of online discussions, factors of enjoying and learning with educational games affecting learning performance and the benefits of using online discussions will be discussed and proven by researchers.

2.1 The Trend and Importance of Online Discussion in Higher Education

Internet has been playing an increasingly important role in higher education [16]. Asynchronous online discussion is one of the most used Internet-based technologies in higher education [30]. Taking Taiwan as an example, according to the survey conducted in 2005, about 80 % of surveyed institutes of higher education have adopted Internet-based asynchronous communications for teaching [24]. Asynchronous online discussion is used either for encouraging reflection as a complementary method to face-to-face teaching [30], or it is used as a major means for communication in distance learning [19]. The commonly reported advantages of online asynchronous discussions included promoting thoughtful and reflective content in the discussion, promoting active learning or self-regulated learning, encouraging critical thinking, and supporting collaborative knowledge construction [19]. However, researchers and practitioners still observed low contribution rates or lack of engagement in online asynchronous discussions at various contexts [13]. Past research discussed the impact of intervention factors, such as use of grades, use of posting guideline, the time-span of the discussion, peer facilitation and instructor's participation and mediation [13, 22]. Although these guidelines and facilitation provide structures and external motivation for some participants, they did not seem sufficient in promoting autonomy or sustained engagement for all the participants.

2.2 Perceptual and Psychological Factors of Online Discussions

Students' contributions in online discussions may be attributed to various factors. One fundamental reason may relate to how students perceived the affordance of the asynchronous communication tools. Students who have realized the affordance of online communication tools, such as the affordance of communicating at any time and the affordance of being able to review past messages, tended to use asynchronous discussion voluntarily [27]. Researchers also explored students' personal psychological status that may influence students' perception in online discussions. The study by [25] synthesized responses from open-ended questions and concluded that self-esteem, self-efficacy, psychological resistance and academic anxiety were the major themes associated with students' feelings of online discussions. Since [25] used a qualitative method, further research is required to validate these preliminary factors and understand their relationships to actual postings.

Students' understanding of the purpose of online discussions or the value of contributing online is another important factor. Hew et al. [13] concluded that one of the major reasons for limited student contributions is because of "not knowing the need of online discussions." When students see the discussion topics directly related to the curriculum [11] or when students were instructed the purposes of the online discussion [17], they tended to contribute more.

2.3 Approaches to Learning in Relation to Online Discussions

Students' approaches to learning are defined as "the ways in which students go about their academic tasks, thereby affecting the nature of the learning outcome [5]. Deep approach is driven by learners' intrinsic motivation and learners tend to appropriately engage the task in order to maximize understanding [4]. Learners usually manage to invest minimal time and efforts to meet the minimal requirements [4]. Researchers also found that deep online approaches tend to associate with deep face-to-face approaches. Additionally, students who viewed discussions as not only collecting ideas but also "challenging and improving one's ideas or arriving a more holistic understanding tended to use deep approaches to online discussions.

2.4 The Factors of Enjoying and Learning with Educational Games Affecting Learning Performance

The growth of educational games in recent years has largely impacted learning procedures [26]. Studies indicated that playing video games gives learners as a mental workout and the structure of activities embedded in computer games develops a number of cognitive skills. Players are faced with a stream of decisions and must engage with problem solving strategies, which involve the engagement with a series or complex tasks and nested sub-tasks [15]. In addition, [23] linked game-playing with the potential to develop skills in decision making, design, strategy, cooperation, and problem solving. The emergence of educational games further facilitated the wide adoption of learner-centered education and other chances in educational practices.

Computer games and online discussions has drawn significant attention from educational institutions and business organizations due to the potential educational and cost benefits, however, the introduction of games and software in teaching is often complex, and learners do not always use them as expected [29], and learners do not have the expected performance when they are using them [18].

2.5 The Benefits of Using Online Discussions

Student learning research has systematically provided evidence over the last four decades for the idea of interrelatedness of the different aspects of student learning. The increasingly common use of innovative, integrated contexts of learning that combine face-to-face and online experiences suggests a need of a focus on key aspects of these experiences of learning. Drawing on a second area of research, which includes recent studies into student learning through discussions [8], this study attempts to replicate findings and further explore ideas initially introduced in the learning through discussion research.

When learning activities are structured comprising both face-to-face and online experiences, discontinuities of learning experience can occur as a result of lack of integration between the two learning experiences. For example, when online and face-to-face activities in seminars or lectures are perceived by students as unconnected, they are also perceived having little or no relation with the learning outcomes. Research has identified evidence showing how learning through online and face-to-face discussions is experienced by students [8]. The findings of these studies suggest that engineering students who conceived of discussions as a way of learning about the topic and deepening their understanding tended to perceived a close relationship between the discussions and the learning outcomes. In contrast, students who mainly saw discussions as a way of improving genic skills or using them to find the right answer had difficulty in perceived a relationship between their discussions and learning outcomes. Some students with cohesive conceptions tended to use discussions in a way which would deepen their understanding while the others tended to use them in a more instrumental way, to help them pass examinations and meet course requirements.

Although the relationships between key aspects of student learning and the quality of learning outcomes have been extensively researched, with many studies focusing on the link between learning approaches and academic performance [3], relatively little research has been explicitly conducted to investigate the existence of causal links between these aspects. One example of such research is a study by [7] looking at learning approaches as predictors of students' academic performance. Structural equation modelling was used to test a path model, which included students' learning approaches and academic performance. The analysis confirmed that academic performance was predicted by approaches to learning which, in turn, were determined by students' beliefs about learning and knowledge.

In addition, improving the quality of the student learning experience is a key issue in the higher education sector. It has been widely recognized that e-assessment can contribute to this. However, it is interesting that whilst much research has been carried out into the attitudes towards e-assessment on the part of instructors, e-learning experts and educational technologists [6], there is relatively little research into what students think. Whilst we often make assumptions about what students feel, it would be useful and interesting to put these to the test and gain some first-hand data from students themselves. Moreover, the attitudes and opinions of candidates are always important because these affect their learning performance [1].

To conclude, improvements in technology allow online resources to be used more extensively to enhance traditional forms of course delivery, such as face-to-face lectures and tutorials. Students' learning experience and performance can be improved when online resources are integrated with these traditional activities [28]. It is important to understand the aspects of online learning environments that are related to improvements in students' performance so that limited resources can be applied where they are most effective. Studies by [21, 20] have shown that improvement can be achieved if online resources are introduced, if they complement existing course delivery methods, and where it is possible to make improvement without a significant application of resources [10]. The use of internet can provide a range of functions for learners and teachers to give some real benefits to traditional environments, such as reducing the time-lag between production and utilization of materials and the free sharing of information [9]. When properly designed and implemented, the use of online learning technologies empowers students by giving them freedom and responsibility to control their learning environment [2]. In addition, academic staff become facilitators who advance the learning process rather than being merely a conduit for content delivery [14]. Improvements in students' performance can be achieved with only a moderate increase in the expenditure of time and other resources [10]. Therefore, a review of existing literature shows that there have been many studies of online learning environments and their relationship to students' performance.

3 Implementation of Online Discussion

Two degree courses have been selected and implemented the online discussion platform through Institute's Moodle system in the period of September 2014 – January 2015. The first course is *Introduction to Marketing (MKT 201)* and the second course is *International Business (BUS 301)*; both courses have 13 weeks of 3-h class. Lecturer of these two courses used the most update news clip from the market and raised relevant discussion topics for students to discuss and share their opinions through the Moodle's online discussion platform.

For example, for the course *MKT 201 – Introduction to Marketing*, the discussion topics are adopted from local products or services which have been just introduced to Hong Kong market, for example: "www.washyourpetpet.com" (Fig. 1). Students based on the captioned topics, and shared their comments and opinions on the online discussion platform; other students were able to view all the online discussion and they may give their responses to the online discussion as well (Fig. 2).

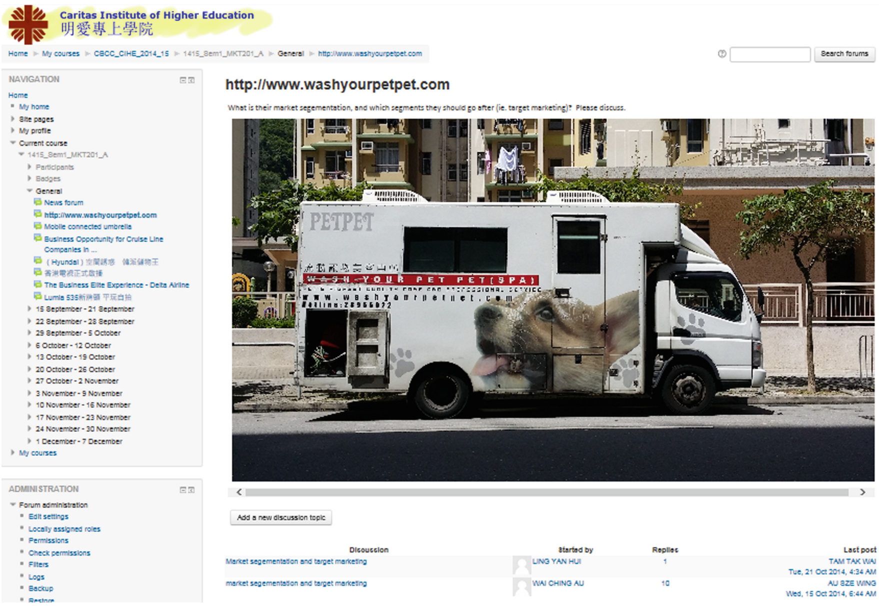

Fig. 1. Discussion topic of *MKT201*

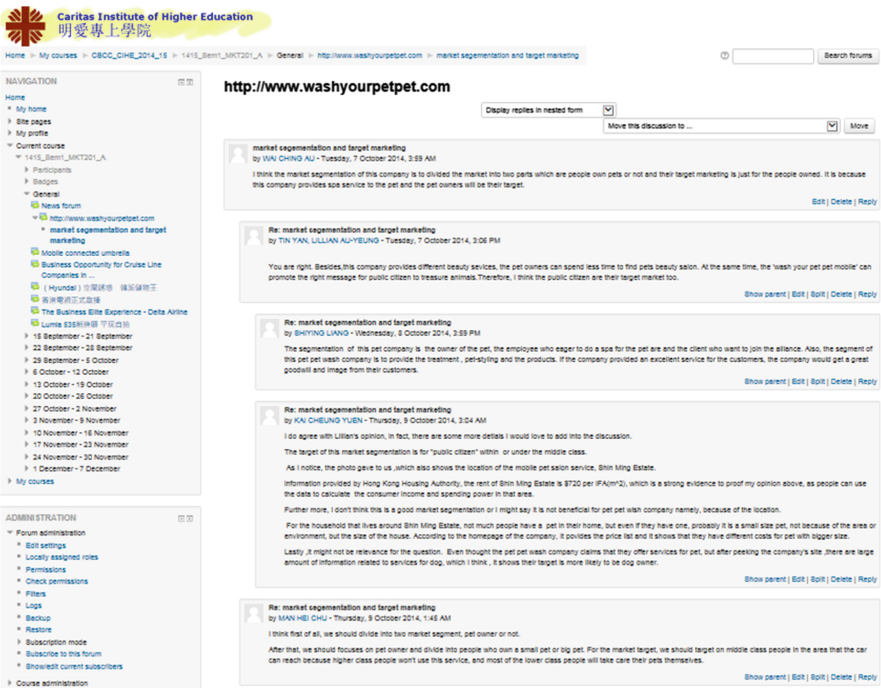

Fig. 2. Student's online discussion of *MKT201*

4 Evaluation

In order to analyse the impacts of online discussions on students' academic performance, two courses, i.e. *Introduction to Marketing (MKT201)* and *International Business (BUS 304)*, the academic performance in these two courses between students who did online discussions and who did not will be compared and the results will be shown in the following parts.

4.1 Research Findings

When compared the respond rate between these two courses, i.e. *MKT201* and *BUS304*; 19 students from *MKT201* participated in the online discussion (32 % participation rate) with 3.58 responses per person for the whole semester, 37 students from *BUS 304* participated in the online discussion (55 % participation rate) with 2.72 responses per person. Even though *BUS304* has a higher participation rate, but its average responses are lower than *MKT201*.

In term of the results, the final marks of those students who participated in online discussion are compared against those who did not join the online forum for *MKT 201* (Table 1) and *BUS304* (Table 2).

Table 1. MKT 201 final marks

MKT 201	Overall	Joined online discussion	Didn't join online discussion
No of students	58	19	39
Lowest mark	14	37	14
Highest mark	77	77	66
Average mark	49.3	58.3	44.9
Std. dev. of marks	15.1	10.0	15.3
Passing rate	81 %	95 %	74 %

Table 2. BUS 301 final marks

MKT 201	Overall	Joined online discussion	Didn't join online discussion
No of students	67	37	30
Lowest mark	21	27	21
Highest mark	61	61	54
Average mark	44.8	46.7	42.4
Std. dev. of marks	7.3	6.4	7.7
Passing rate	88 %	95 %	80 %

The results for both *MKT201* and *BUS301* illustrate that the student groups who have participated in online discussion receive better academic results than those who have not participated in terms of "lowest mark", "highest mark", "average marks", and "passing rate" too. Especially when compared the top 10 students of the class, 7 students and 8 students have participated in the online discussion platform in the courses of *MKT201* and *BUS301* respectively. Thus, students should be encouraged to actively participate in the online discussion platform if they want to enhance their learning performance and academic performance as well.

4.2 Limitation & Future Development

Due to limited time and resource, the samples size are limited in current research project, and it is difficult to draw a definite conclusion about the positive correlation among the online discussion platform, learning performance and academic performance; however, this paper may serve as a beginning stage to conduct an in-depth research study in the relationship among these three factors in future. Researcher suggests comparing those students' results with other courses that did not have online discussion in the same period of September 2014 – January 2015 and investigating if those students who participated in the online discussion and received good results were also the students who received good grading in other courses that did not have online discussion. Especially researcher would recommend further research should conduct a focus group of students and a focus group of lecturers to review their comments and experience in online discussion platform, as well as to study if online discussion platform would actually deliver positive enhancement on students' learning performance and academic performance.

5 Conclusion

The main objective of this study is to explore the relationship between the usage of online discussion and academic performance. In particular, the results show that the groups of students who have participated in the online discussion of both courses could have a better result, which can be shown in terms of "lowest mark", "highest mark", "average mark", "number of passes", "number of fail", and "passing rate". This confirms that students' contribution and participation in online discussions has a positive impact on academic performance. Therefore, especially in blended environments where participating online is not in isolation of other means for learning, e.g., lectures or face-to-face discussions, lecturers should consider how to enhance students' motivation in general and better incorporate online discussions into other learning experiences in the courses. In order to have a deeper understanding in the impact of online discussion on academic performance, future research can be conducted to study the students' views on online discussion learning method through in-depth focus group interviews and questionnaires, which can help strengthen the research results and findings.

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Improved Flexibility of Learning Processes

The Expanding Online Learning Universe: Applications to Business Education

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Abstract. Management education has entered into a seminal period, which is being driven by globalization, demographics, new learning technologies, soaring tuitions, and unprecedented economic uncertainty. The approach being adopted in a growing number of business schools is to engage faculty and students in a virtual online and hybrid-based learning experience. Specifically, this new paradigm fundamentally alters the three pillars of traditional instruction — fixed time, fixed location, and fixed learning pace — with a more flexible, customized, and mobile learning environment. The primary goal of this article is to highlight how the online and hybrid paradigms can significantly improve student learning opportunities and outcomes in business education.

Keywords: Online learning · Hybrid learning · Faculty collaboration · Business education · Social media

1 Introduction

Like the cosmos, the online learning universe is expanding rapidly. The proportion of academic leaders that report that online learning is critical to their long-term strategy now exceeds 90 % [17]. To that end, more and more attention is being paid to both the online and hybrid (blended) learning delivery models throughout the business education universe [10]. The deployment of network-based learning models is at the forefront of this paradigm shift in management education. Speed, agility, and adaptability are three key characteristics of this new learning zeitgeist. Business schools must be able to respond quickly to the changing requirements from both the business community and students. A recent study, sponsored by the Association to Advance Collegiate Schools of Business (AACSB), revealed a wide gap between the changing needs of the business community and the programs being offered by the business management community [6]. Online and hybrid learning environments offered considerable promise in helping address this gap because, in part, these delivery modes mimic the current methods used for training in the business community. The central tenet of this paper is that online and hybrid delivery modalities can enhance both learning opportunities and outcomes compared to traditional methods of instruction. This article is organized as follows (1) a review of current slants and trends in online and hybrid learning; (2) an introduction to online and hybrid program design; and (3)

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an assessment of the future direction of the expanding online universe, including outsourcing.

2 Slants and Trends

It is interesting to note that so-called online programs, which include hybrid courses, are growing at a significantly higher rate than traditional management education programs [8]. This is due, in part, to the flexibility and convenience offered by these delivery modes compared to traditional face-to-face offerings [2]. Faculty are increasingly using web-based technology as illustrated by the following statistics [12]:

- Over 80 % believe that online learning tools can improve student performance and learning outcomes
- Nearly 60 % believe that social media (e.g., Facebook) will influence the delivery of management education
- Nearly 70 % believe that a collaborative network will assist in identifying best practices in management education

Social networks continue to grow in popularity, particularly among the millennial generation, on a worldwide basis [19]. This cultural and technological phenomenon suggests opportunities for utilizing social media throughout management education for enhancing the learning process and learning outcomes. Typically, mobile learning is defined as the acquisition of knowledge through conversations across multiple contexts via interactive social media based technologies. Some specific characteristics of this social media based mobile learning paradigm include: (1) Supports borderless education, (2) Provides for increased student convenience and flexibility, (3) Promotes diversity and sustainability, (4) Offers the capability to receive live webcasts on a worldwide basis, (5) Presents instructional-rich content with real-time feedback, (6) Increases opportunities for student/team participation and interaction, and (7) Is already in widespread use on college campuses. Figure 1 shows the overall faculty adoption social media model. The fundamental idea is to have faculty develop confidence in social media based on their personal use and then to expand that confidence via their professional use and finally to incorporate the use of social media into the curriculum. This three step approach helps optimize the use of social networks to support the learning process. This evolutionary process is further supported by the business community, which has been rapidly expanding the use of social media. To this end, online and hybrid programs are receiving increased student acceptance throughout the business community of practice [1, 22].

Figure 2 highlights some recent trends in the use of social media by faculty for professional activities (e.g., conference presentation scheduling). As can be seen, for example, over 30 % of the faculty are now using LinkedIn in their professional activities and this level of activity is growing.

> *The ubiquity of social media (e.g., Facebook, Twitter) is no more apparent than at the university. Social media are increasingly visible in higher education settings as instructors look to technology to mediate and enhance their instruction as well as promote active learning for students. Many scholars argue for the purposeful integration of social media as an educational tool* [20].

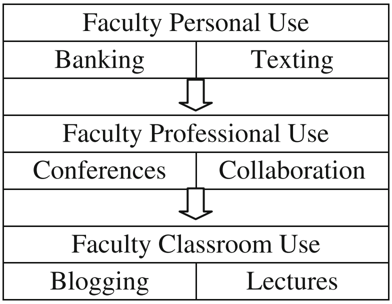

Fig. 1. Social media adoption paradigm

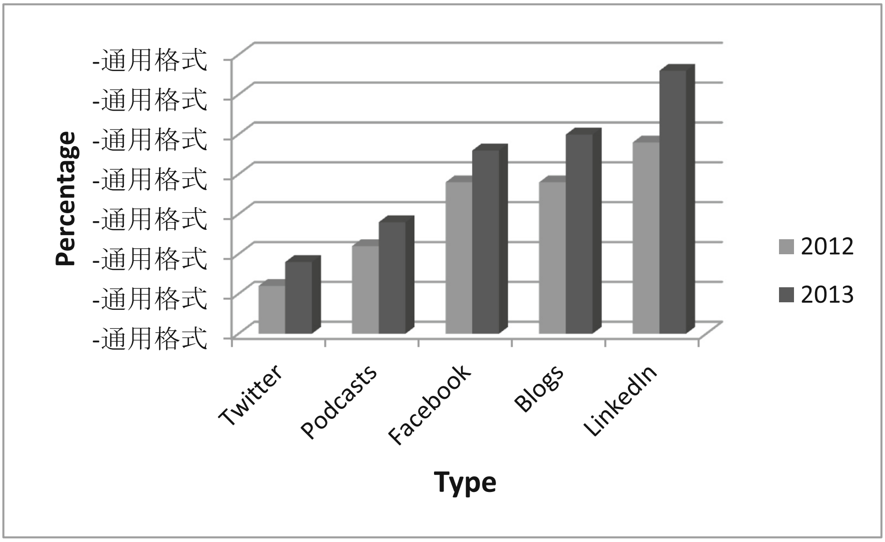

Fig. 2. Faculty use of social media for professional activities

3 Development of Online and Hybrid Programs

The advent of mobile learning has helped accelerate the design and delivery of business courses and programs [9]. Several studies of hybrid (blended) learning environments in management education settings have found that increased time on tasks was associated with higher learning outcomes [7, 21]. However, a more recent study suggests that the consistency and timing of accessing online materials may be more significant predictors of learning outcomes than is the amount of time spent accessing online content [3]. Specifically, measures of timing and consistency were shown to be related to student performance, but volumes and intensity of accesses are not correlated with learning outcomes. To that end, many in the management education community agree that variance in instructor competence and delivery methods are determining factors in learning effectiveness [16].

> *Blended environments may yield more positive outcomes, in part due to both the opportunity for and the requirement of increased learner control over the learning process and collaboration with fellow learners. This combination of self-directed and group-directed activity is enhanced by intentional and thoughtful instructor consideration of the types of activities that are positioned in either aspect of the blend* [15].

A primary design factor for both online and hybrid courses and programs is to optimize student participation and engagement through a variety of interactive learning exercises [5, 18]. Specifically, the design should encourage higher-order thinking through double-loop learning via the following four dimensions: (1) pedagogical role: encouraging students' knowledge sharing and knowledge building through interactive discussion, designing a variety of educational experiences, providing feedback, and referring to external resources or experts in the field; (2) social role: promoting a friendly environment and community feelings to support student cognitive learning processes; (3) managerial role: coordinating assignments, managing online discussion forums, and handling overall course structure; and (4) technical role: referring students to technical support resources, addressing technical concerns, diagnosing and clarifying problems encountered [11].

> *We found that some structural and behavioral characteristics were significant predictors of course outcomes, but in opposite directions. For instance, media variety was a positive predictor of delivery medium satisfaction but a negative predictor of perceived learning, while learner–learner interaction positively predicted perceived learning but negatively predicted delivery medium satisfaction. These findings suggest that instructors of online courses must manage trade-offs in balancing students' learning with their perceptions of the Internet as a course delivery medium* [14].

In deploying online or hybrid courses or programs there are four board functional areas to consider: (1) Content development, (2) Content delivery, (3) Outcomes assessment, and (4) Student recruitment and retention. Traditionally, most of these sectors were internalized. However, the process of outsourcing, as pioneered by industry over the past twenty years, has now reached the university. Today, nearly 90 % of universities are outsourcing a broad range of services and products, including student recruitment. Presented below are some of the advantages and disadvantages, from the universities' perspective, associated with outsourcing one or more of the above listed functions.

Advantages

- Minimal initial investments – Typically, most of costs associated with course/program development are borne by the vendor
- Lower IT overhead and administrative costs – A smaller in-house staff is required when vendoring out student recruitment and program development
- Economies of scale, particularly in developing courses and programs – The same course template can be used throughout the program
- Risk sharing – Mitigates the chances of significant problems associated with the launching of new programs

Disadvantages

- Conflicting cultures – Vendor may not appreciate the academic nature of higher education institutions, which are often committee driven
- Quality control – Vendor may not have the proper quality processes and procedures in place to ensure a high quality product or service, which is essential for online and hybrid programs
- Faculty disengagement – Faculty may opt out assuming that vendor is handling the project
- Intellectual property rights – Vendor may not have the appropriate internal controls to safeguard the institution's intellectual property
- Reduced financial margins – Vendor can consume upwards of 50 % of the revenue stream
- Reliability – Vendor may be working with other clients and thus cannot respond effectively to time sensitive requirements
- Limited experience with the institution's in-house systems – Vendor may not be up to speed with the institution's Learning Management System

There can be little doubt that outsourcing can achieve significant cost saving at a time when business schools are under growing pressure to lower the rate of tuition increases.

The problem of providing appropriate faculty support is critical for sustaining and growing online and hybrid programs [13]. To this end, adjunct faculty will play an ever increasing role as web-based learning continues to grow. Typically, adjunct faculty will work with a course shell that has been designed and developed via outsourcing. Often, adjunct faculty have little discretion to make any design changes to these templates. In order to maintain a high quality of online education, adjunct faculty will require support and training in the proper use of the course shell. On the one hand, overly restricting the individual contributions of adjunct faculty may tend to demotivate, pushing adjunct faculty into more of a course facilitator role. On the other hand, providing too much discretion to change will raise logistical concerns for technology support as well as consistency problems with course integration within the program design.

> *When students are learning online, there are multiple opportunities to exploit the power of technology for formative assessment. The same technology that supports learning activities can also gather data that can be used for assessment. As students work, the system can capture their inputs and collect evidence of their problem-solving sequences* [4].

4 Conclusion

The current economic and business climate calls for innovation methods for delivering world class management education in a most effective and efficient manner. Many business managers believe that there is a growing gap between business and the business education community. To that end, the business community now spends billions of dollars in retraining, primarily using the web. Business graduates need the necessary skill sets to seamlessly transition into the business universe. Another challenge facing most students are rising tuitions. For example, the costs associated with some MBA programs now exceeding US$100,000. Additionally, the global economy continues to be in the doldrums and it appears that this trend will continue into the foreseeable future. In this regard, many students are reluctant to enroll in a management program given the uncertainty of the marketplace. This combination of ongoing forces makes it imperative that business schools offer programs that meet the needs of the marketplace and that are delivered in a cost-effective manner. The number of online and hybrid business degree competitors is growing rapidly. To this end, the Dean of a major Business School recently proclaimed that one-half of U.S. Business School could be gone by 2020! That is a very scary statistic if you are a business school educator and suggests that the role of online business education is growing in an exponential manner. Outsourcing will continue to play an ever increasing aspect in this regard. Furthermore, faculty training, particularly for adjunct faculty, is essential for these courses and programs to thrive in an ever increasing competitive environment. The increasing use of the web throughout schools of business simply underscores an expanding online learning universe, much like the accelerating cosmos.

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Development and Use of a Questionnaire for Evaluating K-12 Smart Classroom

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Abstract. Smart classroom has been considered as an important way to provide easy and engaged learning for the digital learners. Research on the elements, structures, and designs of smart classroom has been carried out a lot, but little attention has been paid to the evaluation of smart classroom. Classroom environment is closely related to students' learning performance. In order to optimize the classroom environment for digital learners, a new framework to evaluate smart classroom was proposed. Based on the framework, a Smart Classroom Evaluation Questionnaire (SCEQ) was developed. A total of 236 students from two schools validated the questionnaire, revealing seven scales, namely, space, showing, surroundings, accessing, enhancing, collaboration, and engagement, with alpha reliabilities ranging between 0.78 and 0.93 (0.94 for the entire questionnaire). Significant differences were discovered on the seven scales between the two schools, the reasons of which were analyzed, and suggestions were provided for improving the classroom environment.

Keywords: Smart classroom · Digital native · Evaluation · New generation of learners

1 Introduction

With the rapid development of ICT in education, smart classroom has gradually been taken as an integrated solution for improving learning experience and students' performance. Smart learning environment is defined to be minimally context-aware (i.e., only the online and real-world states of learners are considered as the context of learning), minimally adaptive (i.e., the adaptivity with respect to emotional states, cognitive capacity, motivation, and socio-economic factors are not considered), and minimally personalized (i.e., pedagogy-oriented guidance is not considered) [1]. Research has been done to provide easy-to-use teaching and learning tools in classroom, which intends to enhance the learning experience. In today's educational environment, educational institutions are taking advantage of new technologies and resources to

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change existing teaching and learning patterns. Shen et al. proposed a smart classroom system that integrated LED character displays, all-in-one computers with multi-touch displays, mobile devices, and near field communication technology for science courses, in order to assist students and teachers by alleviating any difficulties that students experience in expressing their understanding during class, and by assisting teachers in overcoming difficulties associated with recognizing all of the students and their learning behaviors [2]. Gong et al. designed a smart classroom broadcasting system using WSN technology, which was easy to maintain and met the application requirements for current broadcast technology [3]. Kim (2012) implemented smart classroom information display system with 13.56 MHz of RFID, in order to identify and distinguish individual users through RFID tag UID and to provide various services to the users [4]. Lui and Slotta designed a technology-enhanced classroom with immersive simulation and inquiry activity [5]. Li et al. designed the equipment for detecting head and shoulders trajectory in a smart classroom [6]. However, literatures revealed that the attempts for smart classroom always focused on the technology part of designing a smart classroom, and little attention had been paid to the evaluation of a smart classroom considering the learning enhancement by using different technologies.

On the other hand, as aptly suggested by some previous studies, classroom environment are closed related to students' learning performance [7]. Classroom environment instruments have been developed and validated, of which What Is Happening In Classroom (WIHIC) is the most widely used all over the world [8]. The instruments involving the use of technology in classroom include the Constructivist Multimedia Learning Environment Survey (CMLES) [9], New Classroom Environment Instrument (NCEI) [10], Technology-rich Out- comes-focused Learning Environment Inventory (TROFLEI) [11], and Technology Integrated Classroom Inventory (TICI) [12]. However these studies mainly use the structure of WIHIC and only add some elements, which could not meet the evaluation needs of smart classroom with cutting edge technologies equipped.

This study intends to develop a method for evaluating smart classroom based on the digital student's perceptions, with the ultimate purpose to improve the classroom-learning environment by equipping cutting edge technologies. The reason why considering the digital students' perception is that students grown up with digital environments have developed quite different learning preferences [13], which should be considered in the design and evaluation of learning environment [14].

The following section describes the proposed framework for evaluating the classroom environment. Section 3 discusses the methodology used to evaluate the classroom environment in two schools based on the proposed framework. Section 4 presents the results of data analysis and discussions based on the results. Section 5 concludes the paper by summarizing the main contributions of proposed work.

2 Building a Framework and Questionnaire for Evaluating Smart Classroom

According to Fraser, learning environment encompassed "social, physical, psychological, and pedagogical contexts in which learning occurs and affects student achievement and attitudes [15]. Zandvliet and Frazer proposed the physical, social and psychological context as the three dimensions of evaluating classroom environment [16]. According to Wang, a classroom consisted of three aspects: (1) a physical environment; (2) teaching and learning activities; and (3) the integration of curriculum and teaching activities [17]. Yang proposed a smart classroom framework including showing, managing, accessing, real-time interaction, and tracking [18]. Based on the literature review, we focused on the physical environment, technology, and behavior as the three key factors for a smart classroom.

Looking back the research about physical context of classroom environment, we found that the layout, lighting and air quality were the main focus of research [19]. Few researchers had done research on physical context of classroom environment from the perspective of pedagogy, but different pedagogy asked for different learning space [20]. More importantly, the characteristics of digital generation of learners had not been considered when design and evaluate classroom environment. The advantages of more student-centered, engaging and reflective interactive and collaborative learning environments would not happen unless the learning environments were thoughtfully designed [21]. Hence, in the present study, the component of "physical environment", "technology", and "behavior" considered the pedagogical aspect that the digital learners prefer, as shown in Fig. 1. "Physical environment" included space, showing, and surroundings, which evaluated the layout, the learning material presentation, and the light, electricity, temperature; "technology" included accessing and enhancing, which evaluated the access to technologies and learning enhancement by using devices; "behavior" included collaboration and engagement, which evaluated the students' collaboration with peers and their learning engagement in a classroom.

After reviewing the literature and empirical studies that discussed indicators for classroom environment associated with the seven dimensions, the items for each dimension were generated. A total of 40 likert-type items questionnaire were created. The items were evaluated with the options of "not measuring", "somewhat measuring", and "not measuring" by 6 professors from learning technology and at the end 40 items labeled "total measuring" were selected.

A key step in developing this questionnaire was to ensure that the potential respondents could understand the items. For this purpose, the list of 40 items was presented to a group of 10 junior middle school (aged 12–14) students for their feedback. Specifically, these students explained what they thought each statement meant to them. Thereafter, the items were revised for clarity and parsimony in sentence.

Finally the Smart Classroom Evaluation Questionnaire (SCEQ) with 40 items for evaluating smart classroom was developed. The details with the explanation for each dimension and sample question were shown in Table 1.

3 Research Method

3.1 Participants

A survey based on the SCEQ questionnaire for evaluating smart classrooms was conducted in two middle schools named School A and School B in Beijing China. 236 students (146 male, 90 female) from five classes (3 classes with 169 students in School

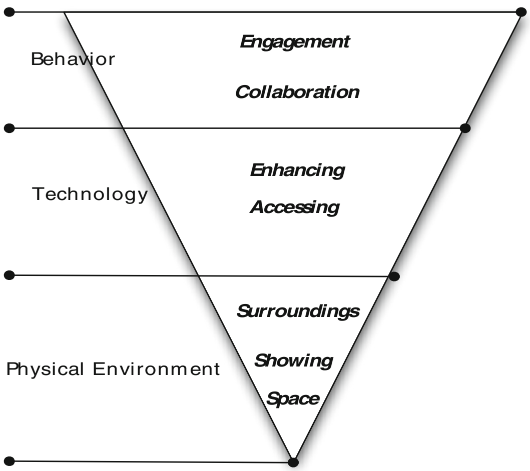

Fig. 1. Framework for evaluating smart classroom

Table 1. Description of dimensions of the framework for evaluating smart classrooms

Dimension	Description	No of items	Sample item
Space	The layout and workspace in classroom	7	The layout in classroom is suitable for my ways of learning
Showing	The condition of presenting digital materials to others in classroom	5	I can see projected visuals clearly from my seat
Surrounding	The conditions of light, temperature, air in classroom	5	Temperature in classroom is suitable for concentrating on learning
Accessing	The conditions of digital devices and learning materials in classroom	10	I can get on Internet easily in classroom.
Enhancing	The perceptions of learning enhancement by using devices	4	I can work with others by using devices
Collaboration	The perception of learning with peers in classroom	4	I can see shared learning outcomes from other students
Engagement	The perception of engaging in learning activity in a classroom	5	I can work at my own speed

"1 = strong disagree," "2 = disagree," "3 = moderate," "4 = agree," and "5 = strong agree."

A and 2 classes with 67 students in School B) took part in the survey. The average student in a classroom in school A was more than 50, compared with less than 40 in school B. The classrooms where these students lived mainly had some networked computers, laser projectors, with Internet access for teachers or students.

3.2 Data Analysis

Data were analyzed in SPSS 20.0. Cronbach alpha was calculated for internal consistency of the responses. An exploratory factor analysis using principal components analysis with varimax rotation was conducted on the 40 items to explore the underlying structure of the SCEQ. One-way ANOVA was performed to investigate differences in all dimensions between the school A and school B.

4 Results and Discussion

The purpose of this study was to investigate the dimensions for evaluating smart classroom and the relationships among these dimensions from the perceptions of digital learners. The average age of respondents was 13.7 years, who were considered as digital learners.

4.1 Factor Analysis

In this study, exploratory factor analysis (EFA) and principle component analysis with varimax rotation were employed. EFA was used to verify whether the survey items for each subscale successfully measure each variable. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity (BTS) were applied to the data prior to factor extraction to ensure the characteristics of the data set are suitable for EFA. Since the KMO and BTS results indicated the data satisfy the psychometric criteria for factor analysis, the EFA was performed.

Consequently, one item from "accessing", two items from "space", two items from "surroundings", and two items from "showing" were deleted. However, the seven original factors remained intact. Table 2 schematically listed the final results. All of the remained items (n = 33) for final version of SCEQ were described in detail in Appendix. The significance of these seven scales was outlined as following with a sample item attached to each.

1. "Accessing" (9 items) measures student perceptions of the extent to which they get access to technology and use technology for learning in classroom. (e.g., "I can get on Internet easily in classroom.")
2. "Space" (5 items) measures student perceptions of the extent to which they regard their workspace suitable for learning. (e.g., I have adequate workspace for the placement of textbooks, tablet PCs and other resources)
3. "Engagement" (5 items) measures student perceptions of the extent to which they engage in learning activity in classroom. (e.g., I can work at my own speed)
4. "Surroundings" (3 items) measures student perceptions of the extent to which they consider light, temperature, and air good for learning in classroom. (e.g., Temperature in classroom is suitable for concentrating on learning)

Table 2. Factor loadings for questionnaire items factor

	Factor loading						
	Accessing	Space	Engagement	Surroundings	Enhancing	Collaboration	Showing
AS1	.861						
AS 2	.855						
AS 3	.854						
AS 4	.816						
AS 5	.758						
AS 6	.698						
AS 7	.689						
AS 8	.673						
AS 9	.639						
SP1		.704					
SP2		.658					
SP3		.649					
SP4		.608					
SP5		.537					
EG1			.755				
EG2			.704				
EG3			.663				
EG4			.600				
EG5			.549				
SD1				.780			
SD2				.740			
SD3				.720			
EH1					.791		
EH2					.721		
EH3					.677		
EH4					.554		
CO1						.787	
CO2						.729	
CO3						.684	
CO4						.427	
SH1							.918
SH2							.916
SH3							.478

Notes: 1. Factor loadings smaller than 0.40 have been omitted.
2. Overall Cronbach α is 0.94, total variance explained is 66.9 %.

5. "Enhancing" (4 items) measures student perceptions of the extent to which they believe devices promote their learning. (e.g., I could work with others by using devices)

6. "Collaboration" (4 items) measures student perceptions of the extent to which they collaborate with peers in classroom. (e.g., I can share my group's learning outcomes with others)
7. "Showing" (3 items) measures student perceptions of the extent to which they see clearly the projecting content in classroom. (e.g., I can see projected videos clearly from my seat)

The seven factors accounted for 66.9 % of the total variance explained, with an overall Cronbach-a = 0.94. For each scale the Cronbach α ranged from .78 of engagement to .93 of accessing, indicating that the internal consistency of the responses was acceptable for evaluating smart classroom in seven constructs. Table 3 outlined and summarized the average student scores for all of the scales, with the percentage of variance explained and Cronbach-a for each attached. As shown in Table 3, the scores were quit different from different scales, whit "surroundings", "showing" and "space" the most highest, which indicated students regarded the physical environment suitable for their learning. While the "accessing" and "enhancing" was the two lowest factors, which indicated students could not get access to technology and use technology in classroom.

Table 3. Average scores on the seven scales extracted out on SCEQ

Scale	Mean	SD	Percentage of variance explained	Cronbach α
Accessing	2.98	1.36	18.9%	0.93
Space	4.21	0.87	9.6%	0.83
Engagement	3.90	0.83	9.2%	0.78
Surroundings	4.37	0.88	7.6%	0.86
Enhancing	3.26	1.28	7.6%	0.82
Collaboration	3.81	1.03	7.2%	0.84
Showing	4.35	0.86	6.8%	0.81

The correlations among the factors were given in Table 4. Statistically significant correlations exist among the subscales of the SCEQ survey. These results showed that accessing, space, engagement, surroundings, enhancing, collaboration, showing were related. Hence, the physical environment, technology in classroom and learning behaviors were related.

Table 4. Pearson correlation coefficients between subscales

	Accessing	Space	Engagement	Surroundings	Enhancing	Collaboration
Accessing	1					
Space	.480**	1				
Engagement	.351**	.518**	1			
Surroundings	.316**	.609**	.527**	1		
Enhancing	.581**	.431**	.510**	.356**	1	
Collaboration	.607**	.557**	.475**	.460**	.548**	1
Showing	.321**	.459**	.364**	.340**	.300**	.385**

**$p < 0.01$

4.2 School Differences

vAfter applying ANOVA, we discovered significant differences on the seven scales between school A and school B, with school B showing more positive responses in each of the scales, as shown in Table 5. In order to understand why the school differences exit in present study, we compared the basic information between the two schools.

Table 5. The comparison of mean scores for SCEQ between School A and School B and results of ANOVA

Scale	School A		School B		F
	Mean	SD	Mean	SD	
Accessing	2.54	1.19	4.07	1.11	82.303**
Space	4.02	.89	4.67	.63	30.262**
Engagement	3.75	.81	4.27	.75	20.545**
Surroundings	4.24	.93	4.68	.67	12.473**
Enhancing	2.95	1.23	4.06	1.06	42.567**
Collaboration	3.58	.98	4.40	.90	35.596**
Showing	4.25	.92	4.60	.64	7.925**

**$p < 0.01$

With the items of basic information applying ANOVA, we found the classes in the two schools equipped with different technologies, and significant difference exist in the "computers for teacher", "projector", "TV", and "Interactive white board" between the two schools, with school B have more technology equipped, as shown in Table 6.

Table 6. The comparison of mean scores for technology equipment between School A and School B and results of ANOVA

	School A		School B		F
	Mean	SD	Mean	SD	
Computers for teacher	.56	.498	.75	.438	7.454**
Projector	.64	.482	.93	.265	21.105**
LCD TV	.34	.476	.90	.308	77.203**
Interactive white board	.30	.458	.84	.373	73.722**

**$p < 0.01$

From Table 7, the correlation coefficient for the relationship of "LCD TV" towards "Accessing", "space", and "Engagement" was 0.310, 0.256, and 0.217. The correlation coefficient for the relationship of "Interactive white board" towards "Accessing", "Collaboration", and "Showing" was 0.287, 0.242, 0.209. These correlations indicated that the students in classroom equipped with LCD TV tended to have a higher perception of technology accessing, suitable workspace, and engagement, and students in classroom equipped with interactive white board tended to hold a higher perception of technology accessing and collaboration.

Table 7. Pearson correlation coefficients between equipment and scales of SCEQ

	Accessing	Space	Engagement	Surroundings	Enhancing	Collaboration	Showing
Computers for teacher	.132*	−.023	.096	−.065	.117	.122	.002
Projector	.130*	−.001	.052	−.081	.044	.113	.064
LCD TV	.310**	.256**	.217**	.249**	.222**	.216**	.123
Interactive white board	.287**	.199**	.110	.043	.138*	.242**	.209**

**$p < 0.01$; *$p < 0.05$

In order to improve student's perceptions of accessing, engaging, etc. in classroom, school A should equip more LCD TV and Interactive white board in classroom. The basic information survey could include more emerging technologies utilized in classroom, and the suggestions could be given for these technologies considering their utilization and impact in classroom.

The other potential reason for the lower score of school A was the number of students in the classroom. As mentioned before, the average students in a classroom in school A were more than 50, compared with less than 40 in school B. Past studies have shown that students' classroom environment perceptions differentiated between classes following alternative curricula and classes varying in class size, teacher personality, grade level, and subject matter [22]. Therefore, technology equipment in classroom is just one of the factors that influence student's perceptions, other factors should also be considered for optimizing classroom environments. However, in this information age, technology equipment was the essential for easy and engaged learning of digital learners.

4.3 Limitation and Future Research

Although a rigorous and comprehensive study was conducted, a few limitations associated with this research do exist. First the sample is limited, and large sample survey should be conducted in future research to validate the questionnaire. Second, the relationship between the scores of this questionnaire and the students' learning performance has not analyzed in the present study, which should be analyzed to validate the importance of the evaluation for smart classroom in the future. Third the comparison between different schools or classes could be subjected to strict constraints control to conclude more specific suggestions. Fourth, the relationship between different scales of the questionnaire should be identified in more details and the casual model between different dimensions will be investigated in the future research.

5 Conclusion

Effective teaching and learning are linked to sufficient fit between the person and classroom environment. Technology has been introduced to classrooms with the intention to facilitate learning and teaching, however, researchers have consistently observed modest use of technology in classroom with no significant influence on learning and teaching. Therefore, we intended to find out the reasons through evaluation of classroom environment and then suggestions could be provided for improving classroom environment based on the evaluation results.

The objective of this study was to produce a new method for evaluating smart classroom to enhance the learning experience of digital learners. A questionnaire with seven scales has been developed and validated with data collected from two schools in China. An important finding of this study is that significant differences exist in student's perception of all the scales of SCEQ in classes equipped with different technologies, not only the perceptions on physical environment and accessing to technology are different, but also the perceptions on learning behavior. The research findings affirm the importance of technology in classroom for digital learners.

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Appendix

All items (n = 33) of Smart Classroom Evaluation Questionnaire (SCEQ)

Accessing	Detailed item description
A1	I can get my notes from computer in classroom, which is taken down in tablets
A2	I can synchronous the digital materials from computers in classroom to my tablets
A3	I can get on line search learning resources anytime in classroom
A4	The materials teacher used in classroom have sent to my digital device before the class
A5	I can get on Internet easily in classroom.
A6	I can get the supplement learning materials in classroom easily
A7	I can get the videos that teachers used in classroom easily
A8	I can use the digital devices in classroom easily
A9	I can get digital learning resources easily in classroom
Space	
S1	Adequate space exists for easy movement among workstations, resources and exits
S2	The podium, blackboard and projector are at the right place for teaching and learning
S3	The layout in classroom is suitable for my ways of learning
S4	No unnecessary noises exist in classroom
S5	I have adequate workspace for the placement of textbooks, tablet PCs and other resources

(*Continued*)

(*Continued*)

Accessing	Detailed item description
Engagement	
E1	I feel I played an important role in my own learning
E2	I made enough effort to reach various information sources
E3	I always ask questions and answer questions from teacher in class
E4	I always discuss with my classmates on a topic in groups
E5	I can work at my own speed
Surroundings	
S1	Temperature in classroom is suitable for concentrating on learning
S2	I don't feel sleepy in classroom because of fresh air in classroom
S3	Light in classroom is enough for reading books or digital books
Enhancing	
D1	I could work with others by using devices
D2	I could share learning resources with others by using devices
D3	I always get clear hint from devices when I use them to learn
D4	Teacher could give feedback in time for my work by using devices
Collaboration	
C1	I can see shared learning outcomes from other students
C2	I can share my group's learning outcomes with others
C3	I can see other group's shared process of solving problem
C4	I work with other students on projects in this class
Showing	
S1	I can see projected videos clearly from my seat
S2	I can see projected visuals clearly from my seat
S3	I understand teaching content better with multi-screen display

Basic information in classroom

1. Please select the technology equipment in your classroom? (Multichoice)

   [1]. Computers for teacher
   [2]. Computers for students
   [3]. Multi-media console
   [4]. Projector
   [5]. Blackboard
   [6]. LCD TV
   [7]. Speaker
   [8]. Interative white board
   [9]. Tablet for students

Other items that has not been used in this article has been omited.

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Research on Problem-Oriented Instruction Mode Supported by Electronic Schoolbag

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Abstract. In view of the current challenges for Problem-oriented Instruction, we explore the functional advantages of electronic schoolbag. In this paper, the problem-oriented instruction mode was structured and proposed to enhance students' capabilities in solving simple mathematical word problems in primary schools. Through experiments, the results prove that adopting problem-oriented instruction mode supported by electronic schoolbag can effectively enhance students' problem-solving capabilities, and it has obviously a better effect than that without electronic schoolbag. Thereby, exploration on problem-oriented instruction mode supported by electronic schoolbag does not only improve the problem-oriented instruction process but also expands the range of electronic schoolbag applications.

Keywords: Problem-oriented instruction · Electronic schoolbag · Simple mathematical word problems · Instructional mode

1 Introduction

1.1 Challenges for Problem-Oriented Instruction

Problem-oriented instruction has become a mainstream instructional method in the field of educational practice. Since problem-based learning was introduced to the education agenda in the 1960 s, problem-oriented instruction (POI) was promoted in various universities [1] and medical colleges [2, 3], followed by primary and secondary schools at a later stage [4]. Because POI requires complex and real problem situations with positive participation, it often encounters some challenges in educational practice in primary and secondary schools such as problem situations too simple, teaching not focusing on learning situations and inefficient cooperation. In this context, some favorable instruction conditions ought to be provided for problem-oriented instruction.

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1.2 Functional Advantages of Electronic Schoolbag

Since 2010, electronic schoolbag (e-schoolbag) as typical intelligent education media has been reported widely used in major cities in China. The e-schoolbag is considered to provide an optimal digital learning environment, to share quality educational resources and to enable practicing the concept of lifelong learning. In view of the challenges of POI, e-schoolbag shows unique advantages in supporting the creation of problem situations, problem analysis, enhancement of evaluation efficiency and targeted guidance, which can effectively promote personalized learning, change learning styles and focus on the learning status of subject of students.

In this paper, we explore the functions and effects of e-schoolbag in supporting problem-oriented instruction. We take primary school mathematics as an example to construct the mode of problem-oriented instruction supported by e-schoolbag, which aims to enhance students' capabilities in solving simple mathematical word problems and verify its effectiveness through experiments.

2 Related Works

2.1 Problem-Oriented Instruction

Problem-oriented instruction (POI) refers to teaching patterns using problem-based learning strategy, which emphasizes to set complex and meaningful problem situations and to guide students in solving real problems through cooperation [5].

The related researches of POI in China mainly include the following four aspects: basic theory referring to modes and methods of POI; applications mainly discussing its deficiency in practical applications and proposing strategies; IT-based instructional design; and integrating POI strategy into networked multimedia course design. Researches about POI applications stress on the design of instructional process, which enlightens us on improving instructional effects matching instructional goals, and classroom organization forms. Some researches discussed its applications by combining our country's education system with traditional instructions [6, 7]; some exploring new attempts of modes in teaching reform [8, 9] but none proposing concrete implementation strategies. Among them, some researches have attempted to use information technology but unable to integrate it with instructional design.

The studies of POI in other countries focused on exploring the change of students' attitudes during POI [10]; applying metacognitive skills on problem-based learning [11, 12]; and analyzing the influential factors of POI [13]. We observe that there are less experimental studies on POI compared to domestic researches and felt the need to adopt rigorous research methods to verify the effectiveness of POI.

2.2 Instructional Applications of Electronic Schoolbag

Through searching and analyzing related researches about application of electronic schoolbag (e-schoolbag) in China Journal Net, World Wide Web and Google Scholar, we got the yearly distribution of literatures in China as shown in Fig. 1.

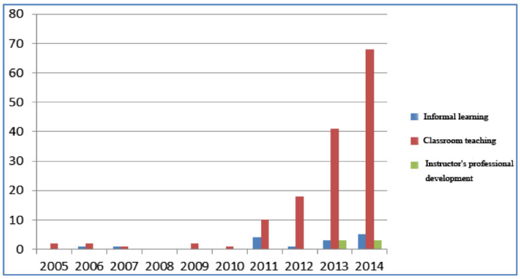

Fig. 1. Yearly distribution of literatures on Electronic Schoolbag applications in China

The instructional applications of e-schoolbag in China were developed in 2011 and have been growing rapidly since then. These applications include classroom teaching, instructors' professional development and informal learning [14–16] with a major focus on classroom teaching. When discussing the application of e-schoolbag in classroom teaching, researchers focus mainly on its theory but fail to elaborate the functional advantages systematically.

The application of e-schoolbag was started earlier outside China, which more applications in informal learning were found. E-schoolbag was regarded as a mobile learning tool and a cognitive tool in supporting innovative learning style [17, 18]. In this study, we explore its mobile and cognitive support to the improvement of problem-oriented instruction.

3 Electronic Schoolbag in Problem-Oriented Instruction

Problem solving is a core task of problem-oriented instruction (POI), in which students defining the problem, gathering information, drawing conclusions, understanding issues and limitations, and reporting experience [19]. Based on previous studies, we summarize the POI process to include problem situations, problem analysis, problem solving, learning outcomes, and reflection and evaluation.

With the rapid development of e-schoolbag applications, majority of people consider that it is an intelligent system using tablet PC, wireless networks, projection display devices with teaching control software, electronic textbooks, learning resources in a server platform. Its functionalities are mainly reflected in three aspects, including rich media interactive elements integrating various interactions among devices, platforms and learners; various virtual learning tools in improving knowledge restructuring with explicit learning goal; and e-learning services to deliver and expand learning contents [20]. E-schoolbag in this study was installed with virtual classroom software, which allows each teacher and student to use cognitive tools and interactive support services from its management platform.

To meet the challenges arising in the implementation of POI, we provide functions of e-schoolbag to support the building of problem situations, autonomic learning, group cooperation, targeted guidance, developmental evaluation, and knowledge management, which is summarized and shown in Fig. 2.

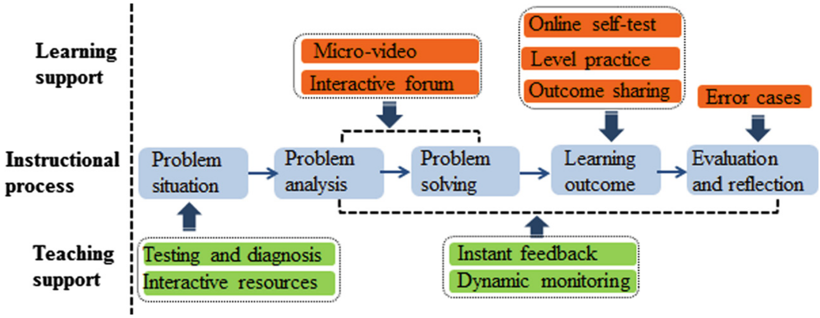

Fig. 2. Functions of electronic schoolbag in problem-oriented instruction

3.1 Supports for Problem Situations

The supports from e-schoolbag for problem situations include learning situation diagnosis based on statistical analysis and problem scene creation based on interactive resources. An instructor uses statistical analysis software in the e-schoolbag to check the pre-defined learning situation, in which the instructor analyzes statistical data of students' scores and then summarizes problems in the learning process. The e-schoolbag can be used to create a problem scene by offering videos and animations. Students may then participate in learning with good human-computer and human-resources interactions.

3.2 Supports for Problem Analysis and Problem Solving

In the process of problem analysis and problem solving, students primarily build their knowledge through activities of autonomic learning, inquiring learning and cooperative learning, and an instructor may offer targeted guidance. It mainly provided the presentations of micro-videos, interactive forum, online self-tests and exercises in levels by e-schoolbag. On the one hand, students watch micro-videos to learn the problem-solving approach, analyze its basic structure, and then formulate the solution. On the other hand, interactive forum of e-schoolbag allows building a virtual team and allows each student (group) to communicate, in which students may share and review their outcomes. In addition, teachers can provide targeted guidance based on real-time monitoring and timely feedback of e-schoolbag.

3.3 Supports for Learning Outcomes

Learning outcomes occur in the process of problem solving and students may perform more exercises with reflections to further enforce their knowledge. In this section, e-schoolbag supports learning mainly by presenting online self-test, level practice and interactive forum. To begin with, exercises are provided based on the results of online self-test, by which students check the correctness and choose the targeted level according to the guidance of e-schoolbag. Then, students may upload their work to the interactive forum, which allows teachers and students to view and comment and thus, achieving multidimensional interactions.

3.4 Supports for Evaluation and Reflection

Targeted evaluation and guidance may be needed in the entire process of POI and it is mainly achieved by means of Error Cases, real-time monitoring and instant feedback of the e-schoolbag. Firstly, the Error Cases support allows students to collect their own error questions generated in learning and practicing and to upload them to the module of Error Cases, in order to achieve personal reflection and evaluation. Secondly, it provided feedbacks on the learning situations continuously utilizing the function of instant feedback in e-schoolbag to adjust the teaching schedule and to change teaching strategies. Thirdly, the real-time monitoring support allows teachers to capture the dynamic learning states of students recording in the learning process with typical problems during the analysis and targeted guidance.

4 The Problem-Oriented Instructional Mode with E-Schoolbag

According to the nature of problem solving, simple mathematical word problems is the most common form of mathematical problems of grades 4 to 6 in primary schools and it is also a difficult topic for students. In order to enhance the problem-solving ability of upper primary students, this study, taking upper primary mathematics teaching as an example, promotes the use of problem-oriented instructional mode supported by e-schoolbag in real teaching practice.

Simple mathematical word problem is a one-step calculation of practical problems. Its teaching is very important for improving the problem-solving ability and quality of mathematical thinking of students [21]. On the one hand, according to its characteristics, teachers should provide students with a variety of opportunities to explore, analyze, summarize and solve the problems, focusing on methods of problem solving in practical problems. On the other hand, elementary school mathematics instruction must take the diverse needs of all students into account and carry out teaching effectively. The problem-oriented instructional supports by e-schoolbag include four elements: problems, students, teachers and e-schoolbag. The e-schoolbag platform consists of teacher terminal and student terminal in supporting activities of teachers and students respectively. The problem-oriented instructional mode supported by e-schoolbag is divided into three parts: learning support, teaching support and problem-oriented instruction, which is shown in Fig. 3.

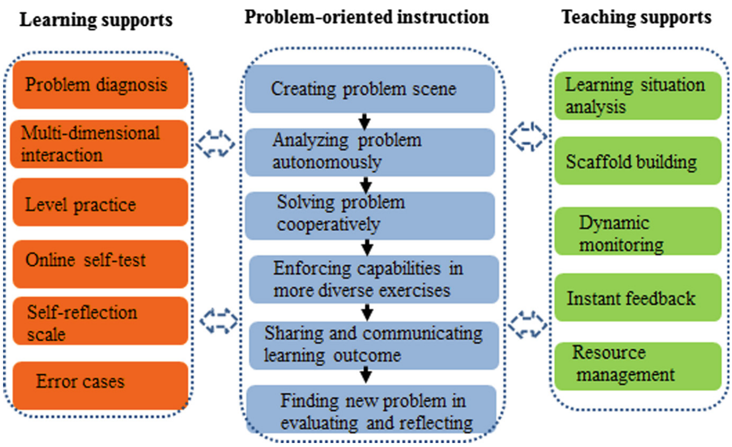

Fig. 3. Problem-oriented instructional mode supported by electronic schoolbag

4.1 Creating Problem Scenes

In this part, teachers and students carry out learning diagnosis with the function of statistical tests on e-schoolbag, analyze and identify learning problems. Teachers use rich learning resource to create problem scenes in order to stimulate students thinking deeply. Students observe the problem situations through thinking and understand the learning problems and the learning tasks clearly.

4.2 Analyzing Problem Autonomously

In this phase, students will divide the problem into several sub-problems; understand learning objectives and preliminarily explore the methods and techniques of solving these problems. Every student can watch micro-videos provided on e-schoolbag, which enable them matching sub-topics with the problem. Students can also publish their questions on the interactive discussion space and ask for help. Teachers can provide the framework of solving a problem or display a case for students at this stage so as giving proper guidance.

4.3 Solving Problem Cooperatively

Cooperative learning is absolutely necessary in problem-oriented instruction, and students use the functions of multidimensional interactive and automatic feedback on e-schoolbag to support collaborative inquiry. Students establish virtual groups in the interactive discussion space, define their work division, and share the discussion results and the collected materials in the interactive space. In the work division, the leader of a group assigns a task to each member or members propose to take up their work initiatively. The final solution or the results of the problem will be published in the interaction space for a group.

4.4 Enforcing Capabilities in More Diverse Exercises

One of the characteristics of primary mathematics subject is that the problems should be closely associated with real life and students should be able to apply their knowledge in the context of practical problems in searching for solutions through cooperative inquiry. In this learning session, students can use online self-test to check their learning situation, schedule their own practice and study by themselves. Teachers monitor student performance with e-schoolbag function and provide targeted guidance for students at different levels.

4.5 Sharing and Communicating Learning Outcome

After solving the practical problems, teachers would organize students to demonstrate their achievement and to share their ideas, which may help promote students to construct their own understanding of the knowledge and methods. Students can discuss the achievement of other students (groups) and comment on the works using the interaction space. Students can also reply to messages and share error cases with other members. Teachers can also select and show a representative case with e-schoolbag with comments so as to enhance and improve learning results.

4.6 Finding New Problem in Evaluating and Reflecting

At this stage, students first need to rethink via sharing and exchanging of ideas, to find what problems still exist during learning, to revise the knowledge of the whole learning process, to reflect on new issues recorded in the error cases, and finally to give evaluation for their self-learning methods based on the Self-Reflection Scale provided by teachers. In this process, teachers would encourage students to discover new problems and share them with others on the e-schoolbag so as to build an effective learning community.

5 Experiment and Effect Analysis

This experiment was located in a school in Guangzhou in China, in which teaching practice with e-schoolbag as described in the last section was carried out for a period of 9 weeks, adopting the POI mode supported by e-schoolbag. In order to compare the different effects between the POI mode supported by e-schoolbag and the traditional POI without e-schoolbag, that is to say, whether the POI mode supported by electronic schoolbag really works, the experiment used quasi-experimental research methods that pretesting and post-testing the unequal experimental group and control group, and tested the change of students' capabilities in solving simple mathematical word problems by compiling the test paper.

5.1 Experimental Design

Experimental hypothesis

For upper grades mathematic instruction in primary schools, POI mode supported by e-schoolbag can better improve students' problem-solving ability, comparing with traditional problem-oriented instruction (Table 1).

Quasi experimental pattern design

Table 1. Quasi-experimental research methods that pretesting and post-testing the unequal experimental group and control group

Pretest(R1 ~ R2)	Groups	Experimental treatment	Posttest
R1	Experimental class Class 1 Grade 4	Receiving	R3
R2	Control class Class 2 Grade 4	Not receiving	R4

Contents in the experiment

The subjects of the experiment are students of Class 1 (43 students) and Class 2 (41 students) in Grade 4, while Class 1 is the experimental class and Class 2 is the control class. Their capabilities in simple mathematical word problems are both at intermediate level. The contents in the experiment are three units in volume one of the fourth grade primary mathematics published by the PEP (People's Education Press): *Double-digit Multiplication, Double-digit Division,* and *Measure of an angle,* with 9 credit hours in total.

Experiment variables

Independent variable: X is the POI mode supported by e-schoolbag;
Dependent variables: Y is Students' capabilities in simple mathematical word problems;
Disturbance variables: natural growth of students' problem solving ability; the proficiency of operating the e-schoolbag.

Evaluation tool

We design the corresponding test paper as the evaluation tool according to the problem-solving ability assessment criteria, which include true or false questions (20 %), inference questions (40 %), summing up and summarizing questions (40 %). It aims to analyze students' problem-reasoning ability, inductive learning ability and problem-solving ability based on the scores.

5.2 The Process of Experiment

Before the quasi experimental research, students were asked to take a pretest by test paper combined with a questionnaire survey and interviews, so as to ensure similar level of the problem-solving ability of the participants.

Pretest

According to the scale designed, the problem-solving abilities of students in the experimental class and the control class were measured in the pretest. This quasi experimental research was conducted in regular teaching session of 45 m. Before the quasi experiment research at the beginning of November 2014, we pretested and analyzed the problem-solving ability of students in Class 1 and Class 2 of Grade 4 with the test paper. The data of test was analyzed by independent sample T-test, showing in Tables 2 and 3 below.

Table 2. The statistics of groups in pretest

	Class	N	M	SD	Std. Error Mean
The pretest of problem-solving ability	Class 1	41	43.51	2.527	.590
	Class 2	38	42.93	2.161	.616

Table 3. Independent Sample T-test for pretest

		Leven-test of The variance equation		T-test of the mean equation				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	SE
The pretest of problem-solving ability	Equal variances assumed	2.234	.090	1.832	59	.073	2.587	.578
	Equal variances not assumed			1.890	65.799	.079	2.587	.569

As we can see from the tables, there is no significant difference of square deviation between the two groups ($p = 0.090 > 0.05$). In the T-test results we select the data of "Equal variances assumed" as the result. We can conclude that there is no significant difference of the problem-solving ability between the two classes from the score of Sig. (2-tailed) = $0.073 > 0.05$.

Teaching implementation

According to the above quasi-experimental model, the POI based on e-schoolbag was implemented by the experimental group, while the traditional POI was carried out by the control group. Furthermore, the same teacher taught both groups, giving the same total time in classroom and the same homework out of school.

Table 4. The statistics of groups in posttest

	Class	N	M	SD	Std. Error Mean
The posttest of problem-solving ability	Class 1	43	47.51	4.527	.690
	Class 2	40	44.93	5.161	.816

Table 5. Independent Sample T-test for posttest

		Leven-test of The variance equation		T-test of the mean equation				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	SE
The posttest of problem-solving ability	Equal variances assumed	.234	.630	2.432	81	.017	2.587	1.064
	Equal variances not assumed			2.420	77.799	.018	2.587	1.069

Posttest

After teaching for 9 weeks, the problem-solving ability of students in the experimental class and the control class were tested with the scale in posttest to analyze whether there is difference on problem-solving ability.

In the process of collecting data, we got 43 valid scales from Class 1 of Grade 4, and 40 valid scales from Class 2 of Grade 4. As indicated in Tables 4 and 5 above, there is no significant difference of square deviation between the two groups ($p = 0.630 > 0.05$). In the T-test results we select the data of “Equal variances assumed” as the result. It can be concluded that there is significant difference of the problem-solving ability between the two classes from the score of Sig. (2-tailed) = $0.017 < 0.05$. And the problem-solving ability of students in the experimental class is apparently higher than that of the control class from the mean value.

5.3 Experiment Results

Through analyzing the experimental data, we can find that there is a significant improvement of problem-solving ability of students in the class using POI mode supported by e-schoolbag comparing with respectively the past classes and the current class not using e-schoolbag. Therefore, we can say that carrying out POI with e-schoolbag can effectively improve the problem-solving ability, and the application of e-schoolbag combined with related resources has been proved as valid.

6 Conclusion

Problem-oriented instruction (POI) will play a vital role in developing personnel in the 21st century, while electronic schoolbag (e-schoolbag) as an intelligent tool is bound to provide strong supports for improving educational effects by integrating its functions into specific activities. In this research, we mainly explore the functional advantages of e-schoolbag in supporting POI in allusion to some challenges.

6.1 Various Supports of E-Schoolbag for Problem-Oriented Instruction

In view of the challenges for POI, we explore the functional advantages and effects of e-schoolbag applicable in teaching and learning according to the process of POI. In terms of learning supports, students can learn autonomously based on micro-videos in problem analysis, conduct collaborative learning using interactive forum in problem solving, practice exercises at various levels in achieving learning outcomes, and collect Error Cases individually with the supports of e-schoolbag. In teaching supports, instructors can conduct diagnosis of learning problems based on statistical analysis in problem situations, provide targeted guidance based on dynamic monitoring, and carry out the formative evaluation based on instant feedback. These supports were integrated into the instructional design for challenges of improper problems, poor guidance and cooperation inefficiency in the traditional POI mode.

6.2 Problem-Oriented Instruction Mode Supported E-Schoolbag and Its Effects

In this research, we take primary school mathematics as an example to construct the mode of POI based on e-schoolbag, which aims to enhance students' capabilities in solving simple mathematical word problems. Through experiments and observations, the results proved that adopting the POI mode supported by e-schoolbag can effectively enhance the problem-solving capabilities of students, and it has obviously a better effect than the POI without e-schoolbag, thereby supports by e-schoolbag are proved valid.

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A Study of an E-schoolbag Supporting Flipped Classroom Model for Junior Mathematics Review Class

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Abstract. The flipped classroom model enables personalized teaching and efficient use of classroom time by reversing the arrangement of knowledge delivery and knowledge internalization, which offers a new direction to solve the problems in the review class of junior mathematics. As the e-schoolbag becomes more applicable, its unique educational functions provide favorable condition for integrating with the flipped classroom. In this study, an e-schoolbag supporting flipped classroom model for junior mathematics is developed and applied in the review class using design-based research methodology. Results indicate that the model does not only stimulate the students' interest in mathematics learning, but also change their learning methods, develop their ability of independent learning, cooperative learning and problem solving, resulting in raising the learning achievement.

Keywords: E-schoolbag · Flipped classroom model · Junior mathematics · Review lesson

1 Introduction

With the continuous advancement of basic education curriculum reform, the mathematics education of junior high school has been gradually transformed from examination oriented towards higher quality outcome based education [1]. Although the curriculum reform has been carried out for a long time, many problems in teaching methods of mathematics in junior high school, especially in review lessons, still exist. These problems include insufficient interactions between teachers and students, and between students and students, lacking interests in learning from students [2], teachers

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ignoring the role of students [3], not being able to deal with individual difference in learning [4], and late feedback of excises [5].

In recent years, a great deal of attentions has been paid on the flipped classroom model. It is a teaching method where learning in traditional classes and homework afterward is reversed into learning at home and work/discussion in class with the support of an information technology (IT) environment [6]. With the flipped classroom, an increased level of students' achievement and learning interest [7], the learning and hands-on ability and the cooperation ability [8] were reported. This successful experience inspires the reform of the review lessons in Mathematics.

A flipped classroom requires a supporting system with functions and capabilities such as teaching and learning management, multimedia presentation management, collaboration and communication [9]. The gradual introduction of electronic schoolbag (e-schoolbag) into classrooms provides extra teaching and learning capabilities to both students and teachers. The e-schoolbag is a wireless teaching platform with a mobile carrier combining hardware and software and containing textbooks and supplementary resources in electronic forms. Such (e-schoolbags) can realize educational functions such as electronic assessment and feedback to meet the individual learning needs, supported by its network connectivity. Personalization, mobility and on-demand service are the key features of e-schoolbag. So the e-schoolbag can become part of the infrastructure of a flipped classroom in which good technical support and personalized learning services can be provided.

However, the role of an e-schoolbag in a flipped classroom and its effectiveness in junior mathematics review lessons is still unclear. This paper aims to develop an e-schoolbag supporting flipped classroom model for junior mathematics review lessons and evaluate the effectiveness in practice. The remaining of this paper reviews the current problems in junior mathematics review lessons; reviews recent developments in flipped classroom and e-schoolbag; proposes an e-schoolbag supporting flipped classroom model; and evaluate its effectiveness.

2 Related Works

2.1 Junior Mathematics Review Lesson

Review lesson is a very important type of lessons in mathematics. Through a review lesson students can master and apply the basic knowledge more accurately under different conditions, as well as develop a habit of thinking rigorously and improve the ability of problem-analyzing and problem-solving [10].

Many teachers are not aware of the importance of a review lesson so they teach in the traditional way. However, the subject knowledge of students in a review lesson is not as fresh as that in a new lesson. Teacher-centered teaching is not desirable in training students' independence and creativity, let alone arousing students' interest in mathematics. Wu proposed some teaching strategies for junior forms mathematics review class in middle schools based on an effective teaching theory [11]. Ni believed that tests in class with timely feedback can improve the effectiveness of a review class, so as to improve the quality of mathematics teaching [10].

2.2 The Flipped Classroom Model

A Flipped Classroom Model is defined as "teachers shift direct learning out of the large group learning space and move it into the individual learning space with the help of one of several technologies" [22]. Firstly, it reversed the traditional "teacher-centered" teaching philosophy, emphasizing students self-learning outside class and collaborative learning with teachers giving guidance with pertinence in classes. Secondly, it reversed the teaching organization and format. Students read materials and view videos before coming to a class and then engage in active learning in lessons using case studies, labs, games, simulations, or experiments.

Talbert summarized that a flipped classroom model may include 5 main stages, watching video lecture with guided practice before class, fast and light assessment, assimilation-oriented problems, debrief and feedback during class [12]. There are some researches on the flipped classroom model reported in China. Zhang et al. analyzed some cases of flipped classroom teaching and generalized their merits as increasing the level of teacher-student interaction and supporting personalized learning and proposed an IT-based and activity-learning-based flipped classroom model [13]; Zhong et al. constructed a Tai Chi style flipped classroom model [14]; and Li et al. proposed a task-based flipped classroom model [8]. As a flipped classroom cannot be implemented without the support of IT, some researchers focus on technology support of the flipped classroom model such as e-learning space [15], QQ and tablet PC [16] and e-schoolbag [17].

There are quite a number of success stories reported in the use of flipped classroom model. After only one year practice of flipped classroom, the failure rate at the 9th grade center of Clintondale High School in America reduced by 33 % in English, 31 % in mathematics and 22 % in science. In China, the demonstrative practice of flipped classroom at Jukui Middle School in Chongqing was based on the use of videos and a learning management platform. The PingZhou 3rd Junior High School at Nanhai District in Foshan City of Guangdong Province built a "practice-assessment-stress" teaching model, dividing the teaching process into four stages including student practice, assistant comment, teacher stress and the group compete. This teaching mode flipping the traditional teaching process "stress-assessment-practice", is regarding as a prototype of the flipped classroom model.

These reported studies on the flipped classroom model involve subjects in Chinese, Mathematics, English and other disciplines in basic education. The research in flipped classroom shows that practice in flipped classroom may induce changes not only to teaching materials but also teaching environments.

2.3 The Application of E-schoolbag

The innovative application of technology in education has pushed the development of 1:1 digital education project rapidly in the world. The e-schoolbag project is particularly prominent. According to a recent survey there are at least 50 countries or regions planning to promote e-book and e-schoolbag [18].

Currently most studies in e-schoolbag were subject-based. Zheng built an e-schoolbag in supporting self-directed learning for primary English and proposed that e-schoolbag functions such as e-portfolio, immediate feedback and effective monitoring can play an important role on building a personalized English learning environment [19]. Zhang proposed two models of e-schoolbag application for primary mathematics: (1) from generating Mathematical concept to acquiring pedagogy Teaching Model, and (2) from consolidating Mathematical knowledge to practicing Teaching Model [20].

The characteristics of subject determine how e-schoolbag would be applied. For example, Chinese and English subjects require students to read, listen, and practice frequently and thus the e-schoolbag would consist of presentation of multimedia resources, dictionary and oral communication tool. However, many teachers treat e-schoolbag as merely a presentation tool leading to ineffective use of the intended innovation in interactive teaching [21].

3 Methodology

Most researches about the junior mathematics reform were conducted from the angle of pedagogy. With the rapid development of IT in education, how to transform traditional teaching methods in not just providing mathematics recitations when adopting information technology is worth exploring in depth. While progress has been made in theoretical studies on how e-schoolbag might support education, practical use of e-schoolbag in an integrated learning environment still await for proof.

In the Mathematics Curriculum Standards for Compulsory Education (Trial Edition), it has been explicitly pointed out that the curriculum objectives are to “learn to ask question, understand question in a mathematical sense, and use the knowledge and skills to solve problems, develop the mathematics application sense”. The process of mathematic problem-solving includes four stages: be aware of the existence of a problem, represent a problem, and select a problem-solving strategy to solve the problem, evaluation and reflection [23].

Our research thus aims to build a flipped classroom model for junior mathematics, and to study its associated changes on teaching philosophy, lesson structure and roles of teachers and students. The proposed platform in this study aims to allow students to discover problems, ask questions, solve problems, and to evaluate and reflection in mathematics review lessons. Design-based research and data collection are to be used in this study.

3.1 Design-Based Research

Within design-based research (DBR) methodology, interventions between researchers and learners are conceptualized and implemented iteratively in natural settings in order to test the ecological validity of the dominant theory and to generate new theories and frameworks for conceptualizing learning, instruction and educational reform. This study adopted the DBR methodology in proposing a preliminary design of e-schoolbag supporting flipped classroom model for junior mathematics, analyzing its basic functions, using junior mathematics review lessons as a case study, putting the model into use, after collecting and analyzing the data in the process, then improving the preliminary model and teaching practice. With two rounds of experiments, this study built a more complete e-schoolbag supporting flipped classroom model in mathematics based on the preliminary results of the evaluation.

3.2 Data Collection

In order to evaluate the design of the e-schoolbag supporting flipped classroom model, we invited some grade one students of Pingzhou (PZ) 3rd Junior High School in Nanhai district of Foshan City in Guangdong province to participate in our experiments. The data collection instrument used in this study are course evaluations, questionnaire and interview. The questionnaire is used to investigate the learning attitude, learning style and learning ability of the students. The questionnaire consists of 18 questions which were measured with a five-point Likert-type scale ranging from "strongly disagree (−2)" to "strongly agree (2)". The data was processed by the formula of two-dimensional scale: $Fi = \Sigma a_j n_{ij}/2N$.

4 The E-schoolbag Supporting Flipped Classroom Model for Junior Mathematics

4.1 Preliminary Design of the Teaching Model

The proposed design of the e-schoolbag supporting flipped classroom model, as shown in Fig. 1, consists of three stages: *before class*, *during class* and *after class*, which is based upon the existing "practice-assessment-stress" teaching model of PZ 3rd Junior High School for review lessons in junior mathematics.

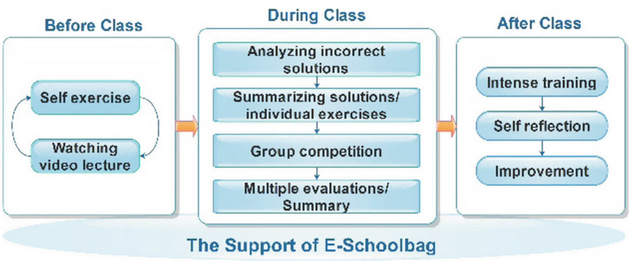

Fig. 1. Preliminary design of the e-schoolbag supporting flipped classroom model

4.1.1 Before Class: Self-Study and Acquire Knowledge

Before the mathematics review class, the teacher produces some micro-videos (no longer than 10 min) or learning materials together with some exercises according to difficulties discovered in concerned mathematical topics and publish them on the e-schoolbag platform. Students study the micro-videos or learning materials and finish the exercises after school. When encountering problems, they can watch the videos again or produce their reflection on the materials.

4.1.2 During Class: Knowledge Internalization and Individualized Training

Constructivism holds the view that acquiring knowledge is a process in which learners recognize the significance of a piece of knowledge through activities of interpersonal collaboration under certain situations. Thus classroom activities should be designed to encourage students arousing learning motivation, inquiring independently, applying the learnt knowledge in problem analyzing and solving in a collaborative manner.

Analyzing incorrect solutions: Using the statistical analysis function of e-schoolbag, the teacher analyzes the preliminary learning outcomes before class and clarifies the review objectives. Students then analyze the problems encountered in a group before class. Each group has an assistant to make a conclusion and put forward the problems they could not solve.

Summarizing solutions/Individual exercises: According to the result of the group work, the teacher explains the common difficulties in details, and guides students in integrating knowledge points of the whole chapter. Students then work on exercises individually provided by the e-schoolbag with intelligence, and the teacher provides individualized tutoring.

Group competition: After the individual exercises, the teacher releases exercises with three decreasing levels of difficulty. Students in groups may choose questions of a suitable level to complete and report the average marks to the teacher. In this stage, students may be motivated to consolidate the key knowledge points.

Multiple evaluations/Summary: The evaluation in a flipped classroom should be multi-dimensional and in multi-modes. In this stage, students conduct a self-assessment; the teacher summarizes the problems, provides an overall evaluation and suggestions for reinforcement and remedy after class.

4.1.3 After Class: Expansive Learning

After class, students may work on extra exercises to remedy the remaining problems provided by the e-schoolbag, or work on additional materials providing necessary extension of their knowledge and skills. The learning inside or outside a classroom can be evaluated in a combined way by the e-schoolbag platform which may provide useful reference for the next instructional design.

4.2 The Functions of E-schoolbag

According to the proposed model for junior mathematics review lesson as described in 4.1, the functions of the e-schoolbag platform include *learning situation analysis*, *online exercise*, *statistical analysis*, *individualized learning support* and *expansive learning*.

(1) *Learning situation analysis*: In a flipped classroom, teachers need to analyze the common problems of students in pre-class learning so that the teacher can then adjust the pedagogy accordingly. The e-schoolbag platform can obtain data of dynamic learning behavior students both inside and outside a classroom which enables teachers to have an overall picture of student learning and to adjust teaching.

(2) *Online exercise*: Online exercise may provide instant feedback over its counterpart in paper assignments. The e-schoolbag does not only provide online exercise but also generate a test paper matching the subject content automatically with support to teacher modification. When students complete their online exercises, they can obtain timely feedback, check the solutions and reflect on the inaccurate answers.
(3) *Statistical analysis*: The e-schoolbag platform can provide accurate analysis on each assignment and get a picture of student learning individually and collectively. The teacher may then provide guidance focusing on common errors for the whole class and provide the personalized guidance at a later stage.
(4) *Individualized learning*: The individualized learning support function provided by e-schoolbag mainly includes three aspects: the "wrong exercise collection" module accumulates the wrong exercise systematically. Students can create their own question database by collecting these exercises according to subjects with labels. The "micro-video" module provides additional resources for learning on their paces. The "personalized push" module suggests suitable exercises and learning materials intelligently according to the learning situation of a student.
(5) *Expansive learning*: There is a large amount of learning resources on the e-schoolbag platform. Students can obtain extra learning materials by keyword search according to their interests and can discuss with other students and teachers via the BBS or the discussion forum provided by the e-schoolbag.

4.3 Experiments

We invited students from PZ 3rd Junior High School to participate in our study. Using the design-based research approach, we re-design, evaluate and optimize the e-schoolbag supporting flipped classroom model for junior mathematics after each iteration of experiments.

4.3.1 The First Round Teaching Practice: Preliminary Exploration

There were 54 students in class 4 of grade 1 in the first round teaching practice. "Linear equation with one unknown" was selected as the teaching content in the review lesson. The teacher organized the lesson according to the preliminary design of the teaching model and conducted teaching and learning activities using the e-schoolbag platform named "The Nanhai Intelligence Class". Students were divided into four groups before the class and elected a leader for better team coordination.

Teachers provided learning materials via the e-schoolbag platform in advance, including the learning plan, micro-videos and a test paper for the chosen topic. Students then watched the micro-videos, completed the test, and reflected on the wrong exercise. On the day before the review lesson, the teacher analyzed the performance of students using the statistical analysis functions of the e-schoolbag and adjusted the instructional design accordingly. During the lesson, the teacher organized class activities, provided guidance to students learning collaboratively with e-schoolbags which in turn provided personalized training to students, and summing up the problem-solving skills. Group competition to check the review effect was organized and the class summary was provided after exchange of learning outcomes. After the class, students used e-schoolbag for making up the deficiencies, discussing the problems further and expanding learning beyond the defined scope.

After the first round practice, the effect was analyzed and evaluated through interviewing teachers and students, analyzing the records of the classroom scene and the data in the e-schoolbag. Four problems were identified: the weak understanding of the flipped classroom model resulting in some students without self-learning before class; insufficient capability of students in asking the right questions in class; unclear instructions from teachers; and lack of self-reflection habit for wrong exercises resulting in the individualized learning support function of e-schoolbag not being fully utilized.

4.3.2 The Second Round Teaching Practice: Improvement

Aiming at solving problems identified in the first round teaching practice, we put forward some improvement strategies in the second round: (i) to strengthen the guidance and feedback before class; (ii) to provide a review scaffold in the class where the teacher summarizing the unit structure of the knowledge in class; (iii) to clarify the leading role of teachers and providing clear guidance so as to improve the effectiveness of students' independent learning, cooperative learning and the group competition; and (iv) to better introduce the e-schoolbag functions to students for cultivating habits of self-learning, working individualized exercises and recording wrong exercises.

55 students in class 5 of Grade 1 were invited in the second round experiment. The teacher revised the teaching design for the second round teaching practice. As some students were not able to summarize the knowledge by themselves, "*generalize knowledge*" was added as the first stage in the teaching process. In this stage, the teacher would help students summarize the knowledge they learned and formed their own knowledge structure.

The teacher in this round practice has better preparations instructions to students were in more details. Students were better motivated in participating learning activities. The well-defined roles of teachers and students in classroom lead to a smoother teaching process. In addition, fully utilization of functions of the e-schoolbag can better support the teaching model in a flipped classroom.

4.4 Improving the Model

Through these two rounds of design-based research, this study improved the flipped classroom teaching model, refined the activities for both teachers and students before class, enhanced the class teaching stages, and introducing the functions of e-schoolbag in the teaching process. The revised model is shown in Fig. 2.

The eventful e-schoolbag supporting flipped classroom teaching model for junior mathematics review lessons has the following features:

(a) This model aims to address existing problems and teaching requirements in junior high school mathematics review lessons and to guide students in solving problems independently.
(b) This model illuminates functions of the e-schoolbag in a flipped classroom from the perspective of teaching support in supporting the integration of curriculum and e-schoolbag.
(c) Based on the existing "practice-assessment-stress" teaching practice, this model integrates the functional supports from the e-schoolbag. The resulting model demonstrates its wide applicability in a flipped classroom environment.

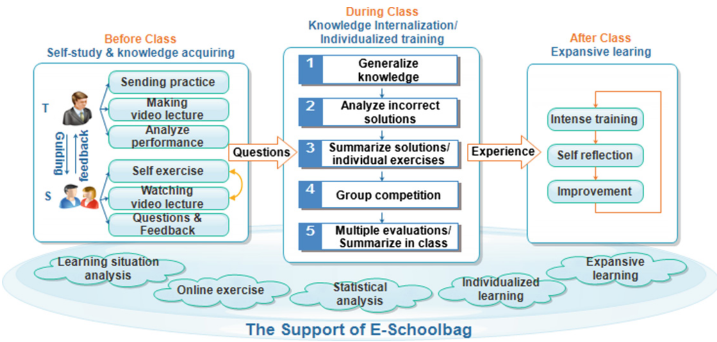

Fig. 2. Revised design of the e-schoolbag supporting flipped classroom model

5 Evaluation

5.1 Learning Attitude

For the learning attitude, we want to assess the level of satisfaction of students for both the e-schoolbag platform and the e-schoolbag supporting teaching model. The results show that the Fi score of each item in the questionnaire is over 0.5. Students believe that the e-schoolbag could increase their interest in learning and they would like to use the e-schoolbag both inside and outside the classroom. The timely feedback provided by the e-schoolbag is appreciated by students. Students feel that learning mathematics becomes more interesting than before resulting in their active participation in class. Therefore, using the e-schoolbag supporting flipped classroom model in junior mathematics review lesson can significantly improve the students' learning attitude and stimulate learning interest (Table 1).

5.2 Learning Style

We want to access the learning style from three aspects: independent learning, cooperative learning and learning methods with e-schoolbag. The results in Table 2 show that the Fi values of most items are over 0.5. We can come to a conclusion that there are changes in their learning styles. Most students are able to learn independently with

Table 1. Student learning attitude data analysis

Item	Value
1. E-schoolbag can improve my interest in learning mathematics	0.74
2. I would like to use e-schoolbag in math class	0.85
3. After using e-schoolbag, the math class is more interesting	0.75
4. After using e-schoolbag, I participate more actively in class	0.76
5. After class, I would like to use e-schoolbag to learn mathematics	0.69
6. The timely feedback of e-schoolbag make me complete excises more seriously	0.67

Table 2. Student learning method data analysis

Item	Value
1. I use the e-schoolbag to do the exercises independently before class.	0.35
2. For wrong exercises, I'll read the solution provided by e-schoolbag carefully.	0.72
3. I record the wrong exercises in e-schoolbag.	0.64
4. When there are difficulties, I discuss with my team members.	0.81
5. The intelligent resources push and hierarchical practice in e-schoolbag make my learning more targeted.	0.59
6. I am learning with the resources in the e-schoolbag according to my need.	0.84

e-schoolbag and have cultivated good learning habits in class. They can communicate with group members and carry cooperative learning and inquiry learning. At the same time, the resources push and hierarchical practice of the e-schoolbag also provides students with individualized learning environment. We also recognize that the value of the item 1 is 0.35, lower than other options, so the habit of learning independently before class needs to be established.

5.3 Learning Ability

For the learning ability, the result showed in Table 3 indicate that the ability of independent learning, cooperative learning, problem-solving and mathematical language expression has been enhanced after applying the e-schoolbag supporting flipped classroom model in junior mathematics review class. Most items score over 0.5, except for the item 5 "After using e-schoolbag, I can be the assistant to help other students".

Table 3. Student learning ability data analysis

Item	Value
1. After using e-schoolbag, my independent learning ability has been improved.	0.72
2. After using e-schoolbag, my cooperative learning ability has been improved.	0.77
3. After using e-schoolbag, my problem solving ability has been improved.	0.82
4. After using e-schoolbag, my problem solving efficiency has been improved.	0.75
5. After using e-schoolbag, I can be the assistant to help other students.	0.28
6. After using e-schoolbag, I can express myself more clearly.	0.58

So in subsequent experiments, we will try to make students be teaching assistants in turns in order to build up their self-confidence.

5.4 Learning Achievement

Students participated in two comprehensive unified examinations before and after the experiments and the difficulty coefficient of the two examinations is consistent. In this study, we use the two scores as the pre-test and post-test results. SPSS Statistics 17.0 was used to analyze the quality of students learning, as shown in Table 4.

We can see from the pre-test and post-test for paired samples t-test results that significant difference probability $p = 0 < 0.05$, indicating that the differences between pre-test and post-test are significant. Overall, it is clear that the practice of the teaching model is beneficial for students' learning.

Table 4. Paired samples t-test of students' grades

		Paired differences					t	df	Sig. (2-tailed)
		Mean	Std. deviation	Std. error mean	95 % Confidence interval of the difference				
					Lower	Upper			
Pair 1	Before-after	−8.54545	8.11906	1.09477	−10.74034	−6.35056	−7.806	54	.000

6 Conclusion

Through two rounds of design-based research, this study built an e-schoolbag supporting flipped classroom model in junior mathematics review class. The model consists of three stages: before-class, during-class and after-class. The during-class stage can be further divided into five steps: *Generalizing knowledge*, *Analyzing wrong questions*, *Summarizing solutions/Individual exercise*, *Group competition* and *Multiple evaluation/Summary*, geared with strong discipline nature and highly practicable. This model integrates the e-schoolbag with the flipped classroom teaching model innovatively. The supporting functions on the e-schoolbag platform include *learning situation analysis*, *online exercise*, *statistical analysis*, *individualized learning* and *expansive learning*. Experimental results show that applying this model in junior mathematics review class can effectively change students' learning attitudes, stimulate their learning interests, transform their learning methods and improve their learning ability resulting in better learning achievement.

Nevertheless, their independent learning habits need to be further cultivated and the functions of the e-schoolbag with the teaching model still need to be refined in practice. We believe that continuous researches in the e-schoolbag supporting flipped classroom model will bring new opportunities and challenges to our education.

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A Study on the Development of an XML-Based E-Book Authoring System

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Abstract. Electronic books or e-books offer many definite advantages over the printed books, such as the convenience, mobility and flexibility of accesses and the incorporation of multimedia elements into the book contents. For e-books, an authoring system is essentially required, not only on content development but also on the subsequent revisions and updates. Ideally, the system should be easy to use and support a variety of multimedia, while adopting some structure and formatting standards so that the e-books can be accessible across different operating systems and platforms. This paper investigates the use of XML as the standards for e-book contents. It is found that using XML to develop e-books is technically feasible, and that the e-book structure and formatting styles can be effectively enforced through XML schema. The developed e-book contents can be readily deployed in different online platforms and devices. Our experience in developing an XML-based e-book authoring system is shared in this paper.

Keywords: E-book · Authoring system · XML · E-learning · Online learning

1 Introduction

In recent years, with the advent of intelligent and sophisticated mobile devices, it is popular among students in schools and universities to use electronic books or e-books in their studies. A recent survey showed that 28 % of American adults read e-books in the past year [1]. Millions of e-books are now available, and many of them are even freely available from the Internet, such as Connexions [2] and Project Gutenberg [3]. E-books offer many definite advantages. First, they can be accessible anytime and anywhere, through mobile devices such as tablets as well as handheld devices such as smart phones. Second, e-book readers or software provide useful features, such as bookmark, cross-reference and online dictionary. Third, multimedia and animation can be incorporated to enrich the e-book contents. Fourth, the content revisions and updates can be rapidly delivered through the Internet. Fifth, user comments and feedbacks, such as rating, can be easily collected online.

The core of an e-book is of course the book contents. Content development is the most important part in the process of e-book production, where a number of issues should be carefully considered. Similar to printed books, e-book contents need to be

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DOI: 10.1007/978-3-319-20621-9_21

continuously revised and updated. Version control is important for e-books, especially as the revisions and updates can be made by many parties. Another issue is the quality control of e-book contents. An indispensable step in e-book development is to assure quality of the e-book contents, besides the technicalities such as consistent styles and typsetting requirements.

Different from printed books, the formatting and compatibility of e-book contents are important technical issues in deployment. Among others, EPUB, AZW, LIT, PDF, ODF and MOBI are the most widely used e-book formats [4]. Yet, at present, there are no universal standards on the formats for e-books. Some of the existing standards are proprietary that can be operated on certain system platforms and devices. There is a genuine need of common e-book formats and standards so as to ensure portability, operability and compatibility for the e-books to be accessible on different operating systems and devices.

This paper investigates the use of XML for e-book development, where the e-book contents are stored as XML files. It would be studied on the feasibility of using XML schema to enforce the structure and formatting styles for consistent presentation of the e-book contents. The key advantage is that e-books so generated from the XML files can be readily accessible through browsers and web applications in most platforms and devices [5]. In this paper, an XML-based authoring system is proposed to assist authors to produce e-book contents in XML format.

The rest of this paper is structured as follows. Section 2 describes the use of XML as the standards for e-book contents, where the advantages as well as challenges are discussed. Section 3 outlines the technical design of an XML-based authoring system for e-books, and illustrates an XML-based authoring system with some examples. Experience in the system development would be shared. Section 4 then concludes this paper with a brief discussion.

2 Use of XML for E-Book Content Development

There are several prevailing formats for e-books, namely, EPUB, AZW, LIT, PDF, ODF and MOBI. Some of them are proprietary for certain e-textbook readers, devices or software, such as Amazon Kindle e-book readers. Although it is a strategy of some e-book publishers to force users to use e-books formatted for them, this sacrifices the portability and compatibility of e-books.

In recent years, the publishing industry is aware of the standardization of e-book formats. Being the trade association for digital publishing, the International Digital Publishing Forum encouraged the use of EPUB for e-books, where EPUB files are packaged within a ZIP file, containing OPF, XML, CSS and XHTML [6]. However, specific software are required in order to access the e-books in EPUB format [7]. This inevitably creates much inconvenience for users who do not have the required software. Besides, the International Digital Publishing Forum has not yet defined the standards on e-book structure, content and style.

Introduced by W3C, XML or Extensible Markup Language is a markup language that defines a set of rules and specifications for encoding documents [5, 8]. These are open standards for documents, emphasizing the simplicity, generality and usability across different platforms through the Internet browsers. This paper proposes to use XML as the standards for e-book contents, where the XML files contain all the texts, images and multimedia such as audio and video.

While XML files are used to store the e-book contents, XML schema are used to define the structure and formatting styles of e-book contents [5, 9]. The XML schema aims to enforce consistent presentation of e-book contents. Validation of e-book contents with the XML schema is compulsory before deployment. In the following, we show a sample XML schema for the citation information of a book, which contains the book title, subtitle, author name, publishing information such as publisher and publish year and place, and the ISBN.

```
<?xml version="1.0"?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
        elementFormDefault="qualified">
  <xsd:simpleType name="ISBN-type">
    <xsd:restriction base="xsd:string">
      <xsd:pattern
        value="\d{1}-\d{5}-\d{3}-\d{1}|\d{1}-\d{3}-\d{5}-\d{1}|\d{1}-\d{2}-\d{6}-\d{1}"/>
    </xsd:restriction>
  </xsd:simpleType>
  <xsd:element name="Book">
    <xsd:complexType>
      <xsd:sequence>
        <xsd:element name="Title" type="xsd:string"/>
        <xsd:element name="Subtitle" type="xsd:string"/>
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        <xsd:element name="Publisher" type="xsd:string"/>
        <xsd:element name="PublishPlace" type="xsd:string"/>
        <xsd:element name="PublishYear" type="xsd:gYear"/>
        <xsd:element name="Edition" type="xsd:string"/>
        <xsd:element name="ISBN" type="ISBN-type"/>
        <xsd:element name="Remark" type="xsd:string"/>
      </xsd:sequence>
    </xsd:complexType>
  </xsd:element>
</xsd:schema>
```

However, one challenge of using XML is to handle multimedia contents, such as audio and video. Since XML is basically for textual data format, multimedia contents cannot be stored as XML files directly. One possible way is to represent the contents as base64 string. It is therefore proposed to convert non-textual contents to base64 string before including them into XML files.

3 An XML-Based E-Book Authoring System

An e-book authoring system aims to provide an online platform for creating e-book contents. This section outlines the design of an XML-based authoring system, and illustrates the system with examples.

Figure 1 shows the overview of the authoring system which produces e-textbook contents in XML files in three distinct steps. The first steps allows authors to prepare e-textbook contents, based on an input template. The second step is to integrate the texts and multimedia, and validate the structure and formatting styles with the XML schema. The third step is to generate the e-textbook contents in XML.

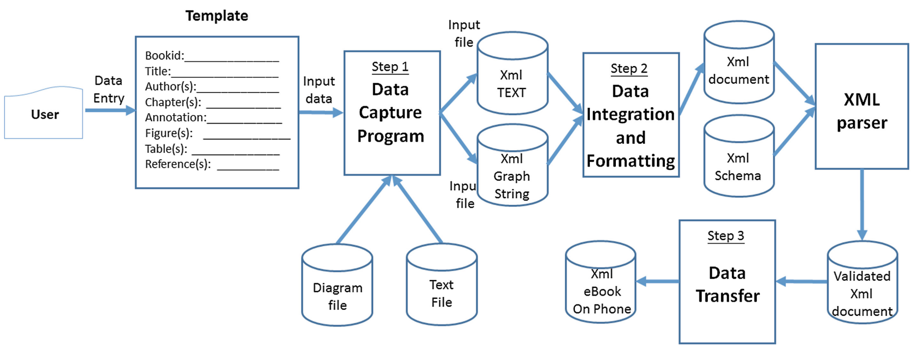

Fig. 1. Overview of an XML-based e-textbook authoring system.

The system should handle multimedia or non-textual contents uploaded by users. It should be able to convert and insert these contents to base64 string. It should also be able to decode base64 string to its original format before displaying the contents to users. XML files are basically for textual data format without style, such as font sizes and font types. XML schema are used for defining the formatting styles to maintain a consistent presentation of the e-book contents. Table 1 lists the key elements or attributes defined in the XML schema for an e-book.

Table 1. Key elements or attributes in the XML schema.

Name	**Type**	**Occurrence**	**Description**
TITLE	String	Only One	This element is used to store the book title.
AUTHOR	String	One to many	This element is used to store the author's name.
PUBLISHER	String	Only one	This element is used to store publisher.
PUBLISHER_TIME	Date Format	Only one	This element is used to store the publish time.
PAGE	Integer	Zero to many	This is used to store the page number.
TABLE_OF_CONTENT	String & integer	Only one	This element will contain two sub elements, namely, chapter title and page number.
FIGURE	String	Zero to many	Figure is converted to base 64 String and store in this element.
FIGURE_CAPTION	String	N/A	This is an attribute of figure. It is used as figure caption.
CHAPTER	String	One to many	This element is used to store the book contents.
TEXT_PARAGRAPH	String	One to many	This element is used to store textual content of a chapter.
INDEXING	String & integer	Zero to many	This element contains 2 sub-elements. One is used to store the word and the other is used to store the page number.
REFERENCE	String	Zero to many	This element is used to store reference.

In the following, we show the steps to develop an e-book through an XML-based authoring system, using a book written by one of the authors as an example [10].

Step 1: Enter basic information of the book

Users need to input basic information of the e-book, as shown in Fig. 2.

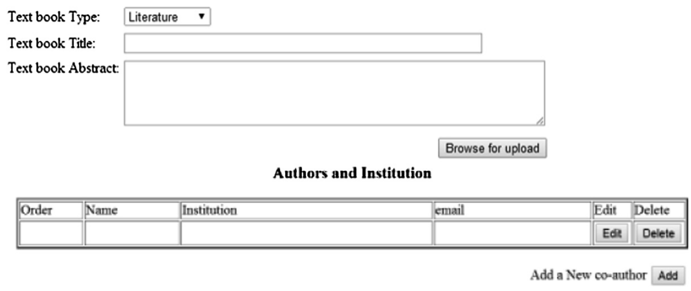

Fig. 2. Capturing book information.

Step 2: Choose the method to input book content

There are two ways for user to input book content. User can input book content by data entry or upload text file.

Step 3.1: Input book content by data entry

For each chapter, user is required to fill in the chapter details form and input the contents in the text area provided, as shown in Fig. 3. If there is an image, users should use a special statement to identify the location of the image. The format of the statement is #image_name#. The “Image_name” must be the actual image file name.

Step 3.2: Input book content by upload text file

User is required to prepare a text file for each paper. User must follow some rules when preparing the text file.

For example, the first few line of the text file is used to specify chapter detail. If the book contain any image or video, user must use a special statement to identify the location of the image. The format of the statement will be #image_name#. The “Image_name” must be equal to the actual image file name.

Step 4: Upload figure, video (if any)

The system allow user to upload figure or video from their computer. User can click the “Browse” button to browse their computer and select the file. The system will check whether the file format is a validate image or video format. If not, the system will reject the file and return an error message.

Step 5: Confirm input

After user confirm the input, the system will convert input contents to XML texts and XML graph strings. The XML texts and XML graph strings are then combined into one XML file for the subsequent validation with XML schema. In the following, the e-book contents in XML texts are shown.

```
<EBOOK>
        <TITLE PAGE_NO="1">
                <TITLE_NAME>Information Systems Reengineering and
Integration</TITLE_NAME>
                <ISBN>1-84628-382-5</ISBN>
                <BOOK_TYPE>Computer Science</BOOK_TYPE>
        </TITLE>
        <PUBLISHER PAGE_NO="1">
```

```
                    <PUBLISHER_NAME>springer verlag london
limited</PUBLISHER_NAME>
        </PUBLISHER >
        <PUBLISHER_TIME PAGE_NO="1">
                    <EDITION>SIXTH</EDITION>
                    <PUBLISHER_YEAR>2011-01</PUBLISHER_YEAR>
        </PUBLISHER_TIME>

        <AUTHOR PAGE_NO="1">
                    <AUTHOR_NAME>Joseph Fong</AUTHOR_NAME>
                    <AFFILIATIONS>Department of Computer Science,City University
of Hong Kong</AFFILIATIONS>
        </AUTHOR>
        <PREFACE PAGE_NO="2">
                    Over the past three decades, there has been a tremendous
investment made in information systems. Such systems have evolved from file system, through
database systems, and we are now seeing the emergence of management information systems
(MIS) and executive information Systems (EIS). With the advent of each new form of technology,
there has been a need to redesign and re-implement existing information systems.
        </PREFACE>
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                  </CHAPTERS_TITLE>
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                </CONTENT>
        </TABLE_OF_CONTENT>
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Step 6: Validate the XML eBook with XML schema

The system then validates the XML files with the XML schema. Online validators can be used for this validation, for example, www.xmlvalidation.com. The XML schema are shown as follows.


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Step 7: Deploy the XML-based eBook

The XML-files are then deployed to a platform or device. Figure 4 shows a typical screen of the e-book after deployment to a mobile phone.

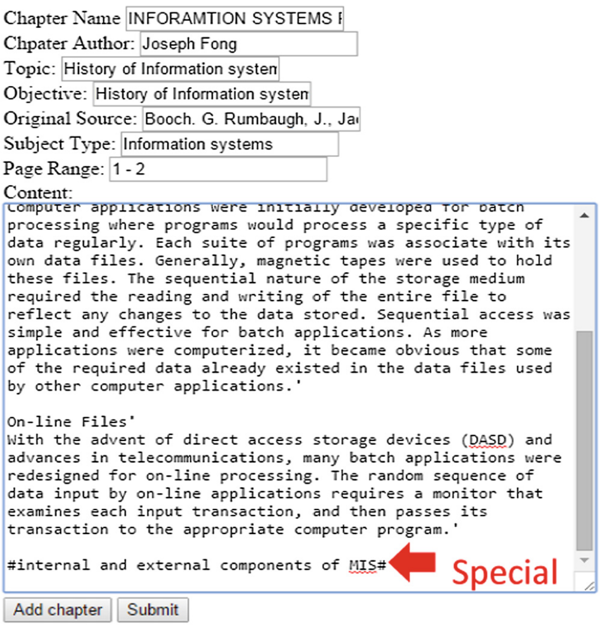

Fig. 3. Capturing chapter contents.

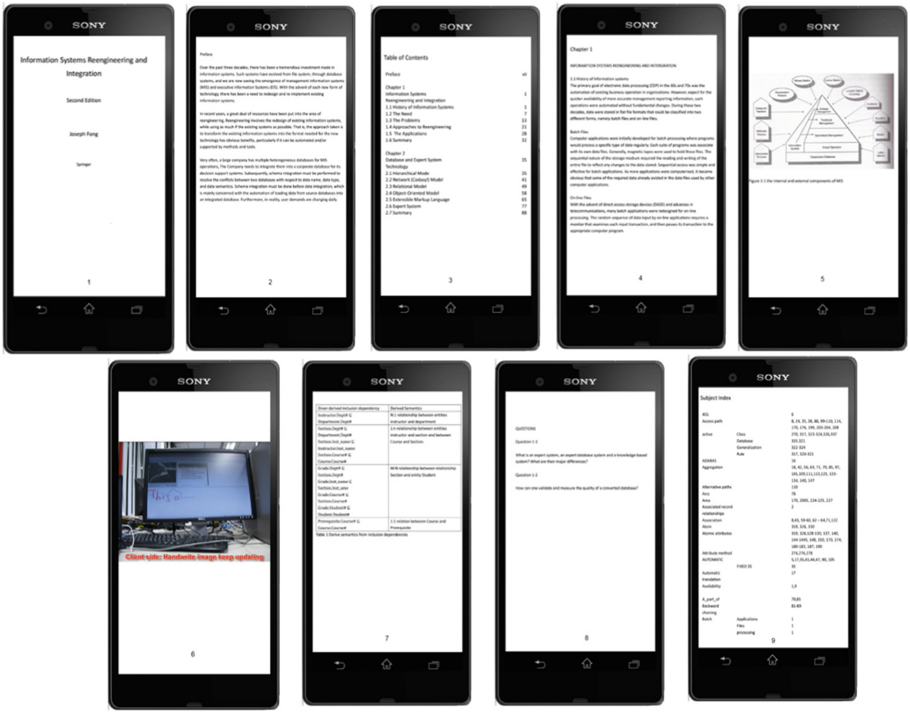

Fig. 4. E-book contents deployed on smart phones.

4 Conclusion

Todays, e-books have been widely adopted by students in schools and universities. Yet, there still lacks some universal standards for e-book contents. In order to achieve maximal portability and compatibility for e-book deployment, this paper explored common formats and standards for e-book content development. It is found that using XML to develop e-book contents is technically feasible. Since XML is basically for textual data, multimedia contents need to be converted to base64 string for inclusion into XML files. XML schema are used for defining the structure and formatting styles of the e-book contents.

An authoring system is essentially required for e-book development. In this paper, we proposed an XML-based authoring system for e-book content development. The system provides templates for capturing the e-book contents in both textual format and multimedia format. Batch upload is allowed. The captured contents are then integrated as XML files, and validated with the XML schema before deployment, thus ensuring their structural completeness and consistent formatting. After the validation, an e-book can be generated from the XML files for deployment. These are illustrated with an example in this paper.

Ideally, an e-book authoring system should be easy to use and support a variety of multimedia, while adopting some common standards for portability and compatibility on deployment. We attempted to develop an XML-based e-book authoring system to achieve these desirable features. In our experience, it is important to maintain a right balance among the functional comprehensiveness, easiness of use, portability and compatibility. It is hoped that our finding and experience can provide a reference for e-book development.

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Study on Learner Model in Adaptive Learning System Based on Ant Colony Algorithm

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Abstract. The adaptive learning system is a hotspot in the field of e-Learning and intelligent education researches. Learner model is the core of adaptive learning system. However, in the light of rapidly growing “big data”, adaptive learning system is facing the challenge of dealing with the realistic data. So in order to respond to this situation, we take a summary of oversea and domestic learner model norm of e-Learning, and then explore the ant colony algorithm and propose a construction method of learner model with consideration on the learners’ knowledge, interests and individual traits in the adaptive learning system. Especially, we regard the learners’ cognitive ability as a vital aspect of the learner model, and creatively employ the forgetting curve to the quantitative learner model built on ant colony algorithm.

Keywords: Adaptive learning · Learner model · E-learning · Ant colony algorithm · Big data

1 Introduction

Adaptive learning broadly refers that the level or type of instruction is dynamically adjusted, based on individual learner abilities or preferences and helps personalize instruction to improve or accelerate the learners’ performance. In other words, adaptive learning is of great humanization to advance learner’s personal development with respect to the distinctive characteristic. Therefore, with the advance of information technology, e-learning system based on adaptive learning theory and named adaptive Learning system (ALS) has been ready to appear. From Fig. 1, we find that the overall architecture of ALS is generally built on fourth core modules: Domain Ontology, learner model, pedagogical model and adaptive engine. So adaptive learner model (ALM) plays the most important role in ALS, which is a representation of information about an individual learner. From a historical perspective, the first learner model oriented the characteristics of adults is proposed by Cross [1], and the second one including education, life style, infrastructure and demographic is used for distance learner [2]. However, in the light of rapidly growing “big data”, ALS is facing the challenge of dealing with the realistic data [3], especially the construction of learner model which is available for collecting learners’ data during the learning processing.

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DOI: 10.1007/978-3-319-20621-9_22

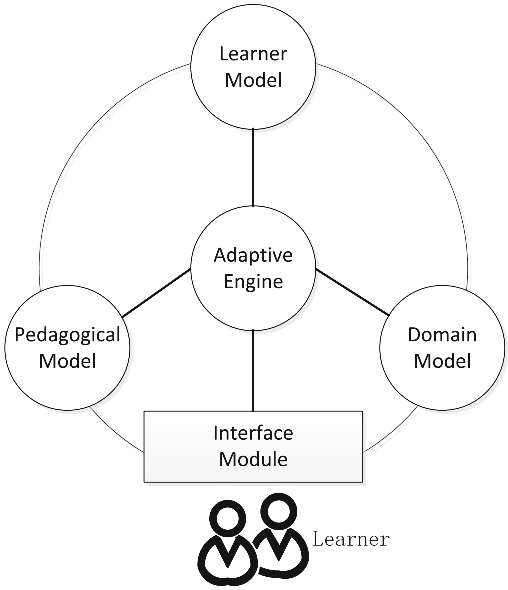

Fig. 1. A general architecture of ALS

In this article, in order to build an effective learner model to adaptive learning with taking into account the problem mentioned above, we mainly focus on modeling the learner tentatively based on the ant colony algorithm with the prerequisite that we are not completely sure that the available information is absolutely true or the values handled are not thoroughly defined. So, our idea is amply interpreted in the following sections: analyzing the theoretical research or criteria of learner model and adaptive learning system, proposing an adaptive learner model based on ant colony algorithm.

2 Relative Work

2.1 The Standards of Learner Model for E-Learning

AS the rapid development of information technology, the trail of e-Learning has been found in our daily life from anywhere and at anytime. But in order to adapt to the advanced education concept, it has more urgent issues needed to be addressed, such as the organization of learning resources, the representation of learners' information, the relation of the former two and on. Hence, Shared Content Object Reference Model (SCORM) [4] that is derived from work that is done by various industries and technology organizations, including the IMS, AICC and IEEE LTSC come into being. It is intended to provide a common standard that will enable the sharing of learning content by making it more durable, interoperable, accessible and reusable. We can learn from the SCORM, in which this standard defines a set of data model elements that can be utilized to communication from Shared Content Objects (SCOs) to the Learning

Table 1. Eight components of learner information model in CELTS-11

Components	Explanation
Personal Information	The learner's information outside the technology system, not directly related to performance measure.
Academic Information	The information is closely related to learning in the education process with great impact on learning.
Management Information	The information related to the learner is conducive to learning in the education management system.
Relationship Information	The information is used to describe the relationship between the learner and other different users.
Security Information	The information is related to the learner's security credence.
Preference Information	The information is related to the learner's learning equipment parameters, learning style and learning mode.
Performance Information	The information of leaner's learning experience, learning outcomes and so on.
Portfolio Information	The learner's representative works and a set of related certificates are used to describe and prove the learner's ability and achievements.

Management System (LMS). The data model includes, among other things: information about the learner, interactions between an SCO and the LMS, objectives, success status and completion status. In other words, the data model of SCORM contains learner model and has achieved satisfactory results towards the above-mentioned issues.

Even so, every country has their national feature including economy, politics and culture, thus in conform to the actual situation of education in China, the Department of Science and Technology in the Ministry of Education organized relevant experts from eight domestic major colleges and universities to develop technical standards for online education, and established the Chinese E-Learning Technology Standardization Committee (CELTSC) that sponsored the technical standards named CELTS. In CELTS, CELTS-11 [5] norm is a specification for learner model called information model. This model constitutes an individual learner model for the learner of any age, background or areas. It legitimately divides learner information into eight components (See Table 1), and even subdivides into more detailed sub-elements.

2.2 Learner Model in Adaptive Learning System

It is no doubt that ALS is of significant adaptability and critical autonomy in providing a student-centered and a targeted study guide to the learner according to his or her requirements such as prior knowledge, cognitive ability, learning preferences, interests and so on. There is a requisite condition that the learner model has a perfect performance in representation learner's information. This implies that the learner model determines whether the quality of ALS is good or nor. So learner model is the core element in an ALS and continues to become more complex, considering additional variables, for instance, the learner's motivational state, emotional response etc.

Stereotype learner model is one of the oldest approaches to learner modeling [6]. It attempts to cluster all possible users of an adaptive system into several groups called stereotypes. However, stereotype learner model ignores the features and uses the stereotype as a whole which is expected to result in having to reassign a user or even recreate a different stereotype when any changes happen at the user's feature. At the same time, an overlay approach to user modeling is the most important and most popular for adaptive education system. Obviously, since modeling is a domain in which there are many different sources of uncertainty and imprecision, numerically approximate reasoning techniques are extremely suitable for modeling. At this uncertain situation, Bayesian Networks and Fuzzy Logic commonly perform a great importance. But there are few studies of using Fuzzy Logic user modeling in the field of ALS. Instead, Bayesian user modeling has been accumulated in the area of modeling users that interact with educational systems, known as student modeling or learner modeling [7].

2.3 Ant Colony Algorithm

Ant colony algorithm is a new kind of intelligent bionic algorithm and is proposed by Dorigo M in 1992 [8]. Its basic principle is as follows:

At first, ants initially wander randomly, and upon finding food return to their colony while laying down pheromone trails. If other ants find such a path, they are likely not to keep travelling at random, but instead is the trail, returning and reinforcing it if they eventually find food. Over time, however, the pheromone trail starts to evaporate, thus reducing its attractive strength. The more time it is taken for an ant to travel down the path and back again, the more time the pheromones have to evaporate. A short path, by comparison, gets marched over more frequently, and thus the pheromone density becomes higher on shorter paths than longer ones. Pheromone evaporation also has the benefit of avoiding the convergence to a locally optimal solution. If there were no evaporation at all, the paths chosen by the first ants would tend to be excessively attractive to the following ones. In that case, the exploration of the solution space would be constrained. Thus, when one ant finds a suitable path from the colony to a food source, other ants are more likely to follow that path, and positive feedback eventually leads to all the ants' following a distinct path.

In particular, the transition probability with which ant k, currently at node i, chooses to go to node j is

$$P_{ij}^{k}(\mathrm{t}) = \frac{\left[\tau_{ij}(t)\right]^{\alpha}\left[\eta_{ij}(t)\right]^{\beta}}{\sum_{l\in N_i^k}\left[\tau_{il}(t)\right]^{\alpha}\left[\eta_{il}(t)\right]^{\beta}}, \quad \forall j\in N_i^k, k\in 1\sim m \tag{1}$$

where $\eta_{ij} = 1/d_{ij}$ is a heuristic value that is available a priori, α and β are two parameters which determine the relative influence of the pheromone trails and heuristic information, and N_i^k is the feasible neighborhood of ant k when located at node i and the set of nodes that ant k has not visited yet. Besides, the pheromone computing is implemented by

$$\tau_{ij} = (1-\rho)\tau_{ij} + \sum_{k=1}^{m} \Delta\tau_{ij}^{k}, \quad \forall(\mathrm{i},\mathrm{j}) \in \mathrm{L} \tag{2}$$

where $0 < \rho \leq 1$ is the pheromone evaporation rate and $\Delta\tau_{ij}^{k}$ is the amount of the pheromone ant k deposits on the arcs it has visited.

Its original intension of discovering ant colony algorithm (ACA) is to enable people understand the organizational pattern in the ant colony, and is applied to the path optimization problem. However, ACA has been employed by the field of adaptive learning because of its stability, robustness and flexibleness. Wang T I et al. propose an extended approach of ant colony optimization in adaptive learning, and achieve a satisfactory result that the style-based ant colony system is able to provide useful supplementary learning paths [9]. Yao Jung Yang and Chuni Wu, in their paper, figures out an attributes-based ant colony system (AACS) based on an ant colony optimization algorithm to help learners find an adaptive learning object more effectively [10]. Wong L H and Looi C K explore the state of the art with respect to deriving the most apt learning pathway to recommend to the learner by proposing the ant colony optimization-based inductive planning [11].

3 Construction of Learner Model Based on Ant Colony Algorithm

The learner model is a key requisite for intelligence and adaption in a learning environment, and it is beneficial to learners themselves when they look to their own models and reflect upon the content [12]. As far as we are concerned, we can gain more wisdom through discovering the biological characteristic of the ants, as they survive in the unfair nature for a longer time than us human beings. So how to construct a learner model based on ant colony algorithm? Actually, there are two steps to set up the construction of the learner model based on ant colony algorithm: firstly, developing the qualitative model involving the definition of the structural model; and secondly, developing the quantitative model involving the specification of the parameters needed and the transition probability in the learning process.

3.1 The Qualitative Learner Model Based on ACA

The development of the qualitative learner model is a process in nature to point out what represented a learner model based on ACA. According to the norm mentioned above, it is not meant completely to apply in an ALS without consideration of learners' distinctive characteristic in its learner model. Since in ALS the learner model should be equipped with the following functions: first, estimating learners' knowledge level and features such as learning style and cognitive ability; second, pushing learning content and providing individual guidance in accordance with the help of the first function; finally, refreshing the learner model in real-time by data mining and information extraction, a learner's structural model consists of knowledge and other features including cognitive ability, affective states, collaborative skills and attitude. In the following section, we mainly attend to combine overlay models and ACA together in order to model learners' knowledge, and then use stereotypes approach to model learners' preference.

Modeling Learners' Knowledge. Modeling of learners' knowledge proposed by us is an uncertainty-based model. That is, learner's knowledge in this model is represented in the form dictated by the selected approach that most frequently, a probability that the learner understands the concept or a probability distribution. Instead that several papers show that Bayesian networks of fuzzy logics has been employed as a form of uncertainty management in uncertainty-based models [13], we try to use ant colony algorithm to model learners' knowledge. As one of the most popular forms of weighted overlay models that correspond to learner modeling and adaptation, the domain knowledge model plays an important role. It clearly represents the domain knowledge (expert knowledge) with a knowledge map shown at the Fig. 2.

It is a network representation of knowledge enclosed in circles named nodes (N_i). Each node is a knowledge unit, and the link (L_{ij}) with direction between two nodes has a weight(W_{ij}) which indicates the width of L_{ij}. With attempt to check out the cost, it is available for us to use the result of a series of elaborate designed interaction event E_{ij} (See in Fig. 3) that provides evidence. These convictive events may be an answer to a test item, solution of a problem, teacher's opinion, the number of Web pages relevant to the knowledge unit that have been visited, etc.

Now that the domain knowledge is a specific map and a learner's knowledge is a subset of the domain knowledge, thus it is no doubt that a learner's knowledge is a part of the map. From this perspective, the learning process is the exploration in the knowledge map, which is similar to a simulated ant travelling in a city map. By analogical method, we can further reveal the modeling of the factors affecting the transition probability in the learning process by comparing with that in the foraging process of ant colony, as shown in Table 2.

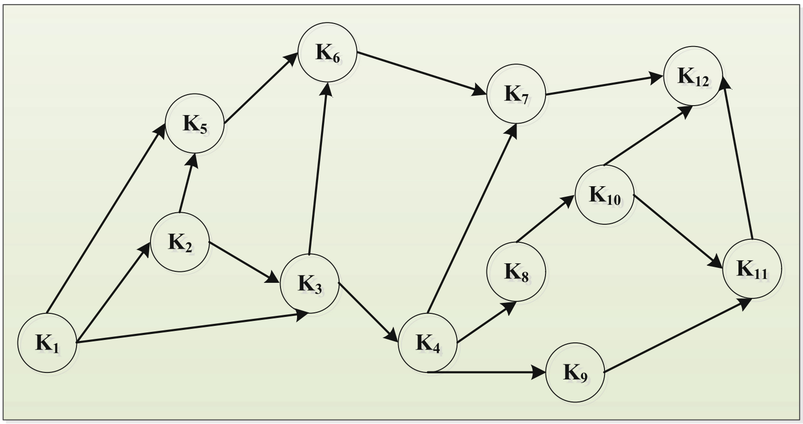

Fig. 2. Representation of a domain knowledge map

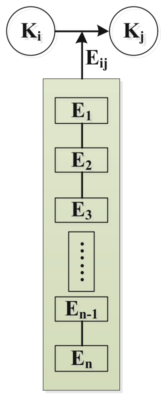

Fig. 3. A series of elaborate designed interaction event

Modeling Learner's Interests. Learner interests undoubtedly constituted the most important part of the learner personal information in the ALS. And in the ant colony system, there is a general structure, called tube, to prevent the ant to travel a city which has been visited. So similarly, there should be a module to represent something (the domain knowledge) that a learner is interested in. Furthermore, when learner registers in the ALS and then fills out a specific domain knowledge he/she focus on, it reasonably infers that related domain knowledge in the knowledge model is attractive to the learner. Therefore, the module of learners' interests is structural table that stores the rules of accessing each learner's interest (See in Fig. 4). And the rules will be

Table 2. Modeling of the factors by analogical method

Factors	Foraging Process	Learning Process
Path	A structure to store a set of name-value pairs where the names are the cities and values are the time that the ant has spent to travel a city from the last city.	A structure to store a set of name-value pairs where the names indicate the domain knowledge and values is the probability distribution.
Taboo List	A structure to store the cities that have been visited in order to prevent the ant to retrace.	A structure to store the knowledge that the learner is interested in.
Heuristic Information	An indicator to measure the aspiration of choosing the next city with accordance to the distance.	A variable to estimate the validity of the evidence provided by the result of a series of interaction event and influenced by the cognitive ability and collaborative skill.
Pheromone	A variable to represent the accumulation of experience and the ability of learning from others during the problem-solving process.	A variable to represent the accumulation of knowledge and the improvement of memory during the learning process.

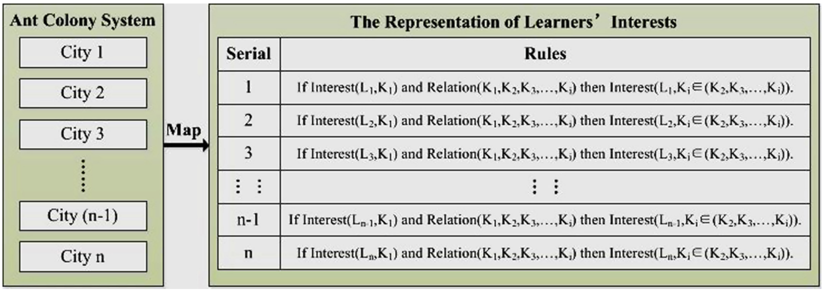

Fig. 4. Representation of Learners' interests

generating automatically by the association between the initialized interests and the domain knowledge model and even by the learner's behavior with data mining based on ACA during the learning process.

Modeling Learners' Individual Traits. A learner's features are of the definition of a learner as an individual, which can be called as individual traits. As we can see from current work on modeling individual traits, it mainly focuses on three aspects: cognitive ability, learning style, affective states and collaborative skills, and hence the following contents are put forward to represent the above-mentioned aspects.

Cognitive Ability. Cognitive ability refers to individual's capacity to think, reason, and problem solved. According to Gardner's multiple intelligences theory, cognitive ability can be subdivided into eight capacities including inductive capacity, memory, observation, abstraction capacity, analytical capacity, calculation capacity, imagination, and logical reasoning capacity. Cognitive ability relates to psychological notions and brain science so that it is full of challenges to estimate learner's cognitive ability in education. Until now, however, a reliable approach of adaptation to learners' cognitive ability hasn't been found yet, even though we have been aware that cognitive ability remains an essential learner feature to take into account. So in an adaptive learning system, we propose there should be cognitive ability test (CAT) module for modeling the cognitive ability based on overlay models (See in Fig. 5). Using an expert's cognitive ability,

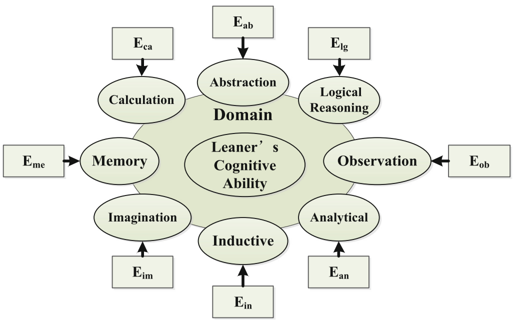

Fig. 5. Representation of learner's cognitive ability based on overlay models

Table 3. Grasha-Reichman learning style scales

Scales	Description
Competitive	Learners who learn material in order to perform better than others in the learning situation.
Collaborative	Typical of learners who feel they can learn by sharing ideas and talents, and cooperating with others or like to work with others.
Avoidant	Not enthusiastic about learning content and do not participate any interaction with others or learning contents.
Participant	Learners who enjoy going to the learning situation and take responsibility for getting the most out of a course want to take part in as much of the activity as possible.
Dependent	Characteristic of learner who show little intellectual curiosity and who learn only what is required.
Independent	Learners who like to think for themselves and learn the content they feel is important, and are confident in their learning abilities.

called domain, as reference, each learner's cognitive ability is a subset of the domain. And the evidences ($E_{capacity}$) derive from the result of CAT that comes from psychological notions. Each capacity in cognitive ability has its independent test topics which is helpful to develop the quantitative models.

Learning styles. Learning styles are typically defined as a suggestion of systematic differences in individuals' natural or habitual pattern of acquiring and processing information in learning processing. Learning styles have been integrated into the ALS attempting to explore content-level adaptation. However, the similarity with the cognitive ability, there are no proven recipes for the application of learning styles in adaptation and still unclear which aspects of learning style are worth modeling. So we maturely make a decision that recommends the Grasha-Reichman Learning Style Scales [14] in the ALS, presented in Table 3.

The learning style of each learner is so complicated and unpredictable that it is a difficult task to be represented in the ALS. Moreover, collaborative ability has been granted special attention in our society and thus we put emphasis up on the collaborative scale. Therefore, there should be intended to support collaborative learning and be equipped with an analysis of learner's log file which is a record of learner's activity in the ALS [15]. And the precondition is the modeling of learners' collaborative learning ability (Shown in Fig. 6).

Affective State. Research on modeling using the affective state has gradually become the focus of study in both learner's modeling and ubiquitous computing areas. The book written by AM Isen also states that a slight positive mood does not just make the learner feel a little better but also induces a different kind of thinking [16]. But it is inflexible for ALS to track learner's emotion at any time during the learning process. So we assume that learner's emotional investigation is relatively steady in the short time, regarded as a constant (See in Fig. 7). Based on this, learner's emotion can be described as a set of name-value pairs.

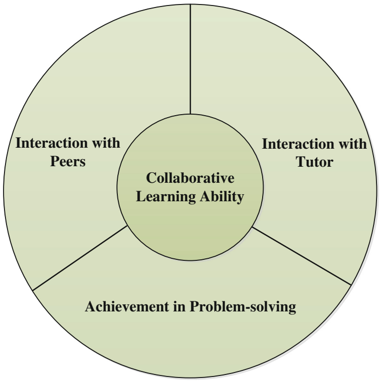

Fig. 6. Measurement of learners' collaborative learning ability

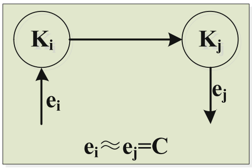

Fig. 7. Assumption of learners' emotional investigation

3.2 The Quantitative Learner Model Based on ACA

Once the first step to construct learner's model has been accomplished, it is necessary to get the specification of the parameters and its effect on the transition probability in the learning process. With comparing to the aforementioned formula (1) for the transition probability in ant colony system, it is not accessible for us to scale the learners' transition probability when they visit the knowledge nodes in the confine of the knowledge map. The primary reason is that our human being is of an especially sophisticated biometrics that enables us to rise to the top of the food chain. These biometrics including the cognitive ability, interests, experience/knowledge accumulation, collaborative ability, have direct or indirect impact on the learning outcomes which are presented by the transition probability on the knowledge map. So there are mainly two steps to quantitative learner model in the following sections: one is to track each learner's pheromone composed by cognitive ability, collaborative efficaciously and timely, and the other is to take the link's weight account into the computing of transition probability in the knowledge map.

The Quantitative Pheromone Based on ACA. As shown in Table 2, the pheromone is an essential attribute in the entity of each learner's representation. It involves the accumulation of knowledge and the improvement of memory and collaborative skill. With the elapse of time, a learner's pheromone affected by the Ebbinghaus forgetting curve is as well as the ants' pheromone evaporating slowly during the learning process.

So with the reference to the formula (2), the quantitative pheromone in learner model is available for computing through the formulas which are

$$\tau_{ij} = R\tau_{ij} + \Delta\tau_{ij}, \quad \forall(\mathrm{i,j}) \in \mathrm{Link}_j \tag{3}$$

$$\mathrm{R} = e^{-\frac{T}{S}} \tag{4}$$

and

$$\Delta\tau_{ij} = \frac{\varphi_j}{\sum_{k=1}^{n} \varphi_k} \tag{5}$$

where $\Delta\tau_{ij}$ is the increment of the pheromone, R is memory retention for the value of $0 < R \leq 1$, S is the relative strength of memory, and T is time. What especially noteworthy in the formula (5) is that φ_j is the coefficient of the cognitive objectives contained in knowledge node j and n is the quantity of the knowledge node that has a direct link connecting to node j. And φ_j can be quantified concretely on the basis of Bloom's taxonomy [17] and shown in Fig. 8.

The Computing of Transition Probability Based on ACA. Undoubtedly, it is an uncertain event to estimate a learner whether or not has grasped the knowledge. From the knowledge map shown in Fig. 3, we can find that there is an indispensable test to collect the evidences (the result of the test) in the road towards the next knowledge node. These evidences can be further described into the w_{ij} from node i the next node j through the following formula

$$w_{ij} = \frac{Score_{test}}{100} \tag{6}$$

where $Score_{test}$ is the score a learner has achieved in the test.

However, the w_{ij} is not the only factor to generate the uncertainty of grasping the knowledge because of the accumulation of knowledge, the cognitive ability and even the affective state playing an essential role during the learning process. As a result, the formula is used to compute the transition probability formula in the learner model,

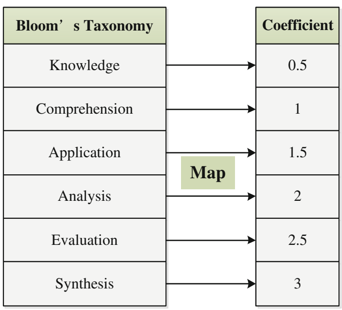

Fig. 8. Transformation of Bloom's taxonomy into the quantitative coefficient

in view of the affective state as a constant and on the strength of its formula in the ACA, which is

$$P_{ij}^{Learner}\begin{cases} e^{-\left(1-w_{ij}\right)/\left(\tau_{ij}^{Learner}\times C_{Learner}\right)}, \tau_{ij}^{Learner} > 0 \\ e^{-\left(1-w_{ij}\right)/C_{Learner}}, \tau_{ij}^{Learner} = 0 \end{cases}, \quad Learner \in 1 \sim m \tag{7}$$

where $\tau_{ij}^{Learner}$ means a learner's accumulation of knowledge and $C_{Learner}$ is a variable to the synthesized evaluation of a learner's cognitive ability. And we synthetically assess a learner's cognitive ability by the comprehensive evaluating method based on radar-graph. For instance, a learner's testing results of CAT are $inductive = 0.33$, $memory = 0.75$, $observation = 0.58$, $abstraction = 0.67$, $analytical = 0.8$, $calculation = 0.9$, $imagination = 0.7$ and $logicalreasoning = 0.95$, which is represent in Fig. 9 and finally the $C_{Learner}$ can be measured by the perimeter and area of the polygon filled with gray.

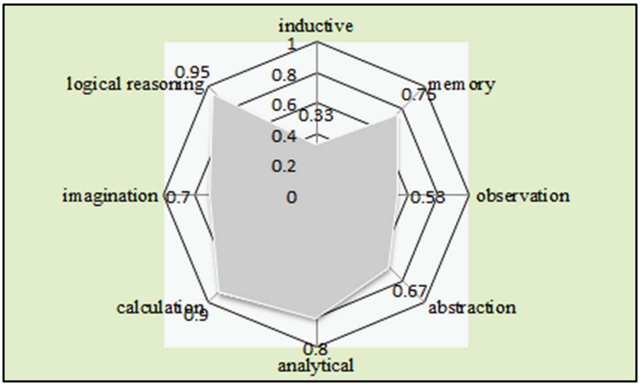

Fig. 9. Example of comprehensive assessment of cognitive ability

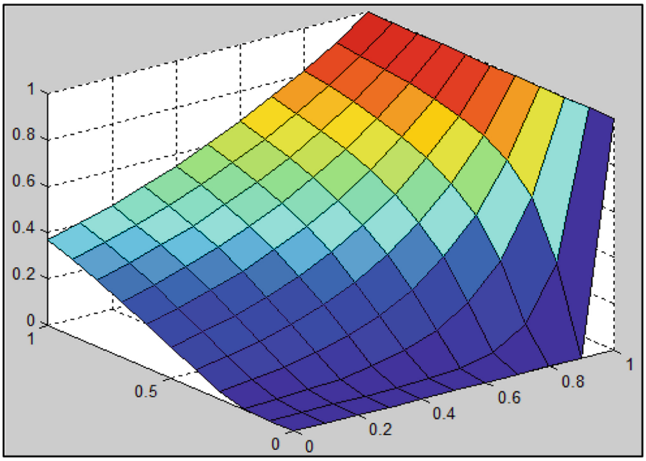

Fig. 10. Simulation result of the transition probability formula

As the changeability of learner's cognitive ability is inconspicuous, thus we can regard $\tau_{ij}^{Learner} \times C_{Learner}$ as a variable $y_{Learner} = \tau_{ij}^{Learner} \times C_{Learner}$ where the value of $y_{Learner}$ is $0 < y_{Learner} \leq 1$. Further, formula (7) is simulated through the MATLAB tool in order to validate its effectiveness. And Finally, it could be found out, as well as we predicted, from the simulation result (Shown in Fig. 10) that the formula (7) which is based on the ACA reaches an expected performance that is available to compute the transition probability in the ALS during the learning process.

4 Summary and Outlook

Adaptive learning system is one of the hottest, most active technologies in modern distance education, dominating great practical value. And the algorithms used in adaptive learning have been the subject of numerous published research articles. Therefore, with the summary of oversea and domestic learner model norm of E-learning, we tentatively does research and explore about using ant colony algorithm to propose a construction method of learner model which is of the consideration of learners' knowledge, interests and individual traits in the adaptive learning system in order to envisage the challenge of dealing with the realistic data. To sum up, there are three main innovation points in the learner model proposed by us: First, we use ant colony algorithm as a bridge to combine the stereotype models with the overlay models which is in favor of taking full advantage of both; Second, we focus on the cognitive ability which has great effects on what results learners get from learning on the construction of learner model, and creatively put the CAT into the adaptive learning system and use the comprehensive evaluating method based on radar-graph to measure the cognitive ability; Third, we can keep a watchful eye on any learners accumulation of knowledge at any moment with the integration of the forgetting curve. In the future work, we will pay greater attention to developing an adaptive learning system. And then, we will take two steps to using the ant colony algorithm deeply: discovering the rules of learners' interests and mining learner's collaborative learning ability. Both steps are a good method to inspect the availability of this learner model we propose as well as our principal study works on the adaptive learning system.

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Learning Styles and Behaviours

Sequential-Global Learning Style Detection Based on Users' Navigation Patterns in the Prerequisite Structure

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Abstract. The preferred way people apply in learning is known as learning style. Adapting different learning strategies to different learning styles yields a better learning outcome. In this paper, we describe a novel rule-based approach to detect the students' learning styles (sequential/global) by analyzing their navigation patterns in the prerequisite structure. In order to evaluate the accuracy of the proposed approach, a case study in dance education was conducted, 32 students were asked to learn 10 dances by browsing the prerequisite structure in a dance education system. Students' browsing histories are recorded and analyzed so that their learning styles are extracted. The result shows that our approach is optimistic.

Keywords: Learning style · Dance education · Navigation pattern · Prerequisite structure

1 Introduction

As stated in [1], different students learn in different ways. Most students prefer specific ways to take in, interact with, and process information. The preferred way students apply in learning is called learning style. Studies have shown that matching between the teaching strategies and the learning styles could lead to improved learning outcome [2, 3].

Considering the difference between students, [4] argued that different strategies should be adapted to different students, which are categorized as serialist and holist approaches. Serialists tend to learn locally and follow a step-to-step manner, they concentrate on simple chains of logical argument. While holists learn globally by seeing the task in the broadest possible perspective and gaining an overview so as to contextualize the details [5]. Pask provided a depth-first/breadth-first structure of learning material for serialists/holists, and he found that depth-first structure suits

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serialists and breadth-first structure suits holists. Based on Pask's experiment, [2] conducted a similar experiment by providing a depth-first/breadth-first structure of learning material to field independent/field dependent students, and their results suggest that matching yields improved learning outcome. In fact, according to [6], serialist/holist is similar to field independent/field dependent. Furthermore, according to [7], serialist/holist is similar to the analytic/global style of the Dunn and Dunn model, Riding's analytic/wholist dimension and the sequential/global style of Felder-Silverman model. It should be noted that, not all people are totally sequential or totally global, some people are comfortable with both sequential and global styles and they could use either one whenever it's needed.

There are mainly two categories of methods to model the students' learning styles: explicit and implicit methods. The explicit methods rely on the measuring instruments associated with the learning style models for diagnosing purposes. The students often need to finish a psychological questionnaire in order for the teacher to obtain their learning styles, for example, CAMELEON [8], AES-CS [9]. In addition, some explicit methods ask the students to choose their preferences, such as ActiveMath [10]. Explicit method is simple yet it is difficult to motivate the students to fill out the questionnaire. On the other hand, implicit methods use dynamic modeling approach to infer the students' learning styles. iWeaver [11] initially applies an explicit method to capture the students' learning styles which are further updated based on the students' feedbacks. Some researchers explored machine learning solution for student modeling, for example, [12, 13] explored Bayes method in detecting the students' learning styles; Decision tree was implemented in [14, 15] to detect the learning style. A neutral network approach was considered in [16]. These models require training before they can perform the desired classification. In [12, 17, 18], the rule-based approach was explored to detect the students' learning styles.

In this paper, we proposed a rule-based method to automatically detect the students' learning styles (sequential/global) by analyzing the students' navigation patterns in the prerequisite structure. The students were monitored while browsing through the prerequisite structure. Every time the students visit a node in the prerequisite structure, we need to judge which rules this visit satisfies. If the visit follows the depth-first rules, then the confidence of sequential preference is increased. If the visit follows the breadth-first rules, then the confidence of global preference is increased. On the other hand, if the visit follows both the depth-first and breadth-first rules, then we don't increase confidence to either global or sequential preference.

A case study in dance education which involved 32 college students (7 female, 25 male) was conducted to evaluate the performance of the proposed methods. They were asked to learn 10 dances by browsing through the prerequisite structure. The learning styles of the students were obtained by analyzing the browsing sequences. The accuracy of the proposed method was acquired by comparing the detection result with the ground truth obtained through Felder-Soloman's Index of Learning Style Questionnaire [19].

The rest of this paper is organized as follows. Section 2 describes the proposed method. In Sect. 3, the evaluation of the proposed method is given. Section 4 concludes the paper and provides future work.

2 Proposed Method

According to [4], students with sequential/global style prefer depth-first/breadth-first way of learning. Recent studies [20, 21] suggest that there is a high correlation between learning style and navigation behavior. Furthermore, many previous works [12, 17] were trying to detect learning style by analyzing navigation behavior. Thus, we try to detect student's learning style by analyzing students' navigation patterns in the prerequisite structure.

A prerequisite structure is defined as the set of all the prerequisite relations. It is actually a directed acyclic graph with an example shown in Fig. 1. Each node denotes a learning object (pattern), and each directed edge denotes a prerequisite relation. If from node x, there is a path to node y, then x is a prerequisite of y, y is a successor of x, x and y are in the same branch, otherwise, we say x and y are not in the same branch, they are called parallel nodes, for example, in Fig. 1, 1 and 6 are in the same branch, while 1 and 2 are not. If from node x, there is a directed edge to node y, then x is a direct prerequisite of y and y is a direct successor of x. We define the level of node x to be the maximum level of the prerequisites of x plus 1. If node x does not have any prerequisites, then $level(\mathrm{x}) = 1$. We say a browsing sequence is legal if only it doesn't violate the constraints hold by the prerequisite relations, for example, 1,2,3,4,5,6,7,8 is a legal browsing sequence, while 1,5,2,3,4,6,7,8 is not, because 2 is a prerequisite of 5, 5 can not be learnt before 2. By default, all browsing sequence discussed below is legal.

The depth-first navigation starts from a non-successor node and explores as far as possible along each branch before backtracking. Here, non-successor node means a node with no prerequisite. The breadth-first navigation also starts from a non-successor node, however, rather than stick to one branch, it always explores different branches, jumping from one branch to another. With the description above, assume x is the current visiting node, different navigation rules can be listed as follows:

(1) **Depth-first navigation rules:**

D1. After visiting x, if the direct successor of x is available for visit (all the prerequisites of that direct successor are visited), visit the direct successor.
D2. After visiting x, if the direct successor of x is not available for visit, visit one of the other unvisited and available prerequisites of that direct successor.

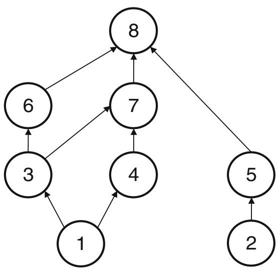

Fig. 1. An example of prerequisite structure.

(2) **Breadth-first navigation rules:**

B1. After visiting *x*, if *x*'s parallel node is not visited and it's available for visit, visit the parallel node.

B2. After visiting *x*, if all the parallel nodes of *x* are visited, visit one of the direct successors of *x*.

In order to detect the learning style, every time the student visits a node in the prerequisite structure, we need to determine which preference it implies. If a visit follows the depth-first navigation rules, either D1 or D2, it implies a sequential preference. On the other hand, if a visit follows the breadth-first navigation rules, either B1 or B2, it implies a global preference. It should be noted that some visits may follow both depth-first and breadth-first navigation rules. Under this circumstance, these visits do not imply any preferences. In fact, in [17], the author proposed a similar method but that method missed rules D2 and B2.

The algorithm below (*LSDetection*) shows the proposed method to detect students' learning styles. When the sequential preference confidence (*SPC*) is equal to the global preference confidence (*GPC*), the student does not have any preferences, they are comfortable with both two structures and use either one of them whenever it's needed. If $SPC > GPC$, the student prefers depth-first structure. If $SPC < GPC$, the student prefers breadth-first structure. In order to make the result comparable to the ground truth obtained from Felder-Soloman's Index of Learning Style Questionnaire [19], the preference is divided into three levels, namely slight, moderate, and strong. If $50\ \% < (SPC \text{ or } GPC)/(SPC + GPC) \leq 66.6\ \%$, then the preference is slight; If $66.6\ \% < (SPC \text{ or } GPC)/(SPC + GPC) \leq 83.3\ \%$, then the preference is moderate; If $83.3\ \% < (SPC \text{ or } GPC)/$

```
Algorithm LSDetection
Input: browsing sequence(BS); Prerequisite structure(PS);
Output: Sequential preference confidence(SPC);
        Global preference confidence(GPC);
begin
   SPC:=GPC:=0;
   Save a copy of the prerequisite structure;
   NextD:=NextB:=L(1);
   for each node x in BS
      if x∈NextD and x∉NextB
         SPC:=SPC+1;
      end
      if x∈NextB and x∉NextD
         GPC:=GPC+1;
      end
      NextD:=UpdateDepth(x, NextD);
      NextB:=UpdateBreadth(x, NextB);
      Remove x from prerequisite structure;
   end
   Restore the prerequisite structure from the copy;
end
```

(*SPC* + *GPC*) ≤ 100 %, then the preference is strong. For example, if *SPC*/(*SPC* + *GPC*) = 90 %, the student's preference is strongly sequential. On the other hand, if *GPC*/(*SPC* + *GPC*) = 70 %, the student's preference is moderately global.

We maintain two sets of nodes, *NextD* and *NextB*, to represent the potential nodes to be visited according to each preference. *NextD* is the set of nodes which should be visited next according to the depth-first rules, while *NextB* denotes the set of nodes which should be visited next according to the breadth-first rules. If the current visiting node *x* belongs to *NextD*, we increase the confidence to sequential preference. On the other hand, if the current visiting node *x* belongs to *NextB*, we increase the confidence to global preference. However, if the current visiting node *x* belongs to both *NextD* and *NextB*, we do not increase the confidence to either sequential or global preference. As the user browsing through the prerequisite structure, *NextD* and *NextB* will be updated according to different rules. Noticed that in function *LSDetection*, each time *NextD* and *NextB* are updated, we need to remove the current visiting node *x* from the prerequisite structure because that (1). *x* is visited now; (2). We have updated *NextD* and *NextB* based on *x*. But before removing any nodes from prerequisite structure, we should keep a copy of the original prerequisite structure.

```
Algorithm UpdateDepth
Input: Current visiting node x; NextD;
Output: Updated NextD;
begin
   NextD=empty set;
   for each direct successor ds of x
      if ds is available for visit after visiting x
          NextD:={NextD,ds};
      end
      else
          NextD:={NextD, the other prerequisites of ds};
      end
   end
end
```

```
Algorithm UpdateBreadth
Input: Current visiting node x; NextB;
Output: Updated NextB;
begin
   NextB=empty set;
   if there exists a parallel node of x
      for each parallel node p of x
         if s is available for visit
             NextB:={NextB,p};
         end
      end
   else
      NextB:={NextB, direct successors of x};
   end
end
```

The sets *NextD* and *NextB* are not static. Every time the student visits a node in the prerequisite structure, *NextD* and *NextB* need to be updated according to the depth-first rules and breadth-first rules respectively. The algorithms to update *NextD* and *NextB* are shown below as algorithm *UpdateDepth* and *UpdateBreadth* respectively. Concerning *NextD*, for each direct successor *ds* of current visiting node *x*, if *ds* is available, then according to rule D1, it should be added to *NextD*. On the other hand, if *ds* is not available after visiting *x*, then according to rule D2, the other available unvisited prerequisite nodes of *ds* are added to *NextD*. For *NextB*, if there exist some parallel nodes of the current visiting node *x,* then according to B1, these parallel nodes are added to *NextB*. On the other hand, if there doesn't exist any parallel nodes of the current visiting node *x*, then according to B2, direct successors of *x* are added to *NextB*.

3 Case Study in Dance Education

A case study in dance education was conducted to evaluate our proposed method. A total of 32 college students (7 female, 25 male) were involved. In order to detect their learning styles, all of them were asked to learn 10 dances by browsing the basic moves (patterns) arranged in the prerequisite structure. The prerequisite structure of a dance can be derived in three steps. First, the patterns, both repetitive and non-repetitive, are extracted from the dance, so that the dance is divided into basic moves; Second, all prerequisite relations are found by revealing the inclusion relation between these patterns; Finally, remove redundant relations, i.e., transitive relations from the set of all prerequisite relations, so that the compact prerequisite structure is built. For more detail, please refer to [22]. The user interface to detect learning style is shown in Fig. 2, it is mainly composed of three panels, namely, the "Prerequisite structure" panel,

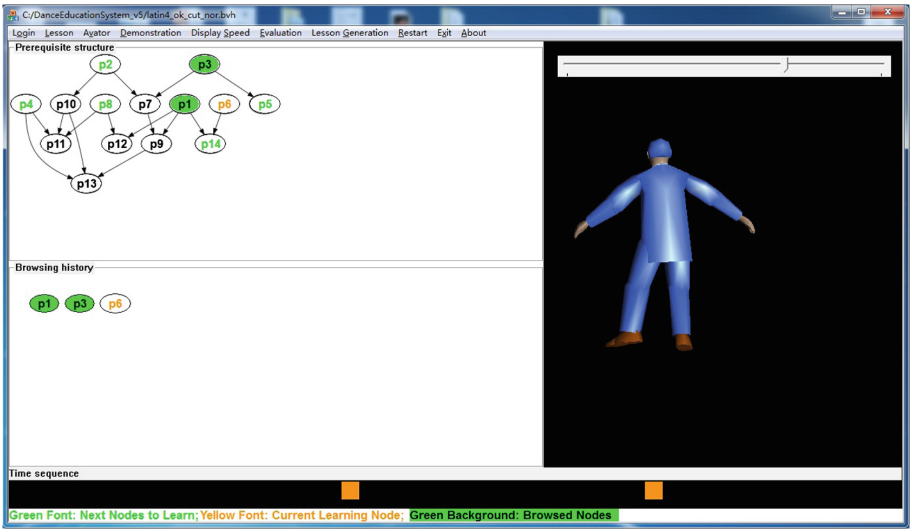

Fig. 2. User interface for detection of learning style.

"Browsing history" panel, and "Time sequence" panel. The "Prerequisite structure" panel is used to demonstrate the prerequisite structure, as we can see in Fig. 2, the dance is divided into 14 patterns, namely, p1, p2, …, p14, and these 14 patterns are organized as a prerequisite structure. The "Browsing history" panel is used to record students' browsing sequences. The "Time sequence" panel shows the corresponding segments in the timeline. The students were only allowed to select learning objects from the prerequisite structure. In addition, the students were only allowed to select pattern nodes which they had already fulfilled the prerequisites (those nodes marked with green font/green background indicating whether students had/had not mastered the patterns). When the learning object is selected, it is added to the "Browsing history", the corresponding ID of the node in both "Prerequisite structure" panel and "Browsing history" panel will be highlighted with yellow font indicating that this learning object is selected, in the meantime, the system will determine which preferences this visit implies. The student can double click on each of the blocks in the "Time sequence" panel to do a test as shown in Fig. 3. The teacher's motion is shown by the avatar on the right while the student's captured motion is shown by the avatar on the left. The student can see both the back and the front of the two avatars since the virtual environment is trying to simulate a dance studio in which people are dancing in front of a mirror. After a student completes a test, a score report (Fig. 4) will be shown to provide feedback about the student's overall performance as well as the performance of each body part. The scoring function to evaluate the students' performance in the test is described in [23]. When the student passes a test, the corresponding node will be shaded in green. In order to make it easier for students to interact with the system, a "hint" bar is designed at the bottom of the window to give clues about different annotations. After learning with the user interface shown in Fig. 2, these students were asked to finish the Felder-Soloman's Index of Learning Style Questionnaire (ILS). By

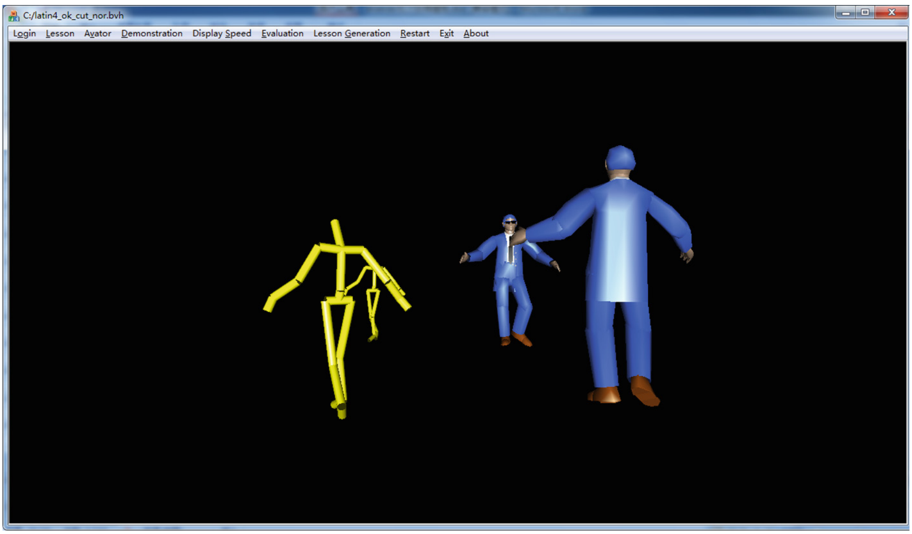

Fig. 3. User interface for performing a test.

Fig. 4. Score report after a user completes a test.

comparing with the ground truth obtained by Felder-Soloman's Index of Learning Style Questionnaire (ILS), the accuracy of the proposed learning style detection algorithm is acquired.

Figure 5 shows the comparison of the detection results between the ILS questionnaire and the proposed method, it can be seen that there is no large gap, thus achieving a high detection accuracy which is 81.25 % (26/32) as shown in Table 1. In addition, if we choose to ignore the extent of these preferences,–this situation is practical when we try to apply the detected learning style to provide adaptive learning, we can get an even higher accuracy which is 93.75 % (30/32). One interesting thing that we should notice is that many students (17 out of 32) involved in the study are sequential learner, that is probably because that all students involved are college

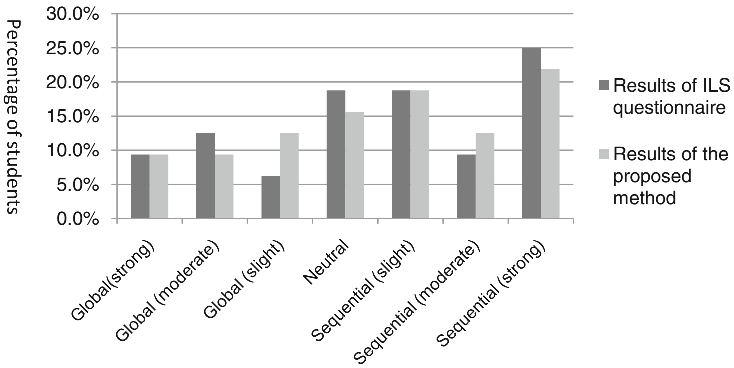

Fig. 5. Comparison of the detection results between ILS questionnaire and the proposed method.

Table 1. Comparison of the detection accuracy between different approaches

Method	Accuracy
(Cha, et al., 2006)-Decision Tree	71.43 %
(Graf, 2007)-Bayesian Network	66.25 %
(Graf, 2007)-Rule-based Approach	73.33 %
(Popescu, 2009)-Rule-based Approach	78.17 %
The proposed method-Rule-based Approach	81.25 %

students, and many of them are trained to think sequentially. Table 1 shows the comparison of the accuracy between our method and other popular approaches. It can be seen that our method gets the highest detection accuracy, it is quite optimistic to put the detected learning style into real usage.

4 Conclusion and Future Works

In this paper, a rule-based method for automatically detecting learning style (sequential-global) is proposed, it analyzes the students' navigation patterns in the prerequisite structure, each time the student visits the learning object in the prerequisite structure, it updates the confidence of corresponding preference. A case study in dance education which involves 32 college students is conducted to evaluate the proposed method. The result is optimistic as regards to the detection of learning style.

The proposed method is implemented on a marker-based motion capture system. The marker-based system is a perfect solution to animation, while it is not so applicable to the fields of entertainment and education, because it is hard to motivate the user to wear those markers. We will further migrate the proposed method on markerless motion capture system, such as Microsoft Kinect.

In addition to sequential/global dimension of the learning style, other dimensions of learning style can be further implemented, such as active/reflective dimension and visual/verbal dimension. Based on the detected learning style, a virtual reality dance educational system can also be implemented to provide adaptive and immersive learning environment.

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The Design of Intervention Model and Strategy Based on the Behavior Data of Learners: A Learning Analytics Perspective

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Abstract. Learning analytics is the technology using the prediction model and data generated in the learning process to analyze and predict learners' future performance, find potential problems and implement intervention. The intervention model is the key of using learning analytics to improve learners' learning performance. This paper constructs the intervention model which is a loop structure on the basis of existing researches. The core of the intervention model is intervention engine including learners' learning status identification, intervention strategy matching and calculation, intervention application and intervention effectiveness analysis. It designs and specifies the intervention strategies from the contents and means of the intervention. The research presents typical intervention strategies involving means of intervention and content of intervention having important academic and practical significance on promoting learning analytics research in the future.

Keywords: Learning analytics · Intervention model · Intervention strategy · Implement analysis

1 Introduction

Reducing learners' dropout rates and realizing personalized learning has been continuously objectives of many education researchers and practitioners [1]. How to resolve the bottleneck of the delay of feedback and to use real-time information to provide adaptive diagnosis and intervention are currently most concerned issues for teachers. Learning analytics provides possibilities for solving these problems. Siemens defines Learning Analytics as "the use of intelligent data, learner-produced data, and analysis models to discover information and social connections, and to predict and advise on learning" [2]. Learning analytics is not only judging learners who are in danger, but also implementing appropriate interventions on the basis of the analysis results for providing personalized guidance for learners helping them achieve learning objectives. The ultimate goal of learning analytics is improving learning and teaching efficiency, thus providing valid intervention based on analysis results is remarkably important [3].

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The existing related research experiments show that effective interventions have important significance on promoting learners' learning performance [4]. However, it is not enough in-depth on invention models research. Some researchers point out that another important, but less studied component is the model for intervention; that is the framing of the activity (for teachers and/or students) of interpreting and making decisions based on the analytics [5]. This paper summarizes research status of intervention models and concentrate on existing intervention means and contents laying the foundation for the intervention model proposed in this paper. Constructing an intervention model which can improve learners' learning performance has an important meaning both in prompting learning and teaching and developing learning analytics.

2 Literature Review

Based on the analysis of students' learning data, intervention model gives corresponding intervention measures, especially for those who are diagnosed with the risk of dropping out of school or failing the exam according to the student's learning status. The project of "Signals-Stoplights for Student Success" of Purdue University collects information from the LMS, CMS and course grade to generate the risk level of learners and labels dangerous level respectively with green, yellow and red. After that, it educates learners pertinently who are diagnosed at risk [6]. The Grade Performance Status of Northern Arizona University can collect learner's performance in class, gives corresponding suggestions, and then sent learners mail including attendance, grades and learning problems. Students should give feedback to the corresponding problem after receiving the email [7]. In Open Academic Analytics Initiative (OAAI) program, students identified as at-risk, were subjected to two different intervention strategies, 'Awareness messaging' and participating in an 'Online Academic Support Environment (OASE)'. Students identified in an Academic Alert Report (AAR) who were assigned to classes in the "Awareness Intervention" group received a message indicating that they were at risk of not completing the course successfully along with guidance on what they might do to improve their chances of success [8].

Some researchers analyze learning intervention from the perspective of the nature of intervention and point out that technical, pedagogical and social must be brought into dialogue with each other to ensure that interventions and organizational systems serve the needs of all stakeholders [9]. There are some other researches about this. Such intervention may involve the teacher sending reminders to students about the suggested progression through the task, emailing students with promoting questions to promote deeper investigation of content, or moderating a planned group discussion to stimulate more equal contribution [10]. Researchers also supported that intervention model should provide learners about their learning performance and learning situation timely, at the same time provide learning activities and recommendations based on learners' weak spots of knowledge. It can help them get learn progress and enhance motivation and confidence. The other hand, researchers also support that providing learners with tools which can help them evaluate the efficacy of their learning and find the best activity is useful in making them achieve learning goals faster [11].

3 Model Construction

3.1 The Analysis of Learning Intervention Mechanism

Online learners tend to face many problems such as loneliness, lack of communication between teachers and students, feedback delay and weak learning motivation [12]. Intervention can increase the frequency of interaction which is important to keep learning state even informal interactions [13]. This research emphasize on analyzing function of intervention model according to the structural functionalism. In existing researches, systematic and completed researches are rarely and Chao Zhang proposes "learning intervention of two-dimensional classification framework" gets high recognition. He views the interference target group and the intervention form as the basic variables of intervention classification system. He concludes four different types of learning intervention means by integrated these two dimensions. They are individual - structured, individual - unstructured, collectivization – structured and collectivization – unstructured [13].

Learning interventions in the individual–structured part is mainly to meet the demands of individual learners' learning and to implement standardized learning. The typical way of intervention is giving individual help. Means of learning interventions in the individual – unstructured part is elastic. It's flexible based on different problem situation. Interventions are sending individual remind, giving bonus and pushing information. Learning interventions in the collectivization – structured is similar to the learning intervention in traditional teaching way. It has a certain orientation, such as standardized test, resources, process guidance and knowledge map and so on. Evaluating learners' mastery of learning content before and after the online learning with the standardized test is the foundation of providing explicit knowledge map for learners and guiding learners to learn and master their own learning progress. Learning interventions in the collectivization – unstructured pay attention to the communication between learners and it is often used in the form of group work. The common ways of intervention are communication through web forums, answering questions and group cooperation.

The existing intervention mechanisms, especially intervention means, intervention contents and intervention implementation, provide reference for the intervention model proposed by this paper. This paper will integrate existing researches and build a new intervention model.

3.2 Model's Design Idea

Learning analytics enables teachers to gather, analyze learner' learning data and then output learner' current learning status, such as learning progress, completeness of learning goals achieved [14]. When teachers or other relative stakeholders get well knows learner' learning situations, they can give learner corresponding intervention measures respectively, such as sending reminder, pushing resources and so on, to help them overcome difficulties and keep on their study. This research presents a systematic model of intervention which concerns identifying learners' learning status, designing intervention strategies database, matching learning status and intervention strategies on the basis of learning analytics and relative research achievement. The basic thinking of building the model of intervention is judging learners' learning conditions, filtrating and implementing corresponding interventions, tracking and analyzing intervention strategies efficiency, identifying learners' learning conditions and giving intervention circularly.

3.3 Intervention Model Construction

According to the basic thinking of model building, this paper presents the model of intervention as following (Fig. 1).

The workflow of this intervention model is elaborated in details below. The start point of the process is identifying learners' learning status basing learning analytics. And then, intervention engine calculates and mates appropriate intervention strategies corresponding learner' personalized features, including means of intervention and contents of intervention. After intervention strategies match learners' learning status, intervention engine implements them and tracks learners' following study process judging learners' updated status for two purposes, one is whether those intervention strategies are effective in improving learner' learning and the other one is looking for new features of learners as new beginning of giving other valid intervention strategies. The whole workflow of this model is a perpetual cycle including four main phases.

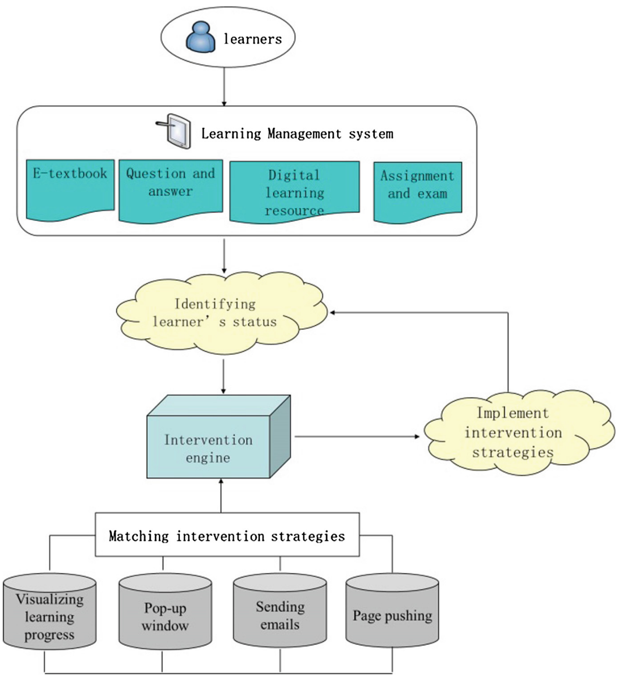

Fig. 1. Intervention model

(1) Identifying Learners' Learning Status.

Judging and identifying learners' status accurately is the necessary precondition for choosing and implementing effectively intervention strategies. Among existing literatures about learners' online learning behavior and learning model, some researchers points out descriptions about learners' learning status which lay solid foundation for this paper. Ling-ling Meng classifies learning analytics tools into five kinds, online learning tools, learning content tools, learning ability analytics tools, learning behavior tools and other comprehensive analyze tools [15]. These five kinds of tools deal with five kinds of students' data correspondently including individual learner's learning progress data, learners' knowledge construction data, learners' learning ability and level data, learners' learning trials and features. In this way, we can mark learners' status with data of these five dimensions.

In conclusion, this paper summarizes learners' learning status data into four dimensions, learning behavior data, learning emotion data, learning network data and learning level data. Learning behavior data involves data among learners and learning platform or learning resources, such as log-in times, study time. Learning emotional data refers to learners' psychological and physiological data during learning process. Learners' interactive data including network relationship and discourse content with others is learning network data. At last, learning level data includes learners' exam or program scores reflecting learners' learning status directly. Thus, intervention engine will judge learners' current learning status for these aspects above. What's more, in following process, intervention engine relies on these aspects to calculate and filter intervention strategies.

(2) Design Intervention Strategies.

After getting learners' learning status, intervention engine chooses and implements suitable intervention strategies. Designing intervention strategies mainly includes means of intervention design and content of intervention design, and this paper concerns about their application situations and matching modes with learners at the same time. In the learning process, learners usually face some risks and intervention engine needs to identify learners' learning status accurately and timely. According to literature analysis, when learners are in risk or inclined to fail they present following behaviors, learning slowly, away for network relationship, down in spirits and so on. In order to solve these difficulties during learning process facilitating learners' future learning, this paper presents intervention strategies, suggests four typical means of intervention, and then illustrates relevant content of intervention and application scenarios (Table 1).

Before giving interventions to students, teachers or other relative teaching staff can choose who and how many learners can receive those intervention strategies basing learners' need, such as for one specific individual learner, a particular group or the whole class. What's more, teachers can rely on particular situations setting intervention frequency and intervention times. If necessary, teachers can design some interventional mechanisms and rules making intervention system gives intervention automatically.

Table 1. Intervention strategies

No.	Means of intervention	Content of intervention	Application situations	Relevant data
1	Visualizing learning progress	completeness of learning goals, learning path, network relationship, learning advice and guidance	Learners have finished some tasks, such as learned one lecture of the course, submitted some paper	Learning behavior data, learning network data, learning level data
2	Pop-up window	announcement and notice, warning information, learning advice and guidance	Learners are in low concentration, facing risks, away from learning and so on.	Learning behavior data, learning emotion data
3	Sending emails	Periodic learning summary, learning plan, learning material, learning arrangement	Learners have finished periodic tasks or achieved learning objectives	Learning behavior data, learning level data
4	Page pushing	learning partners, teacher dialogue, Learning materials, learning tools	Learners are facing difficulties, such as failing to finish homework or tasks	Learning behavior data, learning network data, learning level data

4 Implement Analysis

4.1 Analyzing and Identifying Learners' Learning Status

After calculating learners' learning behavior data and learning level data, learners' current learning status can be known, such as learning path and learning progress. From learning behavior data and learning emotion data, learners' attitude towards learning can be analyzed, such as learners' degree of participation in learning and learning preference. Teachers and relevant stakeholders can design some evaluation rules for judging learners' learning status, such as learners are inactive and tending to fail if their online time is less than two hours per week and the number of their posts are no more than five. Intervention engine will follow these evaluation rules to calculate learners' data and output learners' current learning status.

4.2 Filtrating Intervention Strategies Based on Learners' Learning Status

After identified learners' learning status, intervention engine choose and filter intervention suitable and corresponding strategies for application. When intervention engine finds learners' attitude is negative or learning progress is slow, it can give warning message or emotional reminder through pop-up windows. After finishing some learning assignments, intervention engine basing learners' learning progress and results data visualizes learners' learning outcome facilitating learners get well known their learning data and gives subsequent learning advices and guidance. When learners are facing some risks, intervention engine can detect and analyze reasons for these risks and then push learning materials, learning tools or even learning partners who overcome these risks successfully.

Identifying learners' learning status accurately and timely is the beginning and crucial point for choosing intervention strategies. Designing and matching intervention strategies is the important precondition and requirement for implementing strategies and improving learners' learning performance. Thus, researchers need to keep an eye on learners' online learning patterns and summarize learners' learning feature making preparation for intervention engine judging learners' actual learning status. At the same time, it's important to enlarge and expand intervention strategies database getting more suitable match between learners and strategies. In this ways, learners' learning performance and teachers' teaching achievement could be improved largely and quickly.

5 Conclusion

Learning analytics can extract connotative and potential information from mass data giving intervention support for learners, teachers, managers and other stakeholders, improving teaching efficiency and environment and promoting educational benefit in digital age. The theoretical model of learning analytics is very popular and gains some achievement, but construction and application of intervention model is far less systematic and deep-going. This paper presents a circulatory intervention model involving identifying learners' status, matching and implementing intervention strategies and analyzing implementation effect four stages. What's more, some examples of intervention strategies including means of intervention and content of intervention are shown in detail. Online learning has the property of variety and complexity, so researches in intervention model are facing many difficulties and need researchers to explore.

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Understanding Learners' Intension Toward Massive Open Online Courses

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Abstract. Based on the technology acceptance model (TAM) by Davis *et al.*, this research proposes an acceptance model for studying the learner adoption of massive open online courses (MOOCs) where the factors of trust and perceived playfulness are amended. A total of 212 valid samples were collected in China. The results indicate that trust and perceived usefulness are key factors that determine learners' intention of attending MOOCs; perceived playfulness also affects learners' perceived usefulness and trust toward MOOCs. Furthermore, recommendations for the development, implementation and research of MOOCs are provided based on the findings.

Keywords: Massive open online courses (MOOCs) · Technology Acceptance Model (TAM) · Trust · Playfulness · Intention · Empirical study

1 Introduction

Massive open online courses (MOOCs) have gained a lot of attention in the last years as a hybrid learning approach in education. In China, MOOCs have been trialed and generalized in some institutions of higher education such as Shanghai Jiaotong University, Peking University, and Tsinghua University. More than one hundred higher education institutions have joined the "MOOCs in China Yangtze River Delta Forum in 2013". Some scholars asserted that "the arrival of the era of MOOCs has become inevitable" at the forum [1]. After then, some scholars conducted "2014 Survey on MOOCs' Learners" and found that MOOCs had six hundred fifty thousand registered users in China. However, at least half of registered users did not actually attend the courses, and only about half of those who attended the courses completed their courses

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eventually [2]. For such cases, on the one hand, the analysis from the perspective of education, as Xu *et al.* (2013) pointed out, MOOCs provided the possibility of improving the quality of education, but it was merely possible, because education relied on variety of factors, and among them, the most fundamental one was the learners themselves. No matter how good the course was, if the learners lacked motivation, it might be difficult to give its full play [3]; On the other hand, analyzed from the perspective of information technology (IT) application, the success and popularity of MOOCs depends not only on the progressiveness of the technology, but also on solving the behavior problems, including users' awareness, acceptance, and continuous use. As shown by practice and research on technology innovation, which includes advanced technology and usability, did not automatically lead to users' actual use [4], but it was found that technology acceptance and cognition construction could well predict users' behavior in the use of technology [5]. Thus, it is necessary to construct technology acceptance model for MOOCs through the research for identifying the factors that influence learners' behavior intention for attending MOOCs.

2 Research Background

Technology Acceptance Model (TAM) by Davis *et al.* (1989) [6] was one of the most influential theories in IT adoption research. In TAM, the user's adoption behavior was interpreted into two faiths, namely perceived usefulness and perceived ease of use. After then, Davis *et al.* added the third faith − perceived playfulness to TAM [7], The results of subsequent verification by other scholars showed that the influence of perceived playfulness on users' behavior was weaker than that of the other two faiths [8, 9]. However, since 2000, a number of researches on online games, world wide web, and the use of information systems in the family and the leisure environment presented completely different results that the influence of perceived playfulness on users was stronger than that of the other two faiths [10]. In the field of hybrid learning, the empirical study by Chu *et al.* (2014) also indicated that entertainability had more influence on the students' intention of using electronic sand table (EST) taught systems than usability and reliability [11]. Viewed in this way, the influence of perceived playfulness should be tested during the process of constructing TAM for MOOCs.

In the field of online shopping, Tang & Chi (2005) introduced trust into TAM [12]. Inspired by Tang & Chi's view, Chu *et al.* (2014) proved that trust was an important antecedent variable in students' intention of attending EST taught systems [11]. Like the case in EST systems, MOOC systems were also a kind of taught systems based on IT, hence it was necessary to put trust into the research framework.

3 Research Hypotheses and Model

Based on the discussion above, in this study, the potential factors that influenced learner's intention of attending (*IA*) MOOCs included perceived usefulness (*PU*), perceived ease of use (*PE*), perceived playfulness (*PP*) and trust (*TR*). Perceived usefulness refers to the degree to which a person believes that using a particular system would enhance his/her job performance [13]; Perceived ease of use refers to the degree to which a person believes that using a particular system would be free of effort [13]; Perceived playfulness refers to a user's subjective experience of fun by using a particular system, which made the user indulge in learning and ignore everything else [14]; Trust is the expectation that a service will be provided or a commitment will be fulfilled [15]; In this study, intension to attend refers to a learner's willingness and enthusiasm for attending MOOCs and his/her intention for attending MOOCs in the future.

According to TAM by Davis (1989), perceived ease of use influenced perceived usefulness and behavior intention [13], while in more studies, the results showed that perceived usefulness influenced behavioral intention [10, 13], Therefore,

Hypothesis 1: Perceived usefulness has a positive influence on learners' intension to attend MOOCs;

Hypothesis 2: Perceived ease of use has a positive influence on learners' perceived usefulness of the MOOCs;

Hypothesis 3: Perceived ease of use has a positive influence on learners' intension to attend MOOCs.

According to TAM in which Tang & Chi (2005) introduced [12], the factors of trust, both perceived ease of use and perceived usefulness had influence on users' trust toward MOOCs, therefore,

Hypothesis 4: Perceived ease of use has a positive influence on learners' trust toward MOOCs;

Hypothesis 5: Perceived usefulness has a positive influence on learners' trust toward MOOCs.

As the results of the study by Chu *et al.* (2014), entertainability has a strong influence on students' trust toward taught systems, while trust influences students' intention to use taught systems [11], Therefore,

Hypothesis 6: Learners' perceived playfulness of MOOCs has a positive influence on their trust toward MOOCs;

Hypothesis 7: Learners' trust toward MOOCs has a positive influence on their intension to attend MOOCs.

The study by Venkatesh (2000) presented that among the factors affecting the adoption behavior of the multimedia systems, perceived playfulness had a positive correlation with perceived ease of use [16]; Hsu & Lu (2007) argued that perceived ease of use had a significant effect on perceived playfulness in their study on consumers' loyalty toward online games [17]; Via empirical study, van der Heijden (2004) found that enjoyment influenced users' intention of using hedonic information systems [18]; And Wu & Liu (2007) found that enjoyment influenced players' intention of playing online games [19]; Based on the TAM framework, Agarwal & Karahanna (2000) [20], Yi & Hwang (2003) [21], and Li *et al.* (2005) [22] pointed out that perceived playfulness or enjoyment had an influence on perceived usefulness. Therefore,

Hypothesis 8: Learners' perceived ease of use of MOOCs has a positive influence on their perceived playfulness;

Hypothesis 9: Learners' perceived playfulness of MOOCs has a positive influence on their perceived usefulness;

Hypothesis 10: Learners' perceived playfulness of MOOCs has a positive influence on their intension to attend MOOCs.

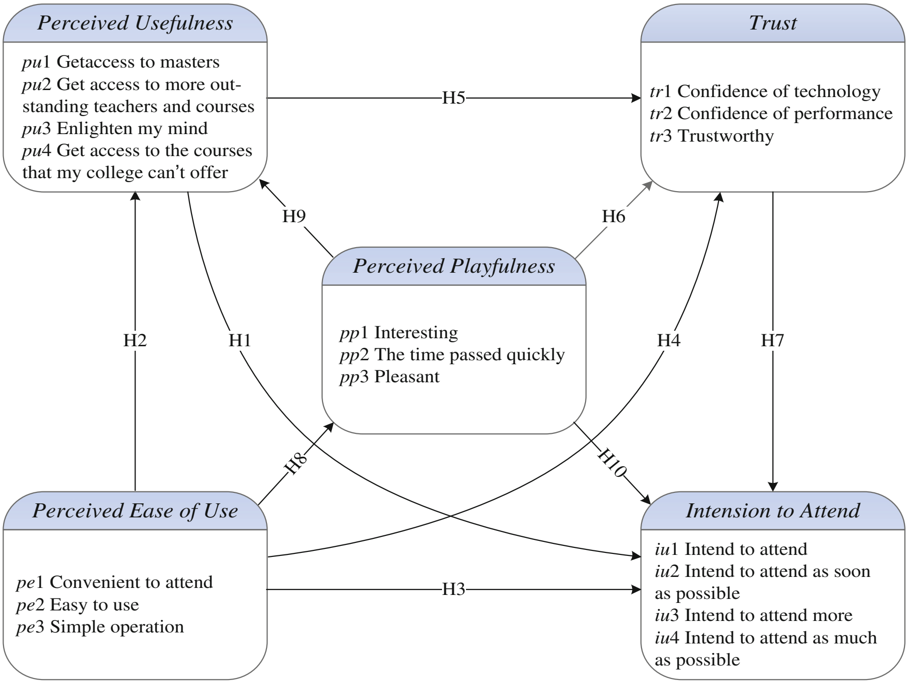

Fig. 1. Research model

In light of the above hypotheses, the research model is shown in Fig. 1.

4 Results and Analysis

This research used a questionnaire survey. The questionnaire consists of 2 sections: Sect. 1 covers 17 questions of 5 constructs and Sect. 2 is the background information of respondents. Respondents are required to express their opinion towards selected statements in the questionnaire in a 7-point Likert scale (7 represents "strongly agree", 1 means "strongly disagree"). The questionnaires were distributed online, inviting respondents from QQ groups of students and teachers to fill them out. In order to prevent duplicate entry, questionnaire was set to reject any entry from the same Mac address.

A total of 239 answer sheets were collected in Feb. 2015. Among them, there were 27 invalid answer sheets, 17 were obviously completed perfunctorily (all questions were chosen the same opinion) and 10 were invalid because the respondents could not properly understand some of the questions (two extreme choices of "strongly agree" and "strong disagree" existed in different questions of the same construct). A total of 212 data were finally retained for the analysis.

Table 1. Respondent characteristics

		Frequency	Percentage
Gender	Male	82	38.7
	Female	130	61.3
Age	<18	3	1.4
	18 ∼ 25	178	84.0
	26 ∼ 30	12	5.7
	31 ∼ 40	13	6.1
	41 ∼ 50	6	2.8
Occupation	Secondary school student	1	0.5
	Technical higher school student	4	1.9
	Full-time undergraduate Student	157	74.1
	Part-time undergraduate Student	18	8.5
	Master candidate	7	3.3
	Ph.D. candidate	1	0.5
	Education industry staff	11	5.2
	Non education industry staff	13	6.1
Participation of MOOCs	Just heard about MOOCs	138	65.1
	Have heard about MOOCs but never participated in	54	24.4
	Have participated in MOOCs as a teacher	2	0.9
	Have participated in MOOCs as a student	18	8.5

4.1 Sample Characteristics

Shown as Table 1, 61.3 % (130 persons) of the effective respondents were females while 38.7 % (82 persons) were males. Most of them (84.0 %) were 18 ∼ 25 years old. Most (74.1 %)of respondents were full-time undergraduate students. But 5.2 % and 6.1 % of respondents were education industry and non-education industry staffs respectively, and the answer sheets from these respondents were valid because learners in MOOCs were not limited to students. 138 respondents (65.1 %) claimed that they just heard about MOOCs, while 54 respondents (24.4 %) stated that they had heard about MOOCs but never participated in. Only 18 respondents (8.5 %) indicated that they had participated in MOOCs as students and 2 respondents (0.9 %) indicated that had participated in as teachers.

4.2 Reliability and Validity Assessment

Table 2 illustrates that overall Cronbach's α is 0.942 which were calculated by utilizing SPSS 19 analysis towards sample data. The highest Cronbach's α value within all constructs is intention to attend (0.948), and it can be seen that the Cronbach's α value of trust is the lowest (0.849). In order to ensure the acceptance of inner-reliability, Hair *et al.* (2010) argued that the score of Cronbach's α should be at least 0.6 [23]. This requirement is verified in the research. The result of Bartlett's test of sphericity

Table 2. Means, standard deviations, and Cronbach's α of the components

Constructs	Items	Means	Std. dev.	Cronbach's α
Perceived ease of use (*PE*)	1 (*pe*1)	4.92	1.426	.867
	2 (*pe*2)	5.00	1.392	
	3 (*pe*3)	5.21	1.413	
Perceived usefulness (*PU*)	4 (*pu*1)	5.71	1.324	.895
	5 (*pu*2)	5.88	1.243	
	6 (*pu*3)	5.90	1.271	
	7 (*pu*4)	5.92	1.159	
Perceived playfulness (*PP*)	8 (*au*1)	4.94	1.330	.895
	9 (*au*2)	4.92	1.327	
	10 (*au*3)	4.88	1.210	
Trust (*TR*)	11 (*tr*1)	5.55	1.133	.849
	12 (*tr*2)	4.71	1.114	
	13 (*tr*3)	4.77	1.143	
Intention to attend (*IA*)	14 (*it*1)	4.90	1.430	.948
	15 (*it*2)	4.62	1.511	
	16 (*it*3)	4.75	1.541	
	17 (*it*4)	4.85	1.490	
Overall				.942

($\chi^2 \approx 3046.549$, $df = 136$, $Sig. \approx 0.000$) indicates that the correlation matrix for these variables is unlikely to be an identical matrix. Further calculation on Kaiser-Meyer-Olkin test shows that $KMO = 0.914$. These results suggest that the scale is compatible for factor analysis.

4.3 Confirmatory Factor Analysis

The analysis presented in Table 3 is using the AMOS 17. Confirmatory factor analysis (CFA) is performed to assess construct validity. Hair *et al.* (2010) provided that individual standardized factor loadings should be at least 0.5 [23]. Table 3 shows that the lowest standardized factor loading of the model is 0.661 (*tr*1, "MOOC is an advanced education idea and technology"). All factor loadings are above 0.5, the construct validity of the questionnaire is provided.

4.4 Correlation

Table 4 shows the Pearson's correlation coefficients matrix between constructs which are calculated by utilizing AMOS 17. The correlation coefficients are all significant ($p < 0.01$), the values ranged from a minimum of 0.449 (between the *PE* factor and the *TR* factor) to 0.781 the highest (between *PP* factor and *TR* factor). Because the highest value is only 0.781, according to the criteria established by Moore (2007) [24], the five constructs are relatively independent from one another.

Table 3. Confirmatory factors analysis

	IA	*TR*	*PP*	*PU*	*PE*
*ia*1	.919				
*ia*2	.922				
*ia*3	.924				
*ia*4	.860				
*tr*1		.661			
*tr*2		.894			
*tr*3		.896			
*pp*1			.797		
*pp*2			.883		
*pp*3			.909		
*pu*1				.867	
*pu*2				.939	
*pu*3				.772	
*pu*4				.736	
*pe*1					.786
*pe*2					.874
*P*3					.818

Table 4. Correlation matrix beteen Constructs

	IA	*TR*	*PP*	*PU*
TR	.723**			
PP	.574**	.781**		
PU	.587**	.582**	.628**	
PE	.485**	.449**	.458**	.653**

**p < 0.01 (two tailed test).

4.5 Model Fit

The overall model $\chi^2 \approx 254.120$ with 109 degrees of freedom ($p \approx 0.000$). $\chi^2/df \approx 2.331$. Bagozzi & Yi (1988) stated that $\chi^2/df < 3.0$ is considered to be good [25]. The value for the root mean square error of approximation (*RMSEA*) is 0.079. Browne & Cudeck (1993) stated that $RMSEA \in (0.05, 0.08)$ as an “adequate fit” [26]. The comparative fit index (*CFI*) is 0.952. Bentler (1990) recommended that $CFI > 0.9$ indicates a good fit of the model [27]. Therefore, the above results suggest that the model provides an acceptable fit and thus it is suitable to proceed to further examination.

4.6 Results of Structural Equation Modelling Analysis

Figure 2 shows the results of structural equation modelling (SEM) analysis. The analytical results indicate that *PE* has a significant effect on *PU* and *PP*, and so

Hypotheses 2 and 8 are valid; *PP* has a significant effect on *TR* and *PU*, and so Hypotheses 6 and 9 are valid; *PU* and *TR* has a significant effect on *IA*, and so Hypotheses 1 and 7 are valid. Alternatively, Hypothesis 3, 4, 5, and 10 are not valid based on the fact that the paths between *PE* and *IA*, *PE* and *TR*, *PU* and *TR*, *PP* and *IA* are found to be insignificant.

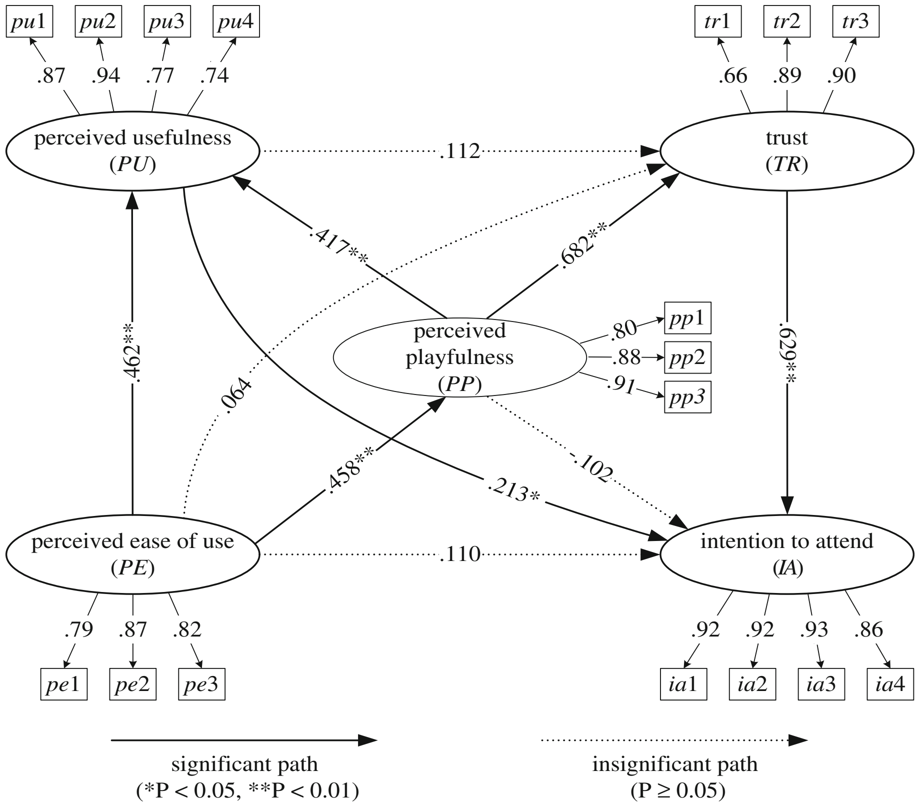

Fig. 2. Structural equation modeling results

5 Discussion

As Fig. 2, the result from SEM analysis shows that Hypothesis 1 and 2 are supported, which is consistent with the conclusion from classic TAM proposed by Davis *et al.* (1989) [6]. Therefore, the main conclusions from classic TAM still hold true for the adoption of MOOCs. Perceived ease of use (standardized weight ≈ 0.462, p ≈ 0.000) influences perceived usefulness, and perceived usefulness (standardized weight ≈ 0.213, p ≈ 0.015) influences learners' intention to attend MOOCs.

Hypothesis 7 is supported, which is consistent with the results of Tang *et al.*'s (2005) [12] and Chu *et al.*'s (2014) [11] researches. Besides, in the model, trust is the most important factor (standardized weight ≈ 0.629, p ≈ 0.000) that influences on intention to attend, which has a greater influence on intention to attend than perceived usefulness does. The result indicates that trust is an essential faith in the acceptance model of learning systems, so it is necessary to include trust factor in the further study of learners' technology acceptance.

Hypothesis 8 and 9 are supported, which are consistent with the results of Venkatesh's (2000) [16], Hsu & Lu's (2007) [17], Agarwal & Karahanna's (2000) [17], Yi & Hwang's (2003) [21], and Li *et al.*'s (2005) [22] researches. In the model, perceived ease of use has a direct significant influence on perceived usefulness and also significantly indirectly influences perceived usefulness through perceived playfulness.

Hypothesis 6 is supported, which coincides with the result of the research by Chu *et al.* (2014) [11]. The result shows that perceived playfulness (standardized weight ≈ 0.682, p ≈ 0.000) is an important factor influencing trust. In the whole empirical model, perceived playfulness plays an essential role because it is the important reason for learners' acceptance of MOOCs. On the one hand, in the design and promotion of MOOCs, it is necessary to attach great importance to its playfulness. On the other hand, it should be noted that learning may not always be interesting (this may partly explain the high dropout rate in MOOCs) and it is inevitable to go through dullness and hardship, so excessive pursuit for playfulness may lead to superficial effectiveness of teaching.

Hypothesis 4 is not supported, therefore perceived ease of use does not show a direct significant influence on learners' trust toward MOOCs. Similarly, the unsupported Hypothesis 10 means that perceived playfulness does not have a direct significant influence on learners' intention to attend MOOCs. The unsupported Hypothesis 3 means that perceived ease of use does not have a direct significant influence on learners' intention to attend MOOCs. The unsupported Hypothesis 5 shows that perceived usefulness does not have a direct significant influence on learners' trust toward MOOCs.

6 Conclusion

This research presents an acceptance model for studying learners' adoption of MOOCs. Questionnaires were collected and empirical data were tested for validating the proposal model. This model provides a framework for future studies of trust and acceptance of hybrid learning.

Small sample size is the limitation of this study. Future researches are suggested to be improved in this aspect. Moreover, in the light of the importance of trust, further consideration of more factors that influence trust toward MOOCs can be added for future study.

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Learning Analytics of Cross-University Educational Resource Based on THEOL Course Union

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Abstract. Learning analytics is commonly used in learning management systems to improve learning. This paper presents a method to use learning analytics in open educational resources. The visiting logs in an open educational resources system – THEOL (Tsinghua Education Online) course union system are categorized by visitors' and resources' university properties (region, educational level and discipline type). The difference between resources' visited count and visitors' visiting count of each category is used to measure the comprehensive index of resources' richness and popularity of this category. Chi-square test and ratio of each category are used to show the difference of different category visitors preferring different category resources. The analysis results can guide administrators on how to share educational resources efficiently.

Keywords: Open educational resources · Learning analytics

1 Introduction

In April 2001, the Massachusetts Institute of Technology (MIT) launched the "Open Course Ware (OCW)" initiative, which makes the MIT course materials available on the Web to be freely used by users all over the world [1]. "Open educational resources"(OER) is first used at United Nations Educational, Scientific, and Cultural Organization's (UNESCO) 2002 Forum on the Impact of Open Courseware for Higher Education in Developing Countries [2]. In 2003, as one of the measures to improve the quality of higher education, the Ministry of Education in China (MOEC) initiated the National Quality Course plan. Until 2009, nearly 3000 courses from more than 500 universities in China had been granted the designation "National Quality Courses" by the MOEC, and all freely available online [3]. Now, there are hundreds of open educational resources projects serve all over the world in order to improve the education equity of the world [4].

The Society for Learning Analytics Research defines learning analytics as: "The measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs" [5]. Chatti's research shows that the data used in learning analytics is

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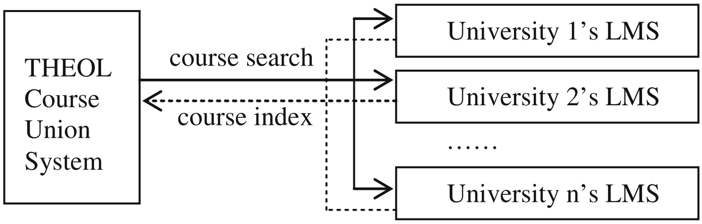

Fig. 1. The architecture of THEOL course union

focused on Adaptive learning system, web-based course and learning management system [6].

The learning analytics can also be used in OER systems. MIT's OCW program report shows that the web access logs are used for geographic analysis [7]. However, it's difficult to conduct further analysis for common OER systems since they usually have nothing visiting information but the IP address.

"THEOL (Tsinghua Education Online) Course Union" is an OER sharing system. The system's architecture is shown in Fig. 1. Instructors in THEOL LMS can set their online courses into one of three opening status (private, opening inside the university or opening to the all). If the instructor set the online course to open to all, the online course becomes an OER. The course union system indexes these OER courses from THEOL learning management systems allocated in union universities and delivered these OER courses to those union universities through search engine. THEOL course union system has indexed more than 400,000 online courses and delivered them to over 120 universities in China [8, 9]. The visiting logs of THEOL course union system can provide additional information – the visitor's university information to be used for learning analytics.

Following parts will introduce how to use the visitor's university information and course's university information in learning analytics. The relationship of the visit and the region, educational level and discipline type of university is analyzed. The result can give guides on sharing educational resources efficiently.

2 Methods

2.1 The Indicator of the Popularity and Richness of Resources

Every visiting log includes a visitor and a resource (open online course). So for all the logs, the number of times the visitors visited equals the number of times the resources having been accessed. If the visitors and resources are divided by the same kind of categories (university's region, educational level and discipline type etc.) the difference between the number of times the resources having been accessed and the number of times the visitors visited by category can be an indicator of the popularity and richness of resources on this category. The difference larger than zero means that more resources on this category are visited and less visitors on this category and this category is relatively popular and rich on educational resources. And vice versa, the difference less than zero means that more visitors and less resources and this category is relatively unpopular and lacking on educational resources.

2.2 Chi Square Test

Chi-square test is any statistical hypothesis test in which the sampling distribution of the test statistic is a chi-square distribution when the null hypothesis is true. The chi-square (I) test is used to determine whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories [10]. Chi-square test requires some conditions: independent observations, adequate sample size and simple random sample. Because the visiting logs are all from course union system and each visiting is independent with others, chi-square test can be used to test whether visitors belongs to different categories have different frequencies on visiting resources of different categories.

3 Data Preparation

The visiting logs between Oct. 1st, 2012 and Aug. 31st, 2014 are extracted from THEOL course union system. Each log includes the visitor's university and resource's university. The universities' property information (region, level, discipline type, etc.) are extracted from the website of China's Ministry of Education.

Then the university's property information is appended onto the log (visitor's university and resource's university). The visiting log has the same university on visitor and resource is ignored (This means the visit is not cross-university, although the visitor used the course union system instead of learning management system) on this pre-analysis period. The total count of the logs after pre-process is 71851.

4 Analysis and Discussion

4.1 Regional Analysis

This section researches whether the location of the university has relation with the visitor-favoring category of resource. The visitors are divided into different categories by their universities' region. Two kinds of regions are used here: eastern, western and central; Northeast, North China, East China, South China, Central China, Northwest and Southwest.

Table 1 shows the visiting count and ratio of the region (Eastern, Western and Central, every region for visitors as 100 %) of universities. Figure 2 shows the total visiting counts of the visitors and resources of the region and difference count between visitors and resources of the region.

The Fig. 2 shows that eastern universities provide most resources (more than 50 %) and the central universities provide most visitors (more than 60 %). The difference between visitors and resources prove that the eastern is relatively rich region and central is relatively lacking region on educational resource.

Table 1. The visiting count of the universities' region (Eastern, Western and Central)

Visitor \ Resource	Eastern Universities	Western Universities	Central Universities
Eastern Universities (100%)	4547(51.6%)	2169(24.6%)	2093(23.8%)
Western Universities (100%)	9896(51.1%)	5115(26.4%)	4348(22.5%)
Central Universities (100%)	23626(54.1%)	11685(26.7%)	8372(19.2%)

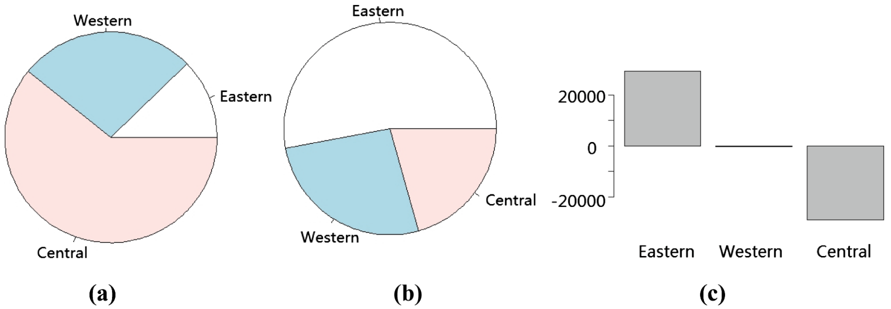

Fig. 2. The total visiting count of the region (Eastern, Western and Central): (a) the visitors from different region (b) the resources from different region (c) the difference between the visitors count and resources count

The chi square test on the visiting count of the region of universities shows that the chi square value is 157.13 and p-value is smaller than 2.2e-16 (coefficient of contingency is 0.047). This indicates there is difference that the visitors from different region of universities prefer different resources of region of universities. The difference of the ratio shows that the visitors from eastern universities and western universities prefer central universities' resources (3.2 % and 1.9 % higher than average) and the visitors from central universities prefer eastern and western universities' resources (1.2 % and 0.3 % higher than average).

Table 2 shows the visiting count and ratio of the region (Northeast, North China, East China, South China, Central China, Northwest, and Southwest, every region for visitors as 100 %) of universities. Figure 3 shows the total visiting counts of the visitors and resources of the region and difference count between visitors and resources of the region (Northeast, North China, East China, South China, Central China, Northwest, and Southwest).

The Fig. 3 shows that universities in north China, east China and northeast provide most resources (each region more than 18 %) and the universities in central China provide most visitors (more than 37 %). The difference between visitors and resources proves that the north China and east China are relatively rich region and central China is relatively lacking region on educational resource.

Table 2. The visiting count of the universities' region (Northeast, North China, East China, South China, Central China, Northwest and Southwest)

Visitor \ Resource	North-east	North China	East China	South China	Central China	North-west	South-west
Northeast (100%)	2335 (20.0%)	1969 (16.9%)	2698 (23.1%)	877 (7.5%)	1706 (14.6%)	725 (6.2%)	1369 (11.7%)
North China (100%)	296 (13.5%)	586 (26.7%)	423 (19.3%)	219 (10.0%)	336 (15.3%)	109 (5.0%)	228 (10.4%)
East China (100%)	1683 (19.0%)	1593 (18.0%)	2122 (23.9%)	933 (10.5%)	1343 (15.1%)	351 (4.0%)	857 (9.6%)
South China (100%)	901 (23.6%)	616 (16.1%)	909 (23.8%)	313 (8.2%)	534 (14.0%)	143 (3.7%)	403 (10.6%)
Central China (100%)	5394 (20.0%)	4838 (18.0%)	7046 (26.1%)	2501 (9.3%)	1844 (6.8%)	1032 (3.8%)	4348 (16.1%)
Northwest (100%)	1323 (18.4%)	1257 (17.5%)	1708 (23.7%)	661 (9.1%)	994 (13.8%)	465 (6.5%)	791 (11.0%)
Southwest (100%)	2173 (19.6%)	2344 (21.2%)	2200 (19.9%)	922 (8.3%)	1487 (13.4%)	512 (4.6%)	1434 (13.0%)
Average (100%)	19.6%	18.4%	23.8%	8.9%	11.5%	4.6%	13.1%

The chi square test on the visiting count of the region of universities shows that the chi square value is 1799 and p-value is smaller than 2.2e-16 (coefficient of contingency is 0.156). This indicates there is significant difference that the visitors from different region of universities prefer different resources of region of universities. The difference of the ratio shows that the visitors from north China prefer north China's resources (8.3 % higher than average) and the visitors from central China show lower interest on central China resources (4.7 % lower than average).

4.2 Educational Level Analysis

This section researches whether the educational level of the school has relation with the visitor-favoring level of the resources. The visitors are divided into different categories by their schools' educational level. Based on the schools in the course union system and the standard from China's Ministry of Education, the schools are divided to undergraduate and higher (schools provide undergraduate education and partial graduate education), undergraduate and vocational (all the schools only provide undergraduate education and higher vocational education), vocational (all the schools only provide higher vocational education) and secondary vocational (all the schools only provide secondary vocational education).

Table 3 shows the visiting count and ratio of the school's educational level (every level for visitors as 100 %). Figure 4 shows the total visiting count of the visitors and resources of the school's educational level and difference count between visitors and resources of the educational level.

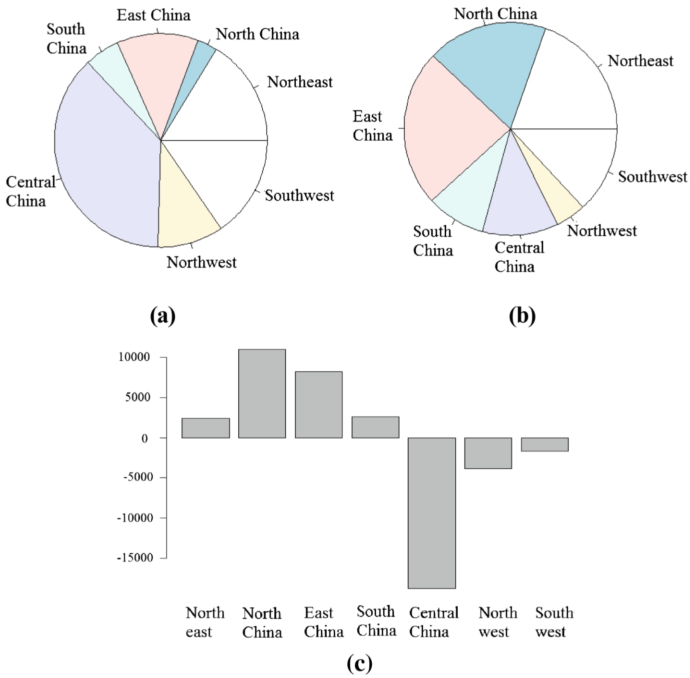

Fig. 3. The total visiting count of the region (Northeast, North China, East China, South China, Central China, Northwest, and Southwest): (a) the visitors from different region (b) the resources from different region (c) the difference between the visitors count and resources count

Table 3. The visiting count of the school's educational level

Resource / Visitor	Undergraduate and higher	Undergraduate and vocational	Vocational	Secondary vocational
Undergraduate and higher (100%)	4982 (22. 5%)	15021 (68. 0%)	2083 (9. 4%)	16 (0%)
Undergraduate and vocational (100%)	10391 (23. 2%)	29814 (66. 6%)	4530 (10. 1%)	24 (0%)
Vocational (100%)	893 (17. 9%)	3370 (67. 5%)	716 (14. 3%)	11 (0%)
Secondary vocational	0	0	0	0
Average	22. 6%	67. 1%	10. 2%	0%

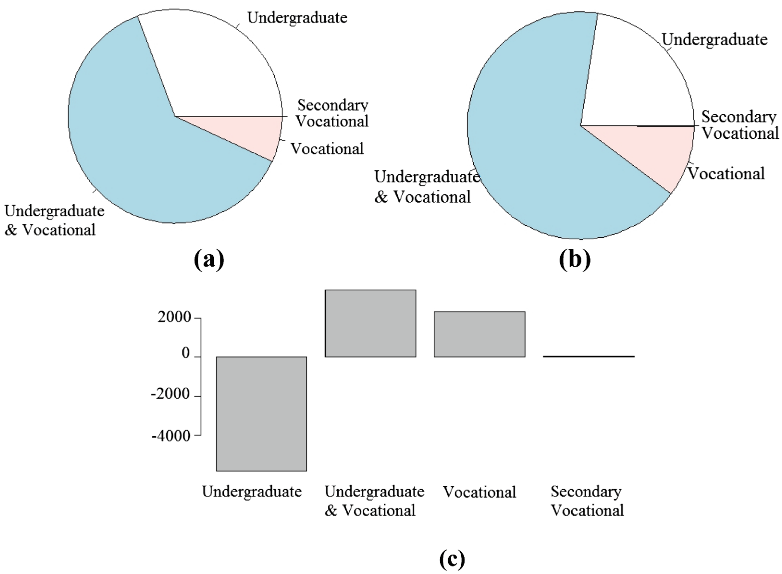

Fig. 4. The total visiting count of the educational level: (a) the school's educational level based on visitors (b) the school's educational level based on resources (c) the difference between the visitor count and resource count

The Fig. 4 shows that most of visitors and resources are from undergraduate and vocational college (63 % and 67 %). The difference between visitors and resources proves that the vocational resources are more popular than undergraduate resources.

The chi square test on the visiting count of the educational level (ignore the secondary vocational school on visitors and resources because no secondary vocational visitors visited resources) shows that the chi square value is 158 and p-value is smaller than 2.2e-16 (coefficient of contingency is 0.047). This indicates there is difference that the visitors from different educational level prefer different educational level resources. The difference of the ratio shows that the visitors from vocational college prefer vocational college's resources (4.1 % higher than average) and have little interest in undergraduate and higher educational level resources (4.7 % lower than average).

4.3 Discipline Type Analysis

This section researches whether the discipline type of the school has relation with the visitor-favoring category of resource. The visitors are divided into different categories by their schools' discipline type. Based on the schools in the course union system and the standard from China's Ministry of Education, the schools are divided to finance and economics, technology, forestry, national, agricultural, normal, physical education, medical, political science and law, arts, language and comprehensive. The forestry, physical education, political science and law, arts and language schools are ignored on following analysis because only few visitors and resources belong to these categories.

Table 4 shows the visiting count and ratio of the school's discipline type (every type for visitors as 100 %). Figure 5 shows the total visiting counts of the visitors and resources of the school's discipline type and difference count between visitors and resources of the discipline type.

The Fig. 5 shows that most of visitors and resources are from comprehensive schools. The difference between visitors and resources proves that the resources from technology school are most popular and those from comprehensive school are unpopular.

The chi square test on the visiting count of the educational level (ignore the financial and economics universities on visitors and resources) shows that the chi square value is 3526 and p-value is smaller than 2.2e-16 (coefficient of contingency is 0.216). This indicates there is significant difference that the visitors from the school with different discipline type prefer different resources from the school with different discipline type. The difference of the ratio shows that the visitors from financial and economics, technology, agriculture and medical school are interest in their own discipline resources (higher than average). The visitors from national school prefer the

Table 4. The visiting count of the schools' discipline type

Resource / Visitor	Finance and Economics	Technology	National	Agricultural	Normal	Medical	Comprehensive
Finance and Economics (100%)	7 (5.3%)	32 (24.2%)	3 (2.3%)	27 (20.5%)	10 (7.6%)	15 (11.4%)	38 (28.8%)
Technology (100%)	289 (2.6%)	3135 (28.6%)	152 (1.4%)	1113 (10.2%)	809 (7.4%)	602 (5.5%)	4851 (44.3%)
National (100%)	164 (4.0%)	1149 (27.8%)	23 (0.6%)	488 (11.8%)	444 (10.8%)	197 (4.8%)	1664 (40.3%)
Agriculture (100%)	196 (1.9%)	1879 (18.7%)	142 (1.4%)	2226 (22.1%)	632 (6.3%)	496 (4.9%)	4487 (44.6%)
Normal (100%)	32 (3.4%)	178 (19.2%)	14 (1.5%)	79 (8.5%)	69 (7.4%)	101 (10.9%)	455 (49.0%)
Medical (100%)	16 (0.5%)	336 (11.2%)	12 (0.4%)	172 (5.8%)	117 (3.9%)	890 (29.8%)	1446 (48.4%)
Comprehensive (100%)	999 (2.4%)	10651 (25.6%)	785 (1.9%)	4885 (11.7%)	3069 (7.4%)	4129 (9.9%)	17071 (41.0%)

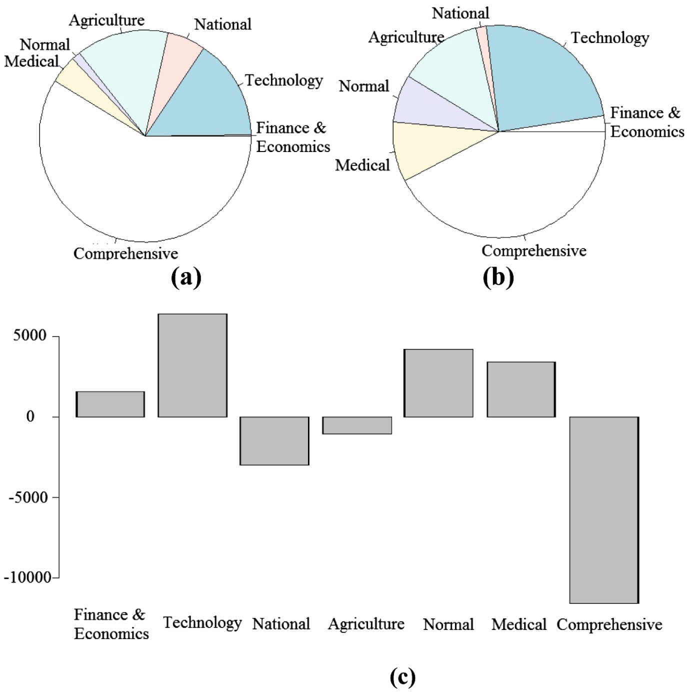

Fig. 5. The total visiting count of the school's discipline type: (a) the school's discipline type based on visitors (b) the school's discipline type based on resources (c) the difference between the visitors count and resources count

resources from technology and normal school. The visitors from normal school prefer the resources from comprehensive school.

5 Conclusion and Further Work

The analysis shows that the visitors from different university prefer resources from different university: the visitors from eastern universities and western universities prefer central universities' resources and the visitors from central universities prefer eastern and western universities' resources in China; the visitors from north China prefer the resources from north China and the visitors from central China show lower interest on central China resources; the visitors from vocational college prefer vocational college's resources and have little interest in undergraduate and higher educational level resources; the visitors from financial and economics, technology, agriculture and medical school are interest in their own discipline resources; the visitors from national school prefer the resources from technology and normal school. The visitors from normal school prefer the resources from Comprehensive school.

The analysis also shows that: the eastern is relatively rich region and central is relatively lacking region on educational resource in China; the north China and east

China are relatively rich region and central China is relatively lacking region on educational resource; the vocational educational resources are more popular than undergraduate; the resources from technology school are more popular and from comprehensive school are relative unpopular.

Learning analytics can be used in not only learning management system, but also open educational resource sharing system. These results can give some guides to the administrators such as which kind of educational resources students and teachers like; which kind of school should construct more educational resources. For further work, the social network analysis can be used in THEOL course union system on university level and get more information about the relationship of universities on educational resources.

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An Investigation of Factors Influencing College Students' Mobile Learning Behavior

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Abstract. The purpose of this paper is to explore the factors affecting college students' mobile learning (M-learning) behavior based on mobile phones. An extended model was proposed by integrating information processing theory into Unified Theory of Acceptance and Use of Technology (UTAUT). Quantitative methods including Structural Equation Modeling (SEM) were employed to validate the proposed model using the data collected from 206 college students via survey questionnaires. The results indicated that performance expectancy, effort expectancy, social influence, resource representation, perceived entertainment, learning style, learning strategy, prior experience, facilitating conditions and satisfaction all had significant impacts on college students' M-learning behavioral intention or behavior. Meanwhile, the study put forward several guidelines for educators and M-learning developers in terms of providing successful M-learning experiences.

Keywords: College students · Influential factors · M-learning · SEM

1 Introduction

New Media Consortium (NMC) Horizon Report pointed out that mobile applications would be the main teaching tool in education in the coming years [1]. M-learning usually refers to any learning which takes place through wireless mobile devices such as smart phones, PDAs, and tablet PCs that allow individuals to learn at anytime, anywhere [2]. The fast spread of mobile devices and wireless networks within a university makes higher education a suitable place to integrate student-centered M-learning [3].

M-learning that utilizes ubiquitous devices would be a successful approach among college students because these devices are cheaper compared with normal PCs and they are satisfactory learning tools [4]. Particularly, mobile phone has become the most widely used mobile device by virtue of its portability and flexibility. Meanwhile, it has formed the largest amount of users. China Mobile Phone Assistance User Behavior Report in 2014 figured out that the smartphone ownership in China was 58 million in

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2013, while in 2017, the overall market capacity is expected to reach 113 million. In addition, the monitoring data showed that among users in App Store, those who under the age of 30 accounted for 57.9 %. Furthermore, college students, the main young group, even played more significant roles in mobile phone market [5].

There has been a large amount of learning resources available for learners in mobile phones. However, college students have been paying much attention to its recreational applications such as gaming, chatting and so on, ignoring the feature of learning. A large scale survey of 164 college students found that in terms of their average number of minutes per day engaging in various mobile phone activities, 57.5 min were spent on games or "status update", while only 6.2 min were used for reading books [6]. Therefore, several issues, especially pedagogical issues might appear while students learn with mobile devices. For example, Ahmad indicated that using mobile devices in class might disturb students' concentration and impede the learning process [7].

In order to eliminate the side effects of mobile phones and develop M-learning resources that could facilitate students' learning, it is necessary to explore the influential factors of college students' M-learning behavior.

Numerous researches indicated that it is necessary for developers to understand human behavior when designing and developing effective and available technology [8]. Consequently, the essence of M-learning includes not only "mobile" media but also "learning" behavior. Therefore, both mobile media and the nature of learning should be considered while investigating the influential factors of M-learning behavior. In terms of mobile media, technology acceptance model was employed to evaluate college students' acceptance level of mobile technology. In addition, information processing theory was utilized in this study to explore if M-learning had meet college students' cognitive characteristics.

2 Theoretical Framework

2.1 Technology Acceptance Model

In 2003, Venkatesh, Morris and Davis proposed the Unified Theory of Acceptance and Use of Technology (UTAUT) through summarizing a series of previous acceptance models based on technology [9]. It was an integration with eight previous technology based acceptance models, including Technology Acceptance Model.

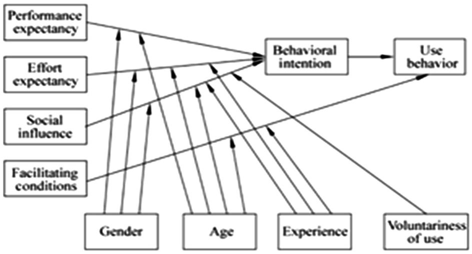

Fig. 1. UTAUT model

According to Fig. 1, UTAUT model includes four core variables (performance expectancy, effort expectancy, social influence, facilitating conditions) and four demographic variables (gender, age, experience, voluntariness of use). Performance expectancy was defined as the degree to which students believed that using the system would help them improve their performance [10]. Effort expectancy was defined as the degree of ease associated with the use of the system [11]. Social influence indicated the influence of others' opinions about adopting a certain system. Facilitating conditions referred to how people believed that technical infrastructures could help them use the system when needed [12]. Various previous studies on technology acceptance had proved the above variables could be effective measurements for willingness to accept new technologies [13]. Meanwhile, it has been verified several times that individuals' behavioral intention had impacts on their behavior [14].

2.2 Information Processing Theory

Gagné suggested that learning was a sustaining process, which could be divided into several stages. Each stage required different information processing [15], as shown in Fig. 2.

When parallelizing Gagné's information processing theory with M-learning process, we would find that college students make use of mobile devices to learn and receive stimulus outside by receptor. When the messages reach one's sensory register, the brain would deal with them preliminarily based on individual's experience and then focus one's attention on certain important information, which stays about hundredths of a second. It should be noted that faced with different types of learning resources, college students may make different behavioral choices. Considering the interaction of mobile phones and richness of its resources, college students are likely to adopt certain representations according to their own learning experience [16]. Therefore, some researchers indicated that resource representation, perceived entertainment and learning style had impacts on individual's behavioral intention [16–18]. Then the messages enter into short-term memory. Here, the

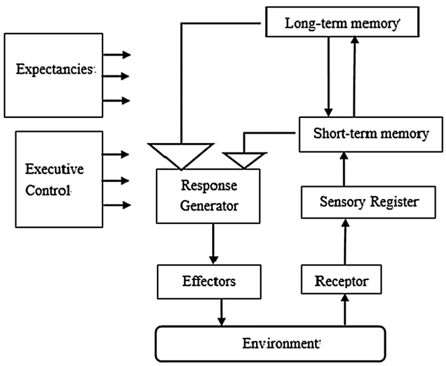

Fig. 2. Gagné's information processing model

messages stay for a few seconds, during which part of stored procedures are done. Besides, the meaning of messages are constructed by means of mental representation. In this process of coding, the individual's ability of ignoring irrelevant information get improved. They can code much information with little effort. So, it is necessary for college students to grasp appropriate learning methods and procedures. Previous study suggested that learning strategy had a significant influence on individual's behavioral intention [19]. Later, the messages are stored in the long-term memory. Learners combine the representation mentioned above with existing knowledge to help them understand or digest new messages. In other words, learners would take advantage of the information schema stored before to speculate or use existing information to process and extract information. It appears that changes in information processing are closely tied to prior experience. College students with rich M-learning experience make it easier to conduct M-learning. A study conducted by Ahmad Abu-Al-Aish and Steve Love indicated that prior experience would affect individual's behavioral intention [3]. Then the messages reach effectors and cause people's activities. Through the process above, the individual has obtained knowledge. And feedback has become the last link in the information flow. The degree of satisfaction with the whole M-learning process was considered to be the key to decide whether an individual was willing to accept information technology [20].

3 Research Questions, Proposed Model and Hypotheses

The study aimed to explore influential factors of college students' M-learning behavior based on mobile phones with the theoretical foundation of existing researches, especially technology acceptance model and information processing theory. This study addressed the following two research questions: what factors affected college students' M-learning behavior with mobile phones from the perspective of technology acceptance?; what factors affected college students' M-learning behavior with mobile phones from the perspective of information processing theory?

According to the literature review, this study used UTAUT model to investigate influential factors of M-learning based on the mobile phones from the point of view that technology itself had an impact on individual, aiming to predict and interpret college students' attitudes and behaviors when facing with new technology. Meanwhile, the study utilized cognitive learning theory to probe the factors from the perspective of learning nature, aiming to distinguish college students' cognitive elements, which make sure that the design of M-learning could better meet students' cognitive features. Finally, the author integrated both to generalize factors. Demographic variables in UTAUT were not included. The respondents involved in the study were college students whose characteristic differences were not significant. Besides, the resources provided by school for M-learning were finite, and college students' experiences of using the resources were even more limited.

Given all that, the study proposed the research model as shown in Fig. 3. The research hypotheses were shown in Table 1.

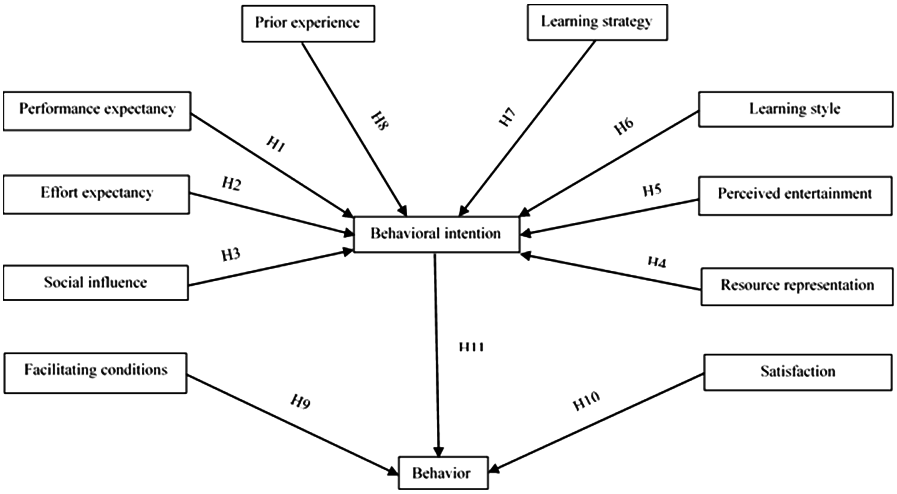

Fig. 3. Research model

Table 1. Research hypotheses

Number	Hypotheses
H1	Performance expectancy has a positive influence on college students' behavioral intention of M-learning
H2	Effort expectancy has a positive influence on college students' behavioral intention of M-learning
H3	Social influence has a positive influence on college students' behavioral intention of M-learning
H4	Resource representation has a positive influence on college students' behavioral intention of M-learning
H5	Perceived entertainment has a positive influence on college students' behavioral intention of M-learning
H6	Learning style has a positive influence on college students' behavioral intention of M-learning
H7	Learning strategy has a positive influence on college students' behavioral intention of M-learning
H8	Prior experience has a positive influence on college students' behavioral intention of M-learning
H9	Facilitating conditions have a positive influence on the behavior of college students' M-learning
H10	Satisfaction has a positive influence on the behavior of college students' M-learning
H11	Behavioral intention has a positive influence on the behavior of college students' M-learning

4 Method

4.1 Participants

Participants involved in this study were college students from various majors, including liberal arts, science, engineering, etc., which guaranteed the generalizability of this study. Besides, all the participants were informed about the purpose of the research at the beginning of questionnaire survey. As a result, a total of 206 college students responded to the survey, and 204 valid questionnaires were collected.

4.2 Instrument

The questionnaire was developed based on previous related literatures, and it was discussed and validated several times by experts in this field. The questionnaire used Likert five-point scale, involving 12 variables: performance expectancy, effort expectancy, social influence, learning style, perceived entertainment, prior experience, resource representation, satisfaction, behavioral intention, behavior, learning strategy, and facilitating conditions. Learning strategy included 3 items; facilitating conditions included 5 items and the other variables each included 2 items.

In addition, the questionnaire was published in an online survey platform, and all the participants were invited to complete and submit the questionnaire. The item samples of the questionnaire were as follows (Table 2):

Table 2. Item samples

Variable	Item samples
Performance expectancy	M-learning based on mobile phone can improve my learning achievement
Effort expectancy	To learn with mobile phone is very easy for me
Social influence	I would use mobile phone for learning if the surrounding friends are using it
Learning style	I think mobile phone can be used for autonomous learning
Perceived entertainment	M-learning can improve my learning interest
Prior experience	I have rich learning experience with mobile phone, so I believe that I can complete the whole learning process with little problems
Learning strategy	I like to do self-assessment when the M-learning process is finished
Resource representation	The resources with picture, text and sound are more attractive
Facilitating conditions	If the mobile phone runs with a smooth system when conducting M-learning, I will continue to learn
Satisfaction	I am very satisfied with the learning process based on mobile phone
Behavioral intention	I would like to learn with mobile phone more frequently
Behavior	I have been using mobile phone for learning

Table 3. Cronbach α assessment standard

Variable	Reliability >0.7	Variable	Reliability >0.7
Performance expectancy	0.82	Learning strategy	0.84
Effort expectancy	0.79	Resource representation	0.85
Social influence	0.77	Facilitating conditions	0.77
Learning style	0.79	Satisfaction	0.83
Perceived entertainment	0.80	Behavioral intention	0.87
Prior experience	0.82	Behavior	0.82

4.3 Data Analysis

SPSS19.0 was used for data processing in this study. AMOS17.0 was employed to build the research model and to validate mutual influences between variables.

5 Results

5.1 Reliability Analysis

In order to test the degrees of internal consistency of the results delivered in the survey, the study used Cronbach's alpha to conduct reliability analysis. The results are presented in Table 3.

According to Table 3, the coefficients of all variables were above 0.7 and the total was 0.949, indicating adequate reliability [21].

5.2 Validity Analysis

The factor analysis method was adopted by validity analysis. KMO test was conducted to determine whether it was suitable for factor analysis; the larger the KMO value was, the more suitable for analyzing. The size of KMO value represented amount of common factors between variables. The KMO value in this study was 0.896, suggesting that it was suitable for factor analysis [22].

Subsequently, Bartlett ball test was employed to suggest the validity of the questionnaire. The result showed that the value of P was 0.000 which was less than 0.05, meaning that the questionnaire has acceptable validity [23].

5.3 Structural Equation Modeling Analysis

To verify the hypotheses, the study used AMOS17.0 to do structural equation model analysis, and the results are as follows:

The Model Fit Index. The standardized path coefficients of the model were shown in Fig. 4. Each value was used to measure the influential degree of each other. Specifically, the value is between −1and 1. If the coefficient is between 0 and 1, then the

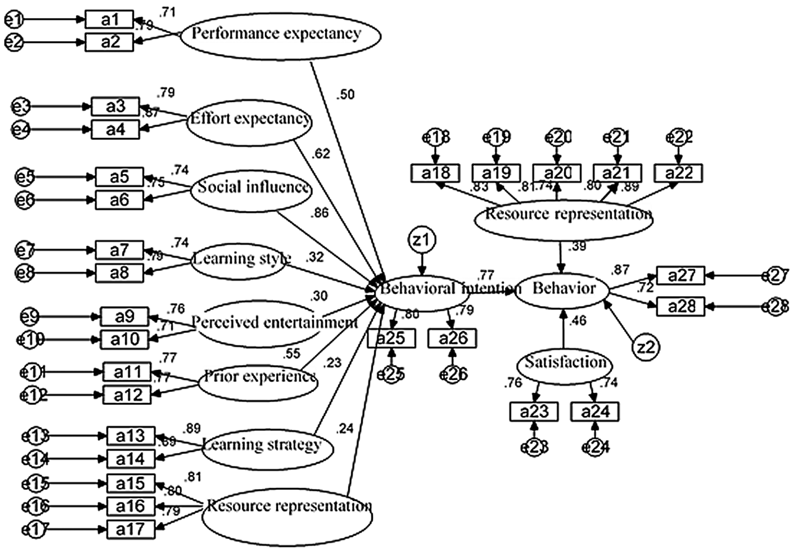

Fig. 4. The standardized path coefficients of the model

Table 4. Goodness-of-fit measures for structural equation modeling

Fit measures	Recommended value	Values	Model adaptation judgment
CMIN	P > 0.05	0.09	Yes
CMIN/DF	<3	1.11	Yes
CFI	>0.90	0.97	Yes
NFI	>0.90	0.94	Yes
RFI	>0.90	0.92	Yes
IFI	>0.90	0.98	Yes
TLI	>0.90	0.96	Yes
RMSEA	<0.08(<0.05 Excellent;<0.08 Good)	0.03	Yes

independent variable has a positive effect on the dependent variable; meanwhile, if the coefficient is between −1 and 0, then the independent variable has a negative effect on the dependent variable. In general, the larger the absolute value of standardized path coefficient is, the greater impact of the independent variable would have on dependent variable [24].

As shown in Table 4, all model–fit indices exceeded their respective common acceptable level [25].

Hypotheses Test. Table 5 showed the results of the hypotheses test. We could see that the T-value of each factor was above 1.96, indicating that all the hypothesized impacts are significant, so all the hypotheses were supported [26].

Table 5. Test of hypotheses

Hypotheses	Standardized estimate	T-value	Result of hypotheses
H1 Performance expectancy	0.50	4.29	Supported
H2 Effort expectancy	0.62	5.02	Supported
H3 Social influence	0.86	5.74	Supported
H4 Resource representation	0.24	2.93	Supported
H5 Perceived entertainment	0.30	3.09	Supported
H6 Learning style	0.32	3.78	Supported
H7 Learning strategy	0.23	2.44	Supported
H8 Prior experience	0.55	4.51	Supported
H9 Facilitating conditions	0.39	3.95	Supported
H10 Satisfaction	0.46	4.08	Supported
H11 Behavioral intention	0.77	5.26	Supported

6 Discussion and Conclusion

The results of this study indicated that the proposed model could predict college students' behavioral intention to adopt M-learning based on mobile phones. Consistent with previous researches in the field of technology acceptance, performance expectancy and effort expectancy had significantly positive influences on behavioral intention [14]. It seemed that students who believed that M-learning could benefit their studies were more intended to accept M-learning. Besides, M-learning was easy for students to conduct in ubiquitous environment. Therefore, it is recommended that high-quality M-learning resources and applications be provided for college students, which take user friendliness into consideration [2]. Social influence and facilitating conditions were also proven to be significant influential factors. This was in agreement with previous researches [27].

Prior experience was found to have a significant impact on behavioral intention to conduct M-learning, which supported the findings of others [28]. As a result, it is suggested that effective strategy should be adopted in the early stage of M-learning, which could enrich individual's learning experience and stimulate their learning motivations. For example, it is recommended that free practices should be offered. Perceived entertainment, which referred to perceived enjoyment, was also found to have significantly positive impact on behavior. This was also in agreement with previous research results [28]. Furthermore, the results of this study supported previous studies which found that satisfaction and learning style (whether the individual was autonomous or not) were major contributors to individual's technology acceptance [29]. Finally, just as the proposed model, resource representation and learning strategy all had significant impacts on individual's behavioral intention to conduct M-learning.

Therefore, the results validated the appropriateness of UTAUT model and information processing theory for predicting college students' behavior acceptance of M-learning with mobile phones. Besides, the results gave an insight into the factors needed to be considered when M-learning resources were designed. For instance, it is suggested that educators and M-learning developers should emphasize the feasibility and benefits of M-learning while providing students with M-learning experiences. Furthermore, students with less learning strategies might need to be motivated at the early stage of M-learning. In addition, developers should design learning applications that are easy to use and could improve students' performance effectively. More importantly, it is necessary for educators to give students reasonable, effective, and corresponding guidance on learning contents, since social influence could promote students' acceptance of M-learning.

7 Limitations

It should be noted that the present study was limited to the college students, while other groups were excluded, such as middle school students. So, future researches may explore influential factors of their M-learning behavior. Furthermore, demographic variables in UTAUT are expected to take into account in the future.

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A Comparison Study of Student Acceptance of Social Network Services and Mobile Technologies in Hybrid Learning

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Abstract. Hybrid learning has been pervading in higher education. The advancement of Information and Communication Technology (ICT) catalyzes hybrid learning approach to integrate different technologies in order to facilitate student learning. With the proliferation of online social networks and mobile technologies, educators begin to consider incorporating these technologies into hybrid learning. This constitutes an important research area to study the student attitude to the acceptance of social network services and mobile technologies in hybrid learning. This paper investigates the differences in the acceptance of these technologies among different age group of higher education students in hybrid learning. Specifically, a comparison of student acceptance of using Facebook private study group through their mobile devices is studied. A number of factors are examined including the perceived usefulness, perceived ease of use and perceived behavioral intention to compare if there are significant differences in the attitude to the technologies acceptance between students of different age group. The research findings provide educators information about (1) the generational differences between student acceptance to using mobile technology and Facebook private study group in hybrid learning; and (2) the development of hybrid learning strategies.

Keywords: Hybrid learning · Mobile learning · Facebook · Social network · Behavioral intention

1 Introduction

One of the major challenges to educators in higher education is how to improve student learning experiences. There are many different teaching and learning strategies, for examples, extensive classroom activities [1], active learning through group tasks [2], collaborative learning [3] and outcome based teaching and learning [8]. Among the different pedagogical approaches, past studies revealed that hybrid (or blended) approach through using ICT is one of the strategies proven benefitting student learning experiences [5, 8, 13]. According to the Blended Learning - Current Use, Challenges and Best Practices Report 2013, common blended learning approaches include, self-paced e-learning, virtual classrooms (webinars), mobile multi-device learning, face-to-face training, one-to-one coaching (face-to-face), one-to-one coaching (telephone/web),

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standalone on-demand learning resources, social learning (e.g. wikis, discussion forums), action learning sets and experiential learning (on the job). In terms of usage frequency, face-to-face training ranks first while self-paced e-learning and standalone on-demand learning resources rank second and third place respectively [14]. The rapid development in Internet ICT speeds up the growth of online communication and applications which, in turn, has been transforming our daily lives [13]. Social network site, Facebook, for example, has grown significantly in recent years providing online communication and community. Besides, Facebook becomes part of most students' daily life where they communicate, share and search for information. In view of the popularity of social network services, for example, Facebook, many educators and researchers make use of the group feature in teaching and is widely used in hybrid learning [9, 10]. Besides, the continuous advancement of mobile technology empowers the functions of the mobile devices. This has brought significant changes to students' daily lives in terms of communicate, search and share information. Many of these operations can be done through mobile devices. Students are increasingly spending much time in mobile usage. The popularity in mobile usage provides the opportunities of mobile learning development. As an extension from e-learning, mobile learning is playing an important role in facilitating student learning because it allows student to learn anywhere anytime. Thus, educators start to consider integrate both social network services and mobile technologies into hybrid learning. Though hybrid learning using ICT is a common approach, this does not mean that hybrid learning with ICT is guaranteed successful. There are many barriers to using ICT in teaching and learning, including, the competence, access to resources and confidence issues in related to technology integration; the ICT support to teachers [4] and also the student affordances of ICT [11].

2 Literature Reviews

2.1 Hybrid Learning

Hybrid learning, sometimes called blended learning or technology-mediated learning are usually interchangeable [12, 14]. According to Garrison & Kanuka (2004), hybrid learning is "a text-based asynchronous Internet technology with face-to-face learning" [13, p96]. In other words, hybrid learning is a teaching and learning approach where both traditional face-to-face classroom and technology-mediated teaching are used to facilitate student learning [7]. Apart from the simple view about hybrid learning, Garrison & Kanuka (2004) points out that it can be complex because of the unlimited possible and applicable design challenges in hybrid learning. This implies that no two hybrid learning approaches are identical for the same classroom settings for different teachers. Effective hybrid learning depends on the knowledge of the teachers about Internet ICT and how it can be integrated into face-to-face learning experiences. Hybrid learning approach is relatively low-risk pedagogical strategy because it depends on the ICT resources of the universities where teachers can customize the technology-mediated instruction with the resources available [13]. Rovai & Jordan (2004) study evidences that blended learning has stronger sense of community than traditional and fully online courses [17]. Graham & Dziuban (2008) further explain the adopting blended approach because it can improve learning effectiveness, increase access and convenience and is more cost effective [14].

Previous literatures have examined and proposed various models for blended learning. Singh (2003) proposes the Khan's Octagonal Framework for blended learning. The Framework contains eight dimensions contributing to blended learning, namely, the institutional, pedagogical, technological, interface design, evaluation, management, resource support, and ethical. The rationale behind these dimensions help teachers to reflect if their designated courses can produce meaningful learning experience for student [16]. Rossett, Douglis & Frazee (2003) point out that there are six areas constituting blended learning, i.e., live face-to-face (formal), live face-to-face (informal), virtual collaboration/synchronous, virtual collaboration/asynchronous, self-paced learning and performance support [18]. Garrison & Kanuka (2004) also argue that in order to achieve effective blended learning, the availability of community of inquiry is an important aspect [13]. Carman (2005) develops five key ingredients for blended learning design based on learning theories of constructivism, cognitivism and performance support. The five key ingredients are live events, online content, collaboration, and assessment and reference materials [19].

In terms of technology-mediated instruction and tools in hybrid learning, it includes web learning modules, online resource links, simulations, and scenarios, video and audio CD/DVDs, online self-assessments and workbooks [18]. Singh (2003) suggests knowledge sharing through collaboration over Internet. Rossett, Douglis & Frazee (2003) also suggest email, online bulletin boards, online communities for asynchronous virtual collaboration; live e-learning classes, e-mentoring for synchronous virtual collaboration. Carman (2005) research study suggests online content containing interactive, Internet-based or CD-ROM training; collaboration using e-mail, threaded discussion and online chat; live events using virtual classroom. In the research study of Lau & Lam (2012), social network services, i.e. Facebook, is used in addition to Learning Management Systems (LMS), i.e. Moodle, to facilitate interaction and knowledge. Lam & Cheung (2013) study evidences that students are benefited from blended approach using social and collaborative learning technologies, i.e. Facebook and Google Drive.

2.2 Mobile Learning

The rapid development of mobile technologies creates the opportunities of learning through mobile device. According to Cochrane (2010), Mobile learning (m-learning) involves "the use of wireless-enabled mobile digital devices (wireless mobile devices [WMDs]) within and between pedagogically designed learning environments or contexts." [24, p134]. Learning through mobile technologies have a number of benefits. Students can make use of their Internet-ready mobile devices to access course information, interact with different course related media and learn in a ubiquitous way [25]. The learning process is not constrained by the classroom and lesson schedule. M-learning encourages the interactions between people; allows access to useful information through the online learning environment; forms different online communities

[26] and promotes life-long, collaborative or problem-based learning [27]. The deployment of m-learning, like e-learning, does not mean replacing traditional classroom teaching learning, but m-learning is a complement to it. Besides, proper use of mobile technologies can add value and is a complement to the existing pedagogical strategies [28]. Past research studies evidence that educators make use of different information and communication technologies to assist and facilitate student learning [8–10]. In terms of new mobile technologies, Wang et al. (2009) argue that students' willingness to adopt technologies is a key to success [29].

2.3 Social Network Sites/Services

In recent years, social network services, for example, Facebook private group, are commonly used by teachers in higher education as a means of teacher-student and student-student communication and interaction [9, 10]. There are some reasons behind using the social network services in blended learning. In contrast to traditional classroom interaction, LMS and Facebook are not restricted by the time and space constraints. However, traditional face-to-face communication is not present online. Thus, teachers become the facilitators to students and intermediaries to resources [30]. Teacher acts as a learning catalyst and knowledge navigator for students [31]. Teachers should be active and interactive enough in order to show your participation and involvement online [32]. Besides, teachers should also adjust their role when participating in Facebook and communicating with students in order to establish the relationship and motivate students in learning [33]. Thus, a successful teacher should have positive attitude, i.e. monitor student progress; identify student learning difficulties; motivate student to learn; give advice to students in learning [34] as well as timely response [35].

2.4 Technology Acceptance

Behavior is an important topic in research study because it helps to understand individual responses to its environment. Past studies evidence that behavior is a consequence of beliefs and attitude where the intention implies the individual's willingness to behave or respond [20, 21]. Behavioral intention (BI) is an immediate antecedent of behavior and indication that an individual is ready to perform the behavior [21]. There are theories explaining the behavioral intention of an individual, including, the theory of reasoned action (TRA), and the theory of planned behavior (TRB) [20]. However, in order to explain the behavioral intention of technologies, Davis, Bagozzi, & Warshaw (1989) develop Technology Acceptance Model (TAM). According to TAM, the acceptance of an information technology is predicted by a number of major determinants, i.e. the perceived usefulness, perceived ease of use, behavioral intention and actual system use. Perceived usefulness (PU) is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" [22, p320]. It means whether the system can help them to perform their job better [23]. Perceived ease-of-use (PEOU) is defined as "the degree to which a person believes that using a particular system would be free from effort" (Davis, 1989:320). It represents the efforts the people needed to use a system [23]. Within TAM, BI is predicted by PU and PEOU. And the Actual System Use is predicted by BI. In order for an individual to have positive attitude and subsequent behavioral intention to use new technology, the individual should believe that the new technology is useful that can improve his/her performance and it is easy to use without extra effort. TAM provides the fundamental constructs for Information Systems (IS) research.

3 The Purpose of Study and Research Questions

Based on the previous literature, even though hybrid learning using ICT is a common approach, this does not mean that hybrid learning with ICT is guaranteed successful. Blindly putting new ICT in hybrid learning may raise the technology affordance issue. Therefore, in this paper, we study the student attitude to the acceptance of using social network services and mobile technologies in hybrid learning by comparing different age group of higher education students. This comes to the research question:

> Is there any significant acceptance difference among different age groups of higher education students to using Facebook private study group via the mobile device in hybrid learning?

3.1 Research Objectives

The objective of our study is to (1) investigate if there is significant difference in the acceptance among different age groups of higher education students to using Facebook private study group via the mobile device in hybrid learning; and (2) discuss the development of hybrid learning strategies.

> To investigate whether there are significant acceptance differences among different age groups of higher education students to using Facebook private study group via the mobile device in hybrid learning.

3.2 Testing Hypotheses

HA0: *There is no significant differences in perceived usefulness among different age groups of higher education students to using Facebook private study group* via *the mobile device in hybrid learning*

HA1: *There is significant differences in perceived usefulness among different age groups of higher education students to using Facebook private study group* via *the mobile device in hybrid learning*

HB0: *There is no significant differences in perceived ease of use among different age groups of higher education students to using Facebook private study group* via *the mobile device in hybrid learning*

HB1: *There is significant differences in perceived ease of use among different age groups of higher education students to using Facebook private study group* via *the mobile device in hybrid learning*

HC0: *There is no significant differences acceptance among different age groups of higher education students to using Facebook private study group* via *the mobile device in hybrid learning*

HC1: *There is significant differences acceptance among different age groups of higher education students to using Facebook private study group* via *the mobile device in hybrid learning*

4 Research Methodology

4.1 Hybrid Learning Approach

In this research, the hybrid learning approach includes face-to-face classroom teaching and technology-mediated instruction. The IT used includes (1) LMS (Moodle) for course materials download, assignment submission using mobile devices (in-class) or computer (after-class); (2) Facebook private study group via mobile devices for (i) in-class activities and (ii) after-class interactive communication and information sharing.

4.2 Measurement Development and Pilot Test

We designed the student questionnaires based on the survey instruments suggested by past literature. Table 1 shows the source of literature and survey instrument for technology acceptance dimension. We invited teachers with significant experiences in hybrid approach using Facebook and mobile technologies to revise the questionnaire again. The questionnaire adopted 5-point Likert scales from (1) strongly disagree to (5) strongly agree. A pilot test of the instruments was conducted with 15 Higher Diploma or Top-up degree students to participate in the pilot test. Some items in the questionnaire were modified or deleted based on the feedback from the pilot test respondents who were excluded from the subsequent official survey.

4.3 Data Collection

The data were collected from the Higher Diploma and Top-up degree students. Our survey adopted random sampling to invite students to participate in the research survey

Table 1. The source of literature and survey instrument for technology acceptance

Dimension	Code	Past literature	Survey instrument
Perceived usefulness	**PU**	Davis et al. (1989)	Wang et al. (2009)
Perceived ease of use	**PEOU**	Davis et al. (1989)	Wang et al. (2009)
Behavioral intention	**BI**	Davis et al. (1989)	Wang et al. (2009)

Table 2. The demographic profile and descriptive statistics of the respondents

Measure and items	Frequency	Percentage (%)
Gender		
Male	32	47.1
Female	36	52.9
Age		
18 - 24 [**G1**]	34	50.0
25 - 40 [**G2**]	34	50.0

study. They were also required to read and sign the consent form about the purpose of survey, the benefits and risks of participating in the survey. A total of 82 students from two age groups were contacted participate in the survey. Since a comparison study is performed between two age groups of students, the sample size of two groups needs to be identical. Therefore, together with irrelevant responses, 14 were discarded. So 68 questionnaire results were used for further analysis and the response rate was 82.9 %. Table 2 shows the demographic profile and descriptive statistics of the sample. Among the 68 respondents, 32 (47.1 %) of them were male whereas 36 (52.9 %) were female. There were 34 (50 %) students with age ranged from 18 - 24 (G1 - group 1) and 34 (50 %) students with age ranged from 25 - 40 (G2 - group 2).

4.4 Data Analysis

In this research, the Statistical Package for the Social Sciences version 18 (SPSS v.18) was used for statistical analysis. The collected data was analyzed by using paired sample t-test is used to compare student acceptance of social network services and mobile technologies in hybrid learning. Table 3 shows a comparison of the mean value of responses by age group. The results shows that both G1 and G2 mean values are comparable with G1's values are relatively higher than G2 among the three dimensions.

Table 4 shows a comparison of the standard deviation of the responses of two age groups. The results show that the variation of responses of G1 is less than G2 among the three dimensions.

Table 3. A comparison of the mean (M) value of responses by age group

Age	PU	PEOU	BI
G1	3.4412	3.8176	3.2356
G2	3.3235	3.6882	3.1474

Table 4. A comparison of the standard deviation (s) of the responses of two age groups

Age	PU	PEOU	BI
G1	0.6638	0.5813	0.7273
G2	0.9000	0.9041	0.9468

Table 5. The paired differences of two age groups of students

Pair G1 - G2	Mean	SD	95 % confidence interval of difference		t	df	Sig. (2-tailed)
			Lower	Upper			
PU	0.1177	1.0573	-0.2513	0.4866	0.649	33	0.521
PEOU	0.1294	0.9980	-0.2188	0.4776	0.756	33	0.455
BI	0.0882	1.1641	-0.3192	0.4944	0.442	33	0.661

Table 5 shows the paired sample t-test of two age groups of students among three dimensions. The mean values of paired G1 - G2 of PU, PEOU and BI are 0.1177, 0.1294 and 0.0882 respectively. The standard deviation of paired G1 - G2 of PU, PEOU and BI are 10.573, 0.9980 and 1.1641 respectively. The t-values of PU, PEOU and BI are 0.649, 0.756 and 0.442 respectively.

Hypothesis HA tests if there is significant difference in PU among different age groups of higher education students to using Facebook private study group via the mobile device in hybrid learning. G1 has ($M = 3.3422$, $s = 0.6638$) and G2 has ($M = 3.3235$, $s = 0.9000$), $t(33) = 0.649$, $p = 0.521$, $\alpha = 0.05$. Since $\alpha \leq p$, then HA1 is rejected, i.e. there is no significant difference in PU among different age groups of higher education students to using Facebook private study group via the mobile device in hybrid learning. Hypothesis HB tests if there is significant difference in PEOU among different age groups of higher education students to using Facebook private study group via the mobile device in hybrid learning. A t-test failed to reveal a statistically reliable difference between the mean number of PEOU that G1 has ($M = 3.8176$, $s = 0.5813$) and that G2 has ($M = 3.6882$, $s = 0.9041$), $t(33) = 0.756$, $p = 0.455$, $\alpha = 0.05$. Therefore, the alternative hypothesis of HB is rejected, i.e. there is no significant difference in PEOU among different age groups of higher education students to using Facebook private study group via the mobile device in hybrid learning. Hypothesis HC tests if there is significant difference in BI among different age groups of higher education students to using Facebook private study group via the mobile device in hybrid learning. As shown from Table 5 BI, G1 has ($M = 3.2356$, $s = 0.7273$) and that G2 has ($M = 3.1474$, $s = 0.9468$), $t(33) = 0.442$, $p = 0.661$, $\alpha = 0.05$, we reject the alternative hypothesis (HC1) and conclude that there is no significant differences in BI among different age groups of higher education students to using Facebook private study group via the mobile device in hybrid learning at 5 % significant level.

5 Discussion

As indicated from the paired sample t-test results, there are no significant differences in technology acceptance among different age groups of higher education students to using Facebook private study group via the mobile device in hybrid learning. This implies the degree to which G1 and G2 students accept using Facebook private study group via the mobile device in hybrid learning is comparative. This is evidenced from the phenomenon that the advancement in Internet ICT has been transforming the daily lives of different age group [13] where social network site, for example, Facebook, is one of the daily channels for communication, information sharing and search. Social network services are not now to students in hybrid learning. Lau & Lam (2012) research study integrates social network site, Facebook and Learning Management Systems (LMS), Moodle, whereas Lam & Cheung (2013) research work makes use of social and collaborative learning technologies, i.e. Facebook and Google Drive. These indicate that higher education students have already been equipped with social networking experiences which enable them to adapt to the hybrid learning environment easily and quickly. On the other hand, even though there are researchers concerning about the student affordance issues of new technologies [4, 11], the issues can be resolved if the chosen technologies in hybrid learning is students ready. Wang et al. (2009) research study in mobile learning evidences that age difference can affect the technology acceptance [29]. However, the age difference represents a big age gap, for example, teenagers and elderly. Therefore, the factor of age difference may not be applicable to G1 and G2 students where the age difference is insignificant.

Hybrid learning using social network services and mobile technologies does not mean that LMS or other technologies are replaced. Garrison & Kanuka (2004) argues that universities have to identify their technological potential so that hybrid learning benefits can be maximized. Traditional face-to-face teaching and technology-mediated instructions are complementing each other in hybrid learning. Therefore, a good mix of technologies as mediation can help facilitating student learning success, for example, LMS as the underpinning e-learning platform and then integrate Facebook to enhance the interactivity and mobile technologies for mobile learning. Besides, there is a trend that effective hybrid learning approach does not simply rely on traditional face-to-face teaching and technology-mediation. Singh (2003) suggests Khan's Octagonal Framework for blended learning containing eight dimensions contributing to blended learning, namely, the institutional, pedagogical, technological, interface design, evaluation, management, resource support, and ethical. The rationale behind these dimensions help teachers to reflect if their designated courses can produce meaningful learning experience for student [16]. Rossett, Douglis & Frazee (2003) suggest six elements in blended learning, i.e., live face-to-face (formal), live face-to-face (informal), virtual collaboration/synchronous, virtual collaboration/asynchronous, self-paced learning and performance support [18]. Carman (2005) recommends five key ingredients for blended learning design based on learning theories of constructivism, cognitivism and performance support. The five key ingredients are live events, online content, collaboration, and assessment and reference materials [19]. In other words, wider scope of consideration is needed for developing effective hybrid learning strategies.

6 Research Limitation

There is a limitation in this research, i.e. the sample size is 68, which is not big enough for other sophisticated statistical analysis. This result is obtained by surveying students about their attitudes towards using Facebook private study group via the mobile device in hybrid learning. More feedback can be obtained if students can be invited to attend a

15-week semester course using such hybrid learning approach. On the other hand, the research findings become more representative and generalized if more students of different universities investigated. However, this research study can be improved by increasing the sample size so that more teachers and students of different programmes can participate in this research. Besides, the scope and depth of the research area should be increased. More dimensions can be included in addition to the three technology acceptance dimensions, for example, social presence [9], gender difference, computer efficacy [29], Regression analysis can be performed to identify the causal relationship among the various determinants.

7 Conclusion

Hybrid learning is a widely used by educators because it can improve learning effectiveness, increase access and convenience and is more cost effective [14]. It requires traditional face-to-face classroom and technology-mediated teaching to facilitate student learning [7]. There is no restriction on the tools and platform of the technology and is subject to the resources available from the university and also the choice of the teachers. Though there are researchers raised the acceptance issue about the technology [4, 11], it can be resolved if the technologies are widely accepted, for example, the mobile technologies and social network services. The effect of age difference is obsoleting in hybrid learning because technologies is part of people's lives [4, 11]. However, hybrid learning approach is evolving over time that is not simply a combination of traditional face-to-face classroom and technology mediation. Hybrid learning success requires the careful planning the blended approach from institutional, pedagogical, technological, interface design, evaluation, management, resource support, and ethical perspectives so that students can have meaningful learning experience for student [16].

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Pedagogical and Other Issues

Research on E-Learning Oriented Micro-Resources Organization and Generation Method

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Abstract. The organization of learning resources is an important part of an online learning system. However, the methods which we commonly use in recent years, such as organizing resources manually and single type resource bundle, cannot meet the requirements of online resources organization. We propose a micro-resources organization and generation method based on mixed resource bundle. This method contains three parts which can respectively realize the pack, analysis and layout of online learning resources. In this paper, we give the details of how these three parts are working. Then, we give an example of English micro-content resource bundle. It proves that our method can work very well in English online learning. In the next phase, we will extend our method to other subjects.

Keywords: E-learning · Resource organization · Resource bundle · Online learning system

1 Introduction

E-learning refers to a type of learning activity over computer networks. Digital learning resource in E-learning is the general name for the learning-aid resource which can be accessed by learners through network. These resources are always used to provide support for learners in a particular field [1]. How to organize these resources is an important task in learning management systems. The organization of resources refers to the process of combining all kinds of topic-related learning materials including text, image, video, audio, flash and exercise into a learning unit. All kinds of learning management systems such as special learning website, excellent network course, resource sharing course, MOOC [2] and resources management system involve the organization of learning resources [3].

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Currently, there are two kinds of organization methods for learning resources: the first method is to organize resources manually, and the second method is to organize resources through resource bundle. Organizing resources manually means during the process of the organization, the resources administrator needs to arrange these resources manually, and combine them into web pages manually. Online courses and excellent network courses are always using this kind of organization method. This kind of organization method has a high request on professional technology for resources administrator. Resources administrator should know the layout of web pages and programming language so they can arrange all materials into web pages. Once the web page is finished, it will be hard to modify the resource or their orders. The second method is the resource bundle. Resource bundle is easy to modify or migrate, and it has a relatively low request for resource administrator on professional technology [4]. So resource bundle can greatly reduce the difficulty of learning resources organization and improve the efficiency [5]. However, the common resource bundle uses XML to describe the metadata of the resources, and it can only be used to organize the single media type resources. This kind of resource bundle can not organize different media types of materials into one package, and cannot automatically generate navigation for users.

In this paper, we first analyze the characteristics and requirements of learning resources organization in e-learning. Based on it, we propose a compounded learning resources organization method based on the resource bundle. This method is a new-style learning resources organization method. It contains the organization, analysis and display of the resources. It can generate navigation for users and improve the organizational efficiency of learning resources. At last, we give an English micro-content organization example which uses the method we proposed in order to prove its effectiveness.

2 The Characteristics and Requirements of Resources Organization in E-Learning

Online learning systems emerge in endlessly recently. However, these systems have some deficiencies more or less. For example, a micro-unit only has a single type of resource such as video, audio or text. There are few correlations between learning units and learners cannot form an overall structure of the domain knowledge [6]. The learning systems cannot give feedback to learners in time which will lower the interest in learning. Aimed at these dificiencies, we conclude the characteristics and requirements of learning resources organizations as follows:

1. Miniaturization [7]. With the development of mobile terminals, more and more people including both students and adults use mobile devices to learn knowledge in their fragmented time. Due to the learning time is not fixed and the learners' attention can only focus for a short time, the organization of learning resources has an obvious trend of miniaturization. Related concepts such as micro-lecture, micro-content and micro-video are typical examples of Miniaturization.

2. Structurization [8]. Though the basic unit of resource organization shows the characteristic of miniaturization, the global organization of resources should have an overall structure. Learners expect the learning content to be gradual, interrelated, rather than fragmented and chaotic. This can help learners to form the overall knowledge structure in certain fields, which can improve the learning efficiency.
3. Multimedia. With the increase of processing capacity of PC and mobile terminals, multimedia in learning resources have already become a common phenomenon. Especially in language learning, different kinds of multimedia materials such as image, audio, video and animation will be used in E-learning. Sometimes, synchronization is needed between these different kinds of materials.
4. Intelligence [9]. In e-learning, the participation of teachers is relatively less, and learners' autonomous learning is more, so it requires that the organization of learning resources should be intelligent. This means learning resources should have intelligent functions such as strong interactivity, timely feedback, appropriate prompt and so on [10]. These intelligent functions can ensure that learners are able to complete the learning content independently in the learning process. When learners have errors or difficulties, they can get timely feedback and adjust their learning process based on the prompting message.

3 The Method of Content Organization and Generation Based on Resource Bundle

3.1 The Basic Principle of Content Organization and Generation

Based on the above-mentioned characteristics and requirements, we put forward a learning content organization and generation method. This method is based on the resource bundle. It can make up the deficiencies in single media type of the resource bundle, automatically generate navigation of learning contents for learners and improve the organizational efficiency of the online learning resources. The basic principle of this method is shown in Fig. 1.

There are three core components used in this method: resources wrapper, resources analyzer and resources choreographer. The operating process is as follows: First, with the help of the resources wrapper, administrator can organize all the learning materials

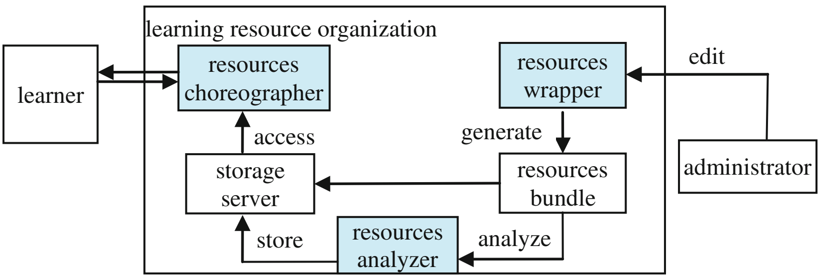


Fig. 1. The basic principle of micro-content organization and generation

in a special way and compress them into a micro-content resource bundle. Then administrator can upload this resource bundle to the online learning system. Resources analyzer will analyze this resource bundle and then store the information and entity files into the storage server of the online learning system. At last, according to learners' request, resources choreographer will generate the navigation, arrange corresponding learning resources and display them to learners. In the following sections, we will introduce the specific working principle of resources wrapper, resources analyzer and resources choreographer.

3.2 The Operation Principle of Resources Wrapper

The main function of resources wrapper is to organize all kinds of learning resources, and pack them into a micro-learning resource bundle. The basic structure of the micro-learning resource bundle is shown in Fig. 2. A micro-learning resource bundle mainly includes the following components: metadata information, resource display order information, resource organization and description information and different types of resource entity files (such as voice, video, photo, cartoon, webpage, exercises and so on). Resources wrapper can organize all these above-mentioned information and files, and then pack them into a compressed file of zip format.

The working process of resources wrapper is as follows:

(1) The administrator needs to input the metadata information of resources in resources wrapper. These metadata information include the producer of the bundle, creating time, course number, course name, costs information etc.
(2) The administrator needs to assign the display order information of the resources. A micro-content will be divided into several knowledge points. Each knowledge point is a learning column. These learning columns should be assigned the following information: display order, column name, the type of the column and the organization file of the column. Organization file is used to organize all the learning materials in each column. The format of display order information is given in Table 1.

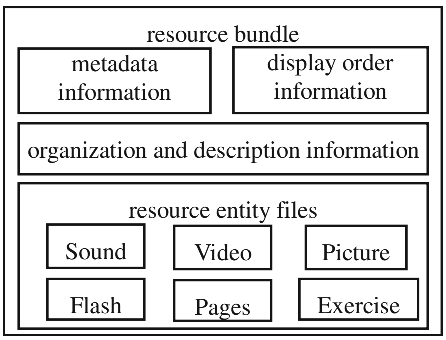


Fig. 2. Structure of the micro-learning resource bundle

Table 1. Display order inforamtion of the resources

Display order	Column name	Column type	Organization file
1	Preparation	1	1.xls
2	Part 1	4	2.xls
3	Part 2	4	3.xls
4	Exercise	6	4.xls*5#5.xls*2

(3) The administrator needs to assign all the learning content and materials for each column, and then organize them according to its column type. After the analysis of the common learning style in e-learning, we define six column types to realize the organization of complicated learning contents which contain multiple types of metrials. These six column types are: text or text with a single media file, vocabulary learning, web page, multiple types of media materials(such as text, image, audio, video, animation) which are synchronous, exercises, and mixed type of the ahead five types. We define an organizational template for each column type. Organization templates use a table to organize the materials. We can use microsoft excel software to edit the organization templates. Different template uses different description properties to organize resources. Table 2 shows the property lists of different templates.

In Fig. 2, exercises type has a property of question type. We define a data dictionary for the question type. The meaning of each question type value and its organization mode is shown in Table 3.

(4) The administrator needs to put all the resource entity files into the corresponding folder. The metadata information file, resource display order information file, resource organization and description information file and different types of resource entity files are all packaged into a compressed file as an independent micro-content resource bundle.

Table 2. The property list of different templates

Type ID	Column type	Properties
1	text or text with a single media file	ID, text ib Chinese, text in English, audio file, video file, animation, analysis
2	vocabulary learning	ID, word, soundmark, paraphrase, audio, image, animation
3	web page	ID, page location
4	mutiple types of media metrials which are synchronous	ID, text ib Chinese, text in English,image, audio, video, beginning time, analysis
5	exercises	ID, question, options, question type, answer, analysis, image, audio, animation, video
6	mixed type	It is a mix of the above five types. Each type is seperated by “#”.

Table 3. The data dictionary of question type for exercises

Question type ID	Question type	Organization mode
1	single choice	"#" is used to seperate the options, use radiobutton to display the question
2	multiple choice	"#" is used to seperate the options, use checkbox to display the question
3	fill in the blanks (single line)	the "options" property is blank, and the blanks which need the user to fill are instead by "#" in "question" property. Use textbox to display the question
4	Essays(multiple line)	Use textarea to display the question
5	ture of false	the answer can only be ture or false. Use radiobutton to display the question
6	static text	no specila handling

3.3 The Operation Principle of Resources Analyzer

The operation principle of resources analyzer is as follows:

(1) Resources Analyzer will unzip the resource bundle. The file in this resource bundle should include: metadata information file, resource display order information file, resource organization and description information file and different types of resource entity files.
(2) Then the resources analyzer parses the metadata information file, and stores all the metadata information into database. Among all the properties, course number is saved as a primary key. It will be used to generate the navigation and associate with other contents.
(3) The resources analyzer parses the resource display order information file and store the sequence information into database. This sequence information can determine the display order of columns and it also can be used as the inner navigation of the resource bundle. Course number can be used as a foreign key to associate the columns for the course.
(4) The resources analyzer will parse the resource organization and description information file of each column. According to the column types defined in Table 2, resources analyzer parses the resource organization and description information files, and store the information into different tables in the database respectively. Column number can be used as a foreign key to associate the column with the resources. All the entity files will be uploaded to the storage server. The display time of each resource and the synchronization information is stored in the database for the arrangement of the resources. By this time, the analysis of the resource bundle is finished. All the information and resource entity files are stored in the storage server.

3.4 The Operation Principle of Resources Choreographer

The main function of resources choreographer is getting the corresponding information and resources from the database and storage server, and presenting them to users according to learners' request. Its basic operation principle is as follows:

(1) The resource choreographer will get the metadata information and display order information from the database according to the course number in learners' request.
(2) According to the display order, resource choreographer get the resource organizaiton files successively. Then according to the six types listed in Table 2, resource choreographer defines different show templates for different column types. The resources in each column will be displayed according to its corresponding show template. All kinds of show templates should provide learning support functions such as analysis, revise, redo, etc. Figure 3. is the structural representation of resource show template. In this figure, the learning content area is used to exhibit the learning materials in the resource bundle, such as: text, image, audio, video, etc.

4 The Application Example of English Micro-Content

4.1 The Organization Structure of the English Micro-Content Resource Bundle

In order to test the effectiveness of our micro-resources organization and generation method, we design an online English learning system for basic education. In this system, we use our method proposed in this paper to organize the English learning resources. Figure 4 shows the basic structure of a resource bundle designed for an English learning unit.

In this resource bundle, the "baseinfo.xls" file is the metadata information file. The "subjectinfo.xls" file is the resource display order information file. "Listen and talk.xls" file is a resource organization file. Folders "exercise", "flash", "images", "pages",

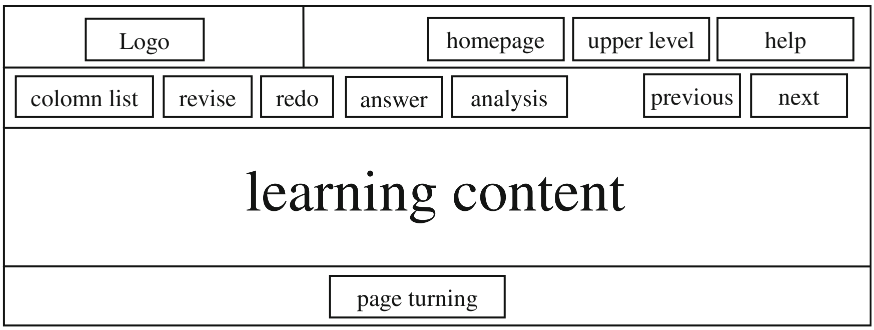


Fig. 3. Structural representation of resource show template

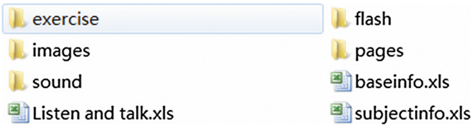
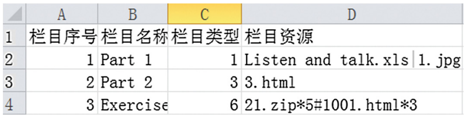


Fig. 4. Basic structure of micro-content English learning resource bundle



	A	B	C	D
1	栏目序号	栏目名称	栏目类型	栏目资源
2	1	Part 1	1	Listen and talk.xls|1.jpg
3	2	Part 2	3	3.html
4	3	Exercise	6	21.zip*5#1001.html*3

Fig. 5. Example of resource display order information

"sound" are used to store different kinds of entity files. Figure 5 shows the main content of "subjectinfo.xls".

In Fig. 5, there are 3 columns: the first column is Part 1. Its type is text with a single media file. Its organization file is "Listen and talk.xls". The second column is Part 2. Its type is web page. The entity file is "3.html". The third column is Exercise. Its type is mixed type nad it contains two parts. The first part is exercises and its content is saved in "21.zip". The second part is a static web page and its entity file is "1001.html".

4.2 The Effect of Resource Layout

In the online learning system, we realize the mobile terminal-oriented resource arrangement and display. Figure 6 shows the final effect of text and exercises resources on mobile phone terminals.

Fig. 6. The effect of resource layout

5 Conclusion

Content organization and generation is an important part of online system. In this paper, we first analyze the characteristics and requirements of digital learning content organization in E-learning. Then aiming at these requirements, we propose a learning content organization and generation method based on the resource bundle. This method mainly includes three parts: resource wrapper, resource analyzer and resource choreographer. With the help of these three parts, we can realize the organization of different kinds of learning resources. At last, to verify the effectiveness of the method proposed in this paper, we give an example of english micro-content resource bundle. It proves that our method can realize the online English resource organization and display. In the following study, we will focus on how to apply our method in other fields of online learning.

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Districts Performance Evaluation of Informatization of Basic Education Based on DEA

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Abstract. In the field of educational informatization, the imbalance between the inputs on infrastructure and the outputs on application has caused wide concern. One of the approaches to solving the problem is to change the orientation of the performance evaluation of educational informatization. Based on Data Envelopment Analysis (DEA), this paper implements a basic educational informatization performance evaluation from both the inputs and the outputs perspective. The key factors accounting for the underperformance of some districts of Suzhou lie in the under-investment, the insufficient training programs and the shortage of time that students use computers. These districts should increase the spending on educational informatization and the number of training programs, and extend the length of time that students use computers.

Keywords: Data envelopment analysis · Basic education · Educational informatization · Performance evaluation

1 Introduction

Suzhou city lies in the east of China with a higher level of overall development. Although it is among the best regarding to the main indicators of educational informatization, the development degrees of its different districts are still different. Generally, the degree of information sharing and utilizing is at low level, and the informatization is usually designed for school management and teaching process rather than the projects for cultivating students' ability [1, 2]. In order to evaluate the level of the basic educational informatization of Suzhou, this research conducts a survey into the status of the development and application in the districts of Suzhou city to discover the problems and give specific suggestions.

DEA is used as a tool to implement the performance evaluation of basic educational informatization of the districts in Suzhou. The value of DEA approach lies in its capacity to relatively evaluate the individual efficiency or performance of a Decision Making Unit (DMU) within a target group of interest that operates in a certain application domain [3, 4]. From the perspective of DEA, the districts of Suzhou are conceived as the production units with multiple inputs and multiple outputs. One of the

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advantages of utilizing DEA is that it is not necessary to determine the weights of each indicator beforehand, and the efficiency value derived from the analysis is relative to other similar departments or units with the same input and output indicators. Therefore DEA has been widely used in the performance evaluation for the public service sectors such as sectors in the banking industry, health care industry, agriculture industry, transportations, education etc. The nature of DEA is adapted to variety of requirements, as Golany and Roll point, including identifying the unsatisfactory or inferior DMUs, ranking the DMUs, evaluating the effectiveness of projects, presenting a quantitative basis for reallocating resources, etc. [5].

DEA was applied to evaluate the efficiency of a large-scale social experiment in public school education by the originator Charnes himself. In 1983 there were already four important DEA educational researches: Charns et al. [6], Bessent A.M. and Bessent E.W. [7–9], which are very influencial even in today's researches on the field of education evaluation. Because the nature of DEA satisfies the requirements of the research on performance evaluation of basic educational informatization of Suzhou, which pays attention to the distinction between different districts, this paper applies DEA to implement the procedure of performance evaluation. From the perspective of DEA, the districts of Suzhou are considered as the DMUs with multiple inputs and multiple outputs. The result of DEA draws the conclusion of the key factors accounting for the inefficiency of districts and the directions and target values of improvement. This research provide the government with specific suggestions for the policy making of the education departments at both the city level and the district level, which contributes to both of the overall improvement of educational informatization of Suzhou and the balanced development of educational informatization of its districts.

This article is organized as follows. In Sect. 2 the nature and basic concepts of DEA are described, and the procedure of measuring each DMU's efficiency through this method is explained. Section 3 narrates the construction of DEA model for the performance evaluation of basic educational informatization with Suzhou as an example. The rules for selecting indicators and data, and the type of DEA model are described. The efficiency value distributions derived from DEA are displayed in the tables in Sect. 4. The key factors accounting for the inefficiency of the basic educational informatization of some districts are recognized and the directions and target value of improvement are presented. In Sect. 5 this paper explores the general overall reason for the inefficiency of the educational informatization in Suzhou and gives specific suggestions to corresponding inefficiency districts according to the displayed results. Section 6 summarizes the main work of this research, and puts forward the future follow-up studies on the application of the improved DEA model for performance evaluation of educational informatization.

2 Data Envelopment Analysis

This chapter describes the basic concepts of DEA and the DEA model this research selects.

2.1 Basic Concepts of DEA

Data envelopment analysis was originally developed by Charnes A. et al. in 1978 [10]. Based on the concept of relative efficiency, DEA evaluates the relative efficiency through programming model for each member of a set of peer DMUs with multiple inputs and multiple outputs. DEA produces measures of DMUs' relative efficiencies by deriving a frontier production function and measuring the distances of observations to the frontier to get their efficiency scores.

2.2 DEA Models

Assuming that there exist n DMUs, and each DMU has m types of inputs and q types of outputs. The variables $x_i(i = 1, 2, \cdots, m)$ and $y_r(r = 1, 2, \cdots, q)$ represent m types of input and q types of output, respectively. The following CCR model and BCC model are the initial models based on the programing model named after their originators.

The following CCR model is developed in the input orientation, and its form is as formula (1).

$$\begin{aligned}
&\min\theta \\
&s.t.\ \sum_{j=1}^{n} \lambda_j x_{ij} \le \theta x_{ik} \\
&\quad \sum_{j=1}^{n} \lambda_j y_{rj} \ge y_{rk} \\
&\quad \lambda \ge 0; \\
&\quad i = 1, 2, \cdots, m; r = 1, 2, \cdots, q; j = 1, 2, \cdots, n
\end{aligned} \tag{1}$$

BCC model is developed on the basis of the original CCR model and is used to study technical efficiencies between production sectors [11]. The model was proposed by Banker et al. in1984. It is defined in formula (2).

$$\begin{aligned}
&\min\theta - \varepsilon(s^- + s^+) \\
&s.t.\ \sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = \theta x_{ik} \\
&\quad \sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{rk} \\
&\quad \sum_{j=1}^{n} \lambda_j = 1 \\
&\quad \lambda \ge 0; s^- \ge 0; s^+ \ge 0; \\
&\quad i = 1, 2, \cdots, m; r = 1, 2, \cdots, q; j = 1, 2, \cdots, n
\end{aligned} \tag{2}$$

In the formula (1), s_r^+ and s_i^- are slack variables, ε is non-Archimedean infinitesimal that is generally set as 10^{-6} in practice. λ_j is a variable that relates the efficient DMUs to form an efficient frontier. The excess variable s_i^- and insufficient variable s_r^+ are non-zero slack variables, making effective frontiers expand in horizontal or vertical directions to form the envelope. The optimal solutions of the above BCC model include θ^*,

λ^*, s^{-*}, s^{+*}. The optimal solution of variable θ belongs to $(0, 1]$ which is the pure technology efficiency score of the DMU. λ^* is the linear combination coefficient. s^{-*} and s^{+*} refer to the improvement value of the evaluated DMU. The comprehensive technology efficiency of each DMU is generated from the optimal solutions of CCR model of DEA, and the scale efficiency of each DMU can be derived from the ratio of the comprehensive technology efficiency of CCR model and BCC model.

3 DEA Based Modeling of Performance Evaluation

Since the samples are non-profit public service sectors with multiple outputs and multiple inputs, the performance evaluation for them is naturally uncertain and complex. The characteristics of DEA offer a solution for the performance evaluation of samples with multiple outputs and inputs [12].

3.1 Selecting Indicators

Proper indicators are vital for measuring the level of educational informatization of each district in Suzhou. This research selects the following 5 categories of indicators, infrastructure development indicators, digital resource development indicators, application and service development indicators, application and efficiency indicators and mechanism of guarantee indicators, which constitutes the first level of indicator system of district educational informatization evaluation. First level indicators consist of 19 s level indicators and second level indicators consist of 29 third level indicators. Taking the numerical relation between the number of DMUs and the number of indicators into consideration, there should be no more than 5 input and output indicators, as there are 11 districts in the samples set.

In this paper the indicators are selected by the following 4 rules.

A. The selected indicators should cover all of the main directions of informatization development of basic education. According to the educational informatization developing characteristics of Suzhou city, 3 points of view are determined to evaluate the inputs, which refer to financial resource, manpower and material resource; the aspects of resource sharing and student-oriented service are determined to evaluate the outputs.
B. The numerical values of indicator variables should be obviously different between different DMUs to reflect the difference between districts. The numerical values of indicator variables which have bad effects on calculation results should be eliminated to meet the requirements of DEA programming model, e.g. the indicators whose numerical values contains zero.
C. The details reflected by the selected indicators should be manageable for schools and government education sectors. The value of the selected indicators should not be affected by the uncontrolled powers or irresistible facts. They should belong to the normal administration of the schools or the government education departments.
D. The natural relation between input indicators and output indicators should be fulfilled. The input status of educational informatization of a district reflected by the

selected input indicators can generate the application result reflected by the selected output indicators, and at the same time the application status reflected by the selected output indicators are caused by the input situation reflected by the selected inputs indicators.

Taking the above 4 rules into consideration, with repeated siftings this research selected 3 input indicators and 2 output indicators reflecting the level of educational informatization of a certain district. The input indicators include the average value of proportions of informatization expenditure to the total expenditure of each school, the number of terminals owned by every 100 students and the proportion of schools which have training programs at regular intervals to all schools in that district. The input indicator variables are labeled successively as Input1, Input2 and Input3. The output indicators include the proportion of schools which have open course resources to all schools in a district and the average length of time that each student spends on computers per week. The output indicator variables are labeled successively as Output1 and Output2.

3.2 Data Collection

According to the development index of educational informatization, combining with the research accomplishment on evaluation of informatization of basic education all over the world, the survey group drew up a questionnaire and investigated into the informatization of basic education of 485 schools spreading across all the districts of Suzhou city in June, 2014. Table 1 shows the number of schools involved in each district in this survey.

Table 1. Number of schools surveyed in each district of Suzhou city

Districts	A	B	C	D	E	F	G	H	I	J	K
Number	68	24	28	48	59	22	42	57	43	27	67

The questionnaire was released on the Internet, and the investigated schools are required to download and fulfil the questionnaire. The feedback was emailed to the survey group, and the data was collected and collated. The effective rate of the feedback is up to 100 %. There are 282 out of 334 primary schools and 203 out of 256 middle schools that participating in the survey and the sampling rates are up to 84 % and 79 % respectively. As the school coverage is high enough, the data collected from the feedback of the questionnaires can reflect the actual development status of informatization of basic education in Suzhou.

The development states of the informatization of basic education of districts of Suzhou city are shown in Table 2. This research evaluates the performance of informatization of basic education through DEA approach with the statistic data derived from the questionnaires as samples.

Table 2. Development status of the informatization of basic education in Suzhou city

DMUs	Input1	Input2	Input3	Output1	Output2
A	0.14	0.13	0.35	0.68	2.17
B	0.15	0.10	0.63	0.58	4.25
C	0.26	0.15	0.76	0.66	2.47
D	0.17	0.11	0.63	0.73	4.03
E	0.20	0.11	0.79	0.69	3.21
F	0.17	0.13	0.42	0.67	1.35
G	0.17	0.14	0.67	0.79	1.34
H	0.16	0.13	0.52	0.50	3.60
I	0.11	0.14	0.48	0.80	2.32
J	0.13	0.10	0.57	0.43	1.42
K	0.12	0.14	0.41	0.60	2.44

3.3 Selecting the Model of DEA

A. Selecting the Type of Returns-to-Scale State of the DEA Model. CCR model assumes the DMUs are in the state of constant returns-to-scale. In fact, the majority of DMUs are not in the state of constant returns-to-scale; as a result, the comprehensive technology efficiency derived from the CCR model includes the concept of scale efficiency. BCC model is presented to solve the pure technology efficiency of DMUs in the various states of returns-to-scale, and at the same time BCC model offers a way to solve the scale efficiency. The scale efficiency value can be obtained by calculating the ratio of the efficiency value of DMUs in various returns-to-scale and the value of DMUs in the constant returns-to-scale.

Generally speaking, the returns-to-scale go through the states of increasing, constant and decreasing in a certain procedure. If the states of the samples are uncertain or the samples spread over the different states, the model type of various returns-to-scale (VRS) should be selected. Since the degrees of basic educational informatization developments of different districts in Suzhou city are different, the states of returns-to-scale of different districts are uncertain. Therefore the VRS model is selected in this research.

B. Selecting the Orientation of the DEA Model. The orientations of DEA models include input-oriented, output-oriented and non-oriented regarding to different observation approaches. The input-oriented model measures the relative efficiencies of DMUs from the input perspective, which concerns the reduction of inefficient DMUs should make to achieve efficiency without cutting down the output; the out-oriented model, from the output perspective, concerns the increase should make to achieve efficiency without extending the input scale; the non-oriented model measures the DMUs from both input and the output perspective.

As both of the input and output are of great importance to the educational informatization, the non-oriented DEA model which regards for both the input and output perspective is the well-balanced and proper choice. This research uses the non-oriented DEA model to implement the performance evaluation [13].

4 Results

After the construction of proper DEA model, a specialized software MaxDEA is applied to get the optimal solutions of the selected DEA programming. The results are displayed in Tables 3 and 4. Table 3 contains comprehensive technology efficiency (TE), pure technology efficiency (PTE), scale efficiency (SE) and returns-to-scale (SR) of all DMUs. Table 4 contains slack movement(S), proportionate movement (P) and target value (T) of the inefficient DMUs.

Table 3. The efficiencies and returns-to-scale of each district of Suzhou city (non-orientation)

DMUs	TE	PTE	SE	SR
A	1	1	1	–
B	1	1	1	–
C	0.68	0.70	0.96	Decreasing
D	1	1	1	–
E	0.94	0.95	0.98	Increasing
F	0.92	0.94	0.98	Increasing
G	0.93	0.99	0.94	Decreasing
H	1	1	1	–
I	1	1	1	–
J	0.67	1	0.67	Increasing
K	0.99	1	0.99	Increasing

The results displayed below represent the main characteristics of the DEA method, which includes identifying the inefficiency DMUs, ranking the DMUs, evaluating the effectiveness of projects, presenting a quantitative basis for reallocating resources, et al. [14, 15]. Table 3 shows the inefficient DMUs, and the rank of DMUs can be obtained by ordering the relative efficiency values of each DMU. Also, Table 3 displays the scale efficiency values and states of returns-to-scale of each DMU, which reflects the production scale of the DMUs. The result displayed in Table 4 shows the deficiencies of the inefficiency districts and lists the reason for the gaps between the inefficient districts and efficient districts. Table 4 shows the directions and target values of reallocating resources from the perspective of quantitative basis.

Table 3 shows the comprehensive technology efficiency values, the pure technology efficiency values, the scale efficiency values and the states of returns-to-scale of the districts of Suzhou, in which the scale efficiency is the ratio of comprehensive technology efficiency and the pure technology efficiency, and the state of returns-to-scale is determined by the value of returns-to-scale and the sum of the linear combination coefficients.

The technology efficient values of the efficient DMUs achieve 100 percent or 1, while those of the inefficient DMUs are merely between zero and one. The achievement of efficiency regarding to comprehensive technology efficiency is in accordance with the state of returns-to-scale.

Table 4. The improvement values and target vales of inefficient DMUs (non-orientation)

DMUs		C	E	F	G
PTE		0.70	0.95	0.94	0.99
Input	P(Input1)	-0.05	0.00	-0.01	0.00
	S(Input1)	-0.08	-0.03	-0.02	-0.05
	T(Input1)	0.14	0.17	0.15	0.12
	P(Input2)	-0.03	0.00	0.00	0.00
	S(Input2)	0.00	0.00	0.00	0.00
	T(Input2)	0.13	0.11	0.12	0.13
	P(Input3)	-0.13	-0.02	-0.01	0.00
	S(Input3)	-0.08	-0.14	0.00	-0.17
	T(Input3)	0.54	0.63	0.40	0.49
Output	P(Output1)	0.11	0.02	0.02	0.00
	S(Output1)	0.00	0.00	0.00	0.00
	T(Output1)	0.77	0.70	0.69	0.79
	P(Output2)	0.43	0.07	0.04	0.01
	S(Output2)	0.13	0.79	1.16	1.14
	T(Output2)	3.04	4.07	2.55	2.49

Table 4 shows the directions and target values of improvement for the inefficient districts C, E, F and G derived from the non-oriented DEA model from both the input and the output perspective. The proportionate movement value and the slack movement value of each district are listed, and the corresponding target value is derived by adding or reducing the movement values from the initial data of each district.

The results displayed in the horizontal direction show the general redundancies or deficiencies of the indicators all over Suzhou city, and at the same time each difference between districts can be observed clearly. In the vertical direction, the specific reasons aiming at a certain DMU are listed as the movement values, and the calculation results of the DEA model gives the target values that a certain DMU should hold to achieve the state of efficiency.

5 Analysis and Suggestions

There are five districts of A, B, D, H and I in all of the eleven districts which participate in the research achieving the efficiency and the constant returns-to-scale status. These districts reach balance between the developing inputs and application outputs. The districts of E, F, J and K are in the increasing returns-to-scale status which means shortage of inputs, and they should expand the global developing inputs scale to achieve efficiency. The districts of C and G are in the decreasing returns-to-scale status which means these districts should adjust the global input resource structure and move the redundancy of some projects into other deficient projects to increase the efficiency value of these districts.

The directions and target values of improvement for inefficient DMUs are generated through the DEA model. Implementing the comprehensive analysis in both the horizontal and the vertical way contributes to an overall understanding of the result and the design of improvement measures [16]. This paper implements a comprehensive analysis on the result as follows.

This research makes a horizontal analysis between the different districts as follows. From the input perspective, the main reasons for the inefficiency of the investment in the informatization of basic education of some districts lie in the indicator of Input1, the average value of proportions of informatization expenditure to the total expenditure of each school, and the indicator of Input3, the proportion of schools which have training programs at regular intervals to all schools in a district. The values of the indicator of Input2, the number of terminals owned by every 100 students of the inefficient districts, are approximate to that of the efficient districts. The result shows that the inefficient districts should adjust the investment structure to increase the operation rate of regular trainings and the expenditure. From the output perspective, the main reason for the inefficiency of these districts is the shortage of the average length of time each student spends on computers per week. The value of another indicator, the proportion of schools which have open course resources to all schools in a district, is very close to that of the efficient districts. Therefore the inefficient districts should lay emphasis on extending the length of time that students spend on computers to increase the informatization facilities usage rate for students.

This research makes vertical analysis to each inefficient district respectively as follows. The district of C has the minimum relative efficiency value, and every indicator, especially the indicator of the average value of proportions of informatization expenditure to the total expenditure of each school, should be adjusted to achieve efficiency. This district should pay more attention to the input and increase the operation rate of the expenditure. The district of G has the maximum relative efficiency value and the direction of adjustment is in accordance with the trend of all the inefficient districts, which means district G should increase the operation rate of regular trainings and expenditure of informatization, and the length of time that students spend on computers per week should be extended. The districts of E and F have relative efficiency values between C's and G's and are close to G, and the efficiency value of district E is slightly larger than that of district F. District E should pay more attention to the application output which means extending the length of time that students spend on computers per week and increasing the operation rate of regular training. From the output perspective, district F should pay attention to the application output in aspect of length of time that students spend on computers in a similar way with district E, while from the view of input, district F should implement strict management control on the ratio of informatization expenditure optimize the investment structure to increase the operation rate of the expenditure.

6 Conclusion

The result of this research shows that the weak spots between each district in terms of informatization of basic education lie in different indicators, and the key factors accounting for the general underperformance of some districts of Suzhou lie in the underinvestment, the insufficient training and the shortage of time that students use computers. The informatization of basic education should optimize the composition of investment and give full play to the resources to obtain the optimum efficient. Since the presented DEA model has not been developed maturely, there are still limitations of this model. There are several efficient DMUs in the results of the application of the proposed DEA model for the performance evaluation of basic educational informatization of different districts in Suzhou. These efficient DMUs should be also analyzed and compared with each other by the presented DEA model [17]. In the future, some more advanced DEA models such as super efficiency model [18] will be applied to rank the efficient DMUs in this research.

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The Comparative Analysis of Teachers' Inclinations to Problem Enriched Instruction Based on Item Response Theory

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Abstract. With the focus on schools in two districts in Beijing (district D where teachers experienced 1-year's blended learning, and district F where teachers did not), we analyzed the videos to record teachers' behaviors of questioning, and then measured instructional inclinations of novice, qualified, and experienced teachers from two districts in elementary and secondary school based on item response theory. After comparative analysis, corresponding suggestions on school-based training were made to two districts: (1) Teachers in district D have higher capacities of giving problem enriched instruction than the other district as a whole, it inferred that the blended learning has brought significant changes in teaching behavior; (2) In district D, teachers in elementary school, experienced and qualified teachers should be provided with more support and help; for three types of teachers in secondary school, their practical knowledge should be enriched as a whole; for teachers in elementary school, more attention should be paid to novice teachers; for teachers in secondary school, more delicate support should be provided for qualified and novice teachers for their professional development; (3) Based on item response theory, a new paradigm composed of classroom observation, analysis and diagnosis, may provide a new perspective and paradigm for school-based training.

Keywords: Teacher training · School-based training · Problem enriched instruction · Item response theory

1 Introduction

More than two thousand years ago, Socrates' maieutic maintains that teachers' questioning in an instruction is very important. As theories and practices update, teachers' modes of problem enriched instruction (PEI) in classes have been well developed, and even been regarded as an effective way to promote students' creation [1]. According to research, teachers' well-designed questions can trigger students' exploratory thinking and excite their interest to learn [2]. As a crucial part for teachers to design instructions, the content and quality of their questions can directly affect students' understanding and responses [3]. According to Brown's [4] research, observing and measuring teachers' questioning in classes is an important step to promote teachers' professional learning and development. Until now, there have been two major matrices to observe

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teachers' questioning by using classroom observation methods and technologies: (1) according to McCarthy's 4MAT model, observe four types of questions [5], which contains "what", "why", "how" and "if"; (2) according to Prof. Wang's observation method on effective questions (OMEQ) in classes, five types of questions "regular administrative questions", "memory questions", "deductive questions", "creative questions" and "critical questions" also can be observed [6].

This study is to deduct teachers' inclinations on questions by analyzing their questions gathered through observation, which can provide data and theoretical support for helping teachers improve their questioning strategies in classes, promote their professional learning and development, and conduct area-targeted, school-based trainings.

2 Literature Review

2.1 PEI

Gagne points out that, the crucial goal of education is to teach learners how to think, and then use rational thinking to solve problems. Thus, as the basic unit of modern curriculum, "questions" that teachers ask in classes should be seriously studied [7]. This study counted and analyzed data from PEI's two perspectives, which have eight dimensions in total. On PEI's first perspective, authors used 4MAT model to measure teachers' questionings in classes. 4MAT model includes four metrical dimensions, and focuses more on questions' rational structure [8].

McCarthy maintains that rising questions "what" can encourage students to focus more on specific "concept" questions, and improve their memories; questions "why" can help students pay more attention to "meaning" questions, and thus encourage their deductive thinking; questions "how" can contribute to students' more focusing on applications, and cultivate their deductive thinking that along with questions "why"; questions "if" can trigger students' more focusing on creative questions, and cultivate their critical & creative thinking [9]. By comparing 4MAT model's four dimensions with OMEQ's, which are "memory questions", "deductive questions", "creative questions" and "critical questions", it can be inferred that questions "what" and "memory questions" can both reflect that teachers are more inclined to basic knowledge and skills, as well as close-ended rather than open-ended questions; questions "how", "why" and "deductive" show that teachers are more focusing on cultivating students' abilities and thinking to solve problems; questions "if", "creative questions" and "critical questions" reflect that teachers pay more attention to students' creative abilities.

2.2 IRT

IRT is a modern pedagogical and psychological test theory, that test is all based on items. Items include normal factors and subdomains that researchers analyze [10]. This study defined eight test dimensions mentioned above as items. One of IRT's important theories is predicting someone's potential characteristics by testing his/her responses to several items. In this study, authors used IRT and its analyzing methods to predict teachers' inclinations when rising questions in classes [11]. IRT has three assumptions: (1) unidimensional, an item denotes a unidimensional trait; (2) local independence of items; (3) the response of a person to an item can be modeled by a mathematical item response function, which characterizes the relation between a latent variable (i.e., individual differences on a construct) and the probability of endorsing an item, and it can fit in an item characteristic curve [12]. The items are scored binary, either incorrect or correct, "0" or "1". In this study, authors compare each teacher's response to each item with mean value, and score "1" when it's above mean value, "0" when not.

IRT is a mathematical model based on the relation between examinee's instructional inclination and the probability of his/her correct response to an item. Thus, IRT is a mathematical model based on the assumption that a teacher's instructional inclination can be quantitatively predicted from the model. Normally, since Logistic model has been confirmed by psychological modeling method, Logistic model has been widely used in IRT [13].

Logistic model includes 1-, 2- and 3-parameter model. Among them, 1-parameter model is also called Rasch model, which only includes item difficulty parameter; 2-parameter model includes difficultly and discrimination parameters; 3-parameter model includes asymptote, difficultly and discrimination parameters [14]. According to Akaike Information Criterion (AIC) [15], and Bayesian Information Criterion (BIC) [16], we selected the simplest model with fewest parameter. After the model is decided, it is possible to predict each teacher's instructional inclinations.

3 Data Analysis

3.1 Data Selection and Explanations

The study selected 36 classes from 36 teachers in Beijing's district D and F, that is 72 classes (38 elementary classes and 34 secondary classes; district D' teachers experienced 1year's blended learning, while district F's teachers did not) as samples. Authors classified these classes into 8 categories, which are "what", "why", "how", "if", "memory questions", "deductive questions", "creative questions" and "critical questions", and then used 0-1 scale to assign value to each teacher on each dimension. According to McCarthy's description about the type of questions teacher ask and students' related abilities, the following assumptions were made: (1) questions "what" and "memory questions" reflects that teachers' instructional inclination is open-ended, (2) questions "how", "why" and "deductive questions" reflect that teachers' instructional inclination is problem-solving, (3) questions "if", "creative questions" and "critical questions" reflect that their instructional inclination is critical and creative. According to IRT, when the corresponding item characteristic curve shows S shape, it means that IRT can be used to measure and predict examinees' instructional inclinations. After analyzing 72 classes, the result is shown as follows:

0 in Table 1 means the ratio of teachers who got score 0, and 1 means the ratio of teachers who got score 1, and logit means the relation between the events of getting score 0 and 1. Larger the logit, closer the relation. If logit < 0, the relation is weak.

Table 1. Ratios of 72 teachers' 0-1 scoring data

	0	1	Logit
Memory Questions	0.5278	0.4722	-0.1112
Deductive Questions	0.5278	0.4722	-0.1112
Creative Questions	0.6111	0.3889	-0.4520
Critical Questions	0.7361	0.2639	-1.0259
Questions "what"	0.5139	0.4861	-0.0556
Questions "why"	0.4722	0.5278	0.1112
Questions "how"	0.5417	0.4583	-0.1671
Questions "if"	0.6389	0.3611	-0.5705

(logit = ratio of value 0's occurrence probability/ratio of value 1's occurrence probability)

3.2 Model Selection

To ensure the scientificity of item response model's selection, the study adopted AIC and BIC to test model's parameters. Taking the statistical results calculated from questions "what" and "memory questions" as data source, and import into SPSS to calculate three models' AIC and BIC values, which is shown in Table 2.

Table 2. Analysis of models evaluating teachers' questions' openness

Model	AIC	BIC
1-parameter model	304.2841	309.6484
2-parameter model	302.3116	307.0401
3-parameter model	308.3116	321.7222

According to AIC and BIC values in Table 2, to reduce analytic errors, the study chose the model with smallest AIC and BIC values as the model to evaluate teachers' questions' openness, that is 2-parameter model. After drawing test characteristic curve (shown in Fig. 1(a)), it can be seen that the curve meets the hypothesis of IRT. Thus, it can be used to calculate teachers' inclinations to open-ended questions.

Taking the statistical results calculated from questions "how", "why" and "deductive questions" as data source, and import into SPSS to calculate three models' AIC and BIC values, which is shown in Table 3.

Table 3. Analysis of models evaluating teachers' questions' openness

Model	AIC	BIC
1-parameter model	456.2515	464.2979
2-parameter model	449.1148	465.2076
3-parameter model	460.25	479.0249

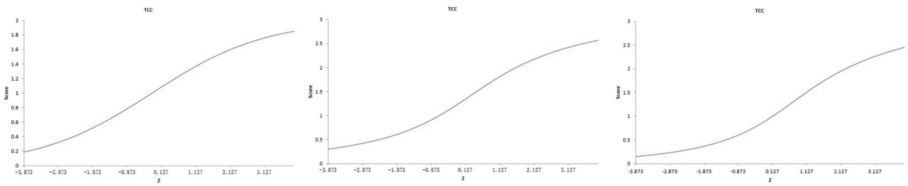
In Table 3, 2-parameter model has the smallest AIC value, while 1-parameter model has the smallest BIC value. After comparing AIC and BIC values in 1- and 2-parameter models, it can be found that the difference between AIC values in 1- and 2-parameter models is bigger than the difference between BIC values in both models. Thus, 2-parameter model was selected to predict teachers' problem-solving inclination from their questions. After drawing test characteristic curve (shown in Fig. 1(b)), it can be seen that the curve meets the hypothesis of IRT. Thus, it can be used to measure teachers' inclinations to problem-solving questions.

Taking the statistical results calculated from questions "if", "creative questions" and "deductive questions" as data source, and import into SPSS to calculate three models' AIC and BIC values, which is shown in Table 4.

Table 4. Analysis of models evaluating teachers' questions' openness

Model	AIC	BIC
1-parameter model	421.5044	429.5508
2-parameter model	420.6224	426.7152
3-parameter model	422.8959	441.6709

It can be clearly seen from Table 4 that 2-parameter model is more suit for calculating teachers' inclinations to critical and creative questions. According to the test characteristic curve drawn based on 2-parameter model (shown in Fig. 1(c)), this model can be used to measure teachers' inclinations to critical and creative questions.



(a) (b) (c)

Fig. 1. Test characteristic curve of teachers' questions

3.3 The Measurement of Teachers' Instructional Inclinations and Comparative Analysis

By using the model selected before, each teacher's instructional inclinations can be predicted. Since IRT can only measure unidimensional abilities, when the study tested teachers' 3 kinds of instructional inclinations, which are teachers' inclination to open-ended, to problem-solving and to critical & creation questions, the predictions on instructional inclinations were made based on correspondent ratios of items (observing dimension).

In this study, according to each dimension's score observed in classes and Fig. 1, it can be inferred that a teachers' instructional inclination is between -4.00 and 4.00.

When a teacher's inclination is below 0, it means that this teacher has a low instructional inclination, otherwise, he/she has a strong inclination.

3.3.1 Prediction on Teachers' Inclinations to Open-Ended Questions

From the perspective of students' answers, questions "what" and "memory questions" teachers use in classes are close-ended questions, which have a small answer pool. Generally, there are two kinds of close-ended questions, one is leading to an unknown information, which is fixed; and another leading to a known information, which is also fixed [5]. When teachers' questions are more inclined to questions "what" and "memory questions", it can be inferred from the perspective of question that the answer pool is mostly fixed, thus, the space teachers give students for divergent thinking is little. If teachers always use this kind of questions, which is a kind of instructional inclination to memorize basic knowledge, it is obvious not good for the development of students' creative thinking. In the predictions of questions' openness, teachers who got lower score have higher inclinations, otherwise, they have lower inclinations. Figure 2 described the mean values and standard deviations of teachers' inclinations to open-ended questions.

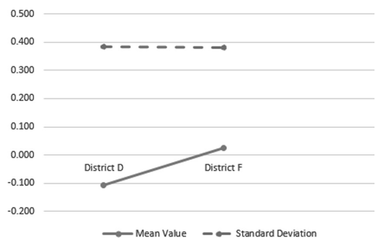


Fig. 2. The comparison of two districts' teachers' inclinations to open-ended questions

It can be seen from Fig. 2 that teachers from district D have the lowest mean score, which means that their questions' openness is the highest; the openness of the questions of from district F's teachers is higher than district D's. It also can be inferred that from the trend and value of standard deviations, two districts' standard deviations differentiate little with each other, thus, teachers' questions' inclinations to open-ended questions in two districts can be concluded from the mean value.

3.3.2 Prediction on Teachers' Questions' Inclinations to Problem-Solving

In classes, the goal of using questions "how", "why" and "deductive questions" is to improve students' logical and deductive thinking through problem-solving process. The questions involved are lower-level open-ended questions. On this level, although learners are given some space for thinking, and answers are not unique sometimes, thus this level of questions is better than close-ended questions in improving students' thinking abilities, it still cannot give learners larger space for thinking and more ill-constructed problem domain. According to the mean values and standard deviations of teachers' inclinations to problem-solving questions, which is described in Fig. 3. In the figure, teachers with higher score have stronger inclinations to problem-solving questions.

In Fig. 3, the score of district D is above 0, while district F is below 0. It can be inferred that district D's teachers' questions have low inclinations to problem-solving questions, thus they need more professional learning and instructional practices. District D, as a capital's strong education district, although its teachers' questions have some inclinations to problem-solving questions, there is still a lot to improve.

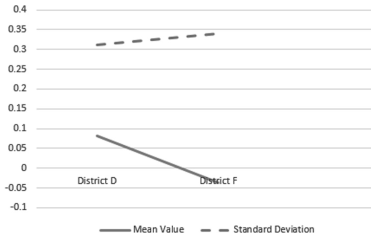


Fig. 3. The comparison of two districts' teachers' inclinations to problem-solving questions

3.3.3 Prediction on Teachers' Questions' Inclinations to Criticalness and Creation

It can be seen from Fig. 4 that district D's teachers have the highest score, which means they have strongest inclinations to critical and creative questions; district F's teachers have the lowest score, which means they have the lowest inclinations. It can also tell from Fig. 4 that, on the dimension of inclinations to critical and creative questions, two districts differentiate largely with each other, and district F's teachers have negative inclinations.

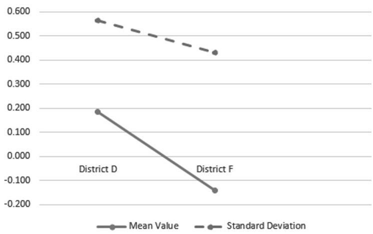


Fig. 4. The comparison of two districts' teachers' inclinations to critical and creative questions

4 Conclusion

Based on his research on teachers' professional development, Berliner maintains that teachers' growth is periodical [17]. As teaching age adding, teachers' teaching knowledge and experience will be obviously improved. To more carefully study two districts' teachers' characteristics and differences on three dimensions mentioned above, authors chose 2 types of schools: elementary and secondary, and 3 types of teachers: novice, qualified, and experienced, and then conducted horizontal comparison on two districts' teachers' inclinations.

4.1 Variation Analysis on the Inclinations of Two Districts' Elementary School Teachers' Questions

In this study, the samples from elementary schools include: 7 experienced and 6 qualified teachers from district D, 6 experienced, 6 qualified, and 9 novice teachers from district F.

By using the model selected before, two districts' elementary teachers' instructional inclinations to open-ended, problem-solving and critical & creative questions can be calculated, as well as the mean values and standard deviations of each district's each type of teachers, which is shown in Figs. 5, 6 and 7.

In Fig. 5, it can be inferred from standard deviations that district D's qualified and experienced teacher groups have high variation, which means that on the perspective of questions' inclinations to openness, there is a large disparity in each group. Comprehensively summarizing the information shown in Fig. 5, it can be concluded that as for novice, qualified and experienced elementary teacher groups, as their teaching age adding, their questions' inclinations to openness have become lower instead.

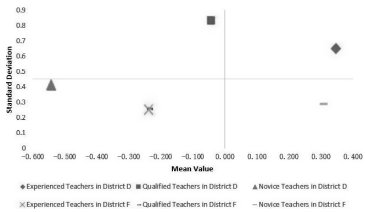


Fig. 5. Difference distribution plot of two districts' elementary school teachers' inclinations to open-ended questions

In Fig. 6, it can also be inferred from standard deviations that district D's qualified and experienced teacher groups, district F's novice and qualified teacher groups have high variation, which means that on the perspective of questions' inclinations to openness, there is a large disparity in each group. Comprehensively summarizing the information shown in Fig. 6, it can be concluded that novice elementary teacher groups have strong and stable inclinations to problem-solving questions, and within district D's qualified and experienced teachers, there is a large disparity, which means that these three types of teachers have strong willing to change the current situation.

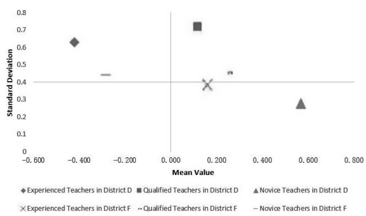


Fig. 6. Difference distribution plot of two districts' elementary school teachers' inclinations to problem-solving questions

According to Fig. 7, it can be concluded that experienced teachers in district D, experienced and qualified teachers in district F have not only higher inclinations to critical and creative questions, but also lower inner disparity; as for novice and qualified teachers in district D and novice teachers in district F, they have not only lower inclinations to inclinations to critical and creative questions, but also lower inner disparity, which means that for these 3 teacher groups, they need to take the chance of school-based training to make targeted transformation on their teachers' beliefs, master basic techniques and methods to design PEI, improve their inclinations to critical and creative questions, to improve classes' effectiveness.

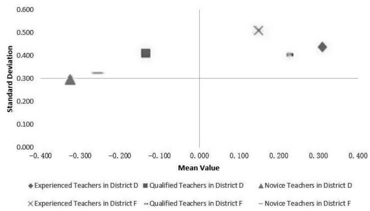


Fig. 7. Difference distribution plot of two districts' elementary school teachers' inclinations to critical and creative questions

4.2 Variation Analysis on the Inclinations of Two Districts' Elementary School Teachers' Questions

In this study, the samples from secondary schools include: 8 experienced, 5 qualified and 6 novice teachers from district D, 8 experienced, 5 qualified, and 2 novice teachers from district F. By using the model selected before, two districts' elementary teachers' instructional inclinations to open-ended, problem-solving and critical & creative questions can be calculated, as well as the mean values and standard deviations of each district's each type of teachers, which is shown in Figs. 8, 9 and 10.

In Fig. 8, it can be inferred from standard deviations that except qualified teachers from district D, other 5 teacher groups have high variation in terms of questions' openness, which means that on the perspective of questions' inclinations to openness, there is a large disparity in each group except for district D's qualified teacher

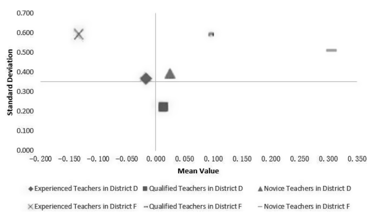


Fig. 8. Difference distribution plot of two districts' secondary school teachers' inclinations to open-ended questions

group. Comprehensively summarizing the information shown in Fig. 5, it can be concluded that in terms of questions' inclinations to openness, 5-teacher groups have high variation, which means that they are on the process of adjusting their inclinations to openness. Moreover, compared to qualified and experienced teacher groups, novice teacher groups have the lowest inclinations to open-ended questions.

In Fig. 9, it can be inferred from standard deviations that district F's novice and qualified teacher groups and district D's novice teacher group have high variation, which means that in terms of inclinations to open-ended questions, there is a large disparity in each group. Comprehensively summarizing the information shown in Fig. 6, it can be concluded that district D's experienced teacher group has not only high inclinations to problem-solving questions, but also small inner disparity, which means that they have stable inclinations to problem-solving questions. And for district F's qualified teachers and district D's novice teachers, although they have high inclinations to problem-solving questions, their inner disparity is large, which means that among part of teachers, there is an obvious divergence on their inclinations to problem-solving questions.

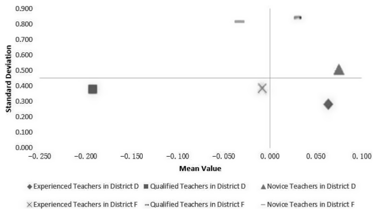


Fig. 9. Difference distribution plot of two districts' secondary school teachers' inclinations to problem-solving questions

According to Fig. 10, it can be concluded that for district D, its 3 teacher groups have high inclinations to critical and creative questions, but its inner disparity is large; for district F, its 3-teacher groups' inclinations differentiate a lot with each other, and each group's inner disparity is small.

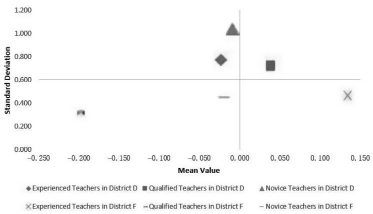


Fig. 10. Difference distribution plot of two districts' secondary school teachers' inclinations to critical and creative questions

5 Research Conclusion and Prospects

Based on IRT and classic statistics, the study took McCarthy's 4MAT model and Professor Wang's OMEQ as measuring standards of instructional inclinations, targeted 72 teachers in Beijing's 2 districts, to conduct careful measurement on the dimension of inclinations (to open-ended, problem-solving, and critical & creative questions), the dimension of school level (elementary and secondary), and the dimension of teacher group (novice, qualified, and experienced). After data analysis and discussion, the following conclusions were drawn:

First of all, Beijing's district D, during one year's blended learning, have shown its obvious improvements in 3 instructional inclinations which can reflect new curriculum reform's core values. As a whole, teachers in district D have higher capacities of giving problem enriched instruction than the other district, from this point of view, it could be inferred that the blended learning has brought significant changes in teaching behavior.

Secondly, (1) In district D, for elementary school teachers, more help and support should be provided for experienced and qualified teachers' professional development; more attention should be paid to affect experienced teachers' instructional beliefs on open-ended questions; for novice teachers, on the premise of enriching their subject knowledge, their strategic knowledge of designing questions and giving feedback as well as replies should also be enriched, thus to effectively increase their inclinations to critical and creative questions; for secondary school teachers, three teacher groups' practical knowledge should all be focused; trainings should focus on the transformation of qualified teachers' instructional beliefs, enrich their problem-solving strategies, improve their inclinations to problem-solving questions; trainings should also guide part teachers of three groups to improve their inclinations to critical and creative questions. (2) In district F, for elementary school teachers, novice teachers' professional development should be focused. It is suggested that trainings can start from improving their design skills of PEI to increase their questionings' effectiveness; for secondary school teachers, qualified and novice teachers should be provided with more delicate support for their professional development. Trainings should guide part of novice and qualified teachers to develop instructional strategies of questioning, giving feedback and reply based on subject knowledge, and also increase teachers' inclinations to problem-solving questions and critical & creative questions.

Last but not least, classrooms are not only rooms for teaching and learning, but also powerful contexts for teachers' professional learning. The IRT-based paradigm authors used to conduct classroom observation, analysis and diagnosis makes it possible for regional school-based trainings to target teachers' professional shortcomings and conduct targeted trainings, and it may become a new paradigm for regional school-based trainings.

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Involving Students in Mobile Learning Content Development: Successes and Challenges

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Abstract. The content of e-learning is at least as important as e-learning delivery systems, if not more important. In the past, e-learning content development was dominated by teachers and e-learning professionals while the major recipients of e-learning, i.e., students, were seldom included. In this study, we hypothesized that if e-learning content were developed by students, it would be a source of learning motivation for the students and would provide a source of material for a database of re-usable e-learning materials. Based on this idea, two universities in Japan started a mobile learning project in 2013 that involved students in developing materials for an English email magazine. In the first stage of the project, students were paid to write short essays, make grammar and vocabulary quizzes, and create learning animations. In the second stage, we are calling for volunteer contributions from current subscribers in the hope of sustaining a project by the students and for the students. Although the project is ongoing, the data collected has already highlighted several areas which may be helpful in guiding future stages of the project and in clarifying mobile learning practices in general: 1) Mobile learning materials are usually short and focused, making them suitable for development even by students. 2) The content developed by students is perceived to be as readable by their peer users as teacher-generated materials, and it invites as large, if not a larger, response from readers. 3) Without proper instruction and training, students tend to contribute e-learning content that needs substantial editing by teachers. 4) Even with an offer of payment, few students are motivated to contribute content. How to sustain student participation in content development continues to be a major challenge in the project.

Keywords: M-learning · Content development · Student involvement · Essays and quizzes · Successes and challenges

1 Introduction

Mobile-assisted Language Learning (MALL) first became a reality as mobile devices, particularly cell phones, developed web connectivity at the beginning of the 21st century. The advent of phones with email or SMS capabilities was the first step towards

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mobile-assisted learning because it opened the way for content delivery. Any teacher could create content for reading and send it to multiple learners simultaneously. This differed from previous CALL (Computer Assisted Language Learning) where learners had to access a website and retrieve or "pull" the information. With email-capable cell phones, content could now be "pushed" to the learners wherever they were.

Some of the first pedagogical experiments with mobile learning, particularly in Japan, involved "pushing" content to learners' cell phones via email at regular intervals. This form of delivery was shown to be more effective in promoting retention of vocabulary in one project which compared it to online content delivery and the traditional paper delivery [1]. Another study indicated that the use of mobile technology helped to sustain regular study among learners of Italian [2].

While there were initial concerns about the availability of mobile devices for students, the university student market for cell phones in Japan quickly approached saturation, with Thornton & Houser saying in 2002 that, "Educators in Japan can assume their students will have recent hardware, and in particular, will carry mobile 'Internet phones' that can surf the Web and exchange email." (2002, pg. 231).

MALL has been receiving more and more attention with rapid technological advances in mobile phone hardware and wireless telecommunication networks. Many applications which used to be only available on PCs now have mobile versions, while MALL practices that used to be limited to vocabulary quizzes now are being extended to a variety of areas including reading, listening, cultural study, writing, and pronunciation training.

Vocabulary learning is one of the most common activities in MALL as can be seen in the large number of MALL vocabulary studies [3–9]. Kennedy and Levy's [4] research investigated the acceptability of a pushed mode of mobile phone operation; these authors sent short messages containing known words and new words mixed together to students' cell phones. Cavus and Ibrahim developed a system to send out technical English language words together with their meanings in the form of SMSs [10]. Obviously, the learning materials in these projects were created and sent out solely by teachers.

Web 2.0, or in case of mobile learning, Mobile 2.0, can be used as platforms for users to produce content. Podcasting, blogs, Wikis, WeChat, LINE, Second Life, and YouTube are all examples of Mobile 2.0 that have been enthusiastically adopted for language learning content development. Pinkman [11] showed that peer reading and writing, as well as the interactive nature of blogs, can have a positive motivational effect on student writers. Pritchard [12] also pointed to the motivating effect of writing for sites with user-generated content (UGC) such as Wikipedia. While these constructivist activities give learners the opportunity to practice the target language, the content created by these learners may not be accurate enough for "push" content such as email magazines, which aim to provide both reading content and writing examples for learners.

University students these days have grown up as "digital natives" with Web 2.0 and Mobile 2.0, and are used to reading and writing short texts on mobile devices. Because of the screen size of mobile devices, mobile learning materials have tended to be short and focused, features that make these materials easier for students to cope with not only as readers and but also as creators.

So far, teachers and e-learning professionals have dominated the development of e-learning content with little student involvement. One study indicates that e-learning content development is regarded as expensive, time-consuming and complicated [13]. Ideally, teachers have ample funding and time to develop online materials. Unfortunately, the fact is, at least in Japan, that teachers are busy with face-to-face teaching and many other school obligations and responsibilities. At the same time, they are facing budget cuts every year. This generates the gap between what the teachers can afford to provide and what the students really need in terms of mobile learning content. This paper aims to answer the following research questions:

(1) Is it feasible to involve students, i.e., the learners themselves, in developing content for mobile learning?
(2) Can students be motivated to develop mobile learning content for their own use?
(3) Do the readers accept student-developed content and perceive it as equal to teacher-developed content?

2 Feasibility of Involving Students in Mobile Learning Content Development

Compared to PC based e-learning materials, such as PowerPoint slides, VOD (Video On Demand), and flash and other movie formats, mobile learning materials are usually in text or at their most complicated, in short audios or videos. This is one of the reasons we hypothesize that students are capable of developing such materials for mobile learning. At the same time, if students are given freedom to develop content that they like, the content will arouse interest in their peers. Finally, language teachers are usually too busy to create a large quantity of e-learning materials to store in a database for future use. Students may be able to fill this need for learning content. As student content developers are users at the same time, they should know what their cohorts are interested in and what their needs are, allowing them to create content that is more accessible. Teachers can shift from creating materials to supervising and assisting student content developers. To test these hypotheses, Shimane University and Nagoya Women's University, both universities in Japan, started a mobile learning project in 2013 that involved students in developing materials for an English email magazine targeting mobile phone users. In the first stage of the project, students were paid to write short essays, make grammar/vocabulary quizzes, and create learning animations. The second stage is calling for volunteer contributions from the several hundred current subscribers to maintain the project. The 2013 project is based on the following two pilot projects.

2.1 The Jaremaga Project

The Jaremaga Project began as an email magazine for extensive reading practice targeting the general public as well as university students. The university students who read the email magazine were English majors at a Japanese women's university studying in a curriculum that emphasized oral communication skills. Their TOEIC (Test of English for International Communication) scores and survey feedback indicated that reading was one of their weakest skills, so the daily email magazine was started to encourage regular reading practice.

Hamajima Shoten, a publisher of school workbooks, provided technical assistance to make a website so that learners could sign up for the email magazine. The company also set up an email server so that the messages could be sent out at a fixed time, 7:30 a.m., every morning. The texts were limited to approximately 80 words to make them readable on all the cell phones in use at the time. Topics covered a broad range, from cultural differences to the news of the day. The texts (hereafter called "essays") were purposely written in short sentences using simple English grammar. The readability level of the stories was equivalent to that of an American 6th grader (readability determined by a combination of tests including Flesch-Kincaid and Gunning-Fog, see [14]).

2.2 The Mobile Learning Project

In 2009, the Mobile Learning Project (MLP) was begun at Shimane University. Unlike the Jaremaga Project, which has continued as a public email magazine, the MLP was restricted to students at one university. Participation in the Jaremaga Project was part of the coursework for the university students, but in the case of the MLP, participation was voluntary. Flyers were handed out to all first-year students who then registered their email addresses in order to take part in the project. Students who did not want to register their email addresses were still able to access the content on a blog site designed for both PCs and mobile phones. Up to February 25, 2015, this site got 117,984 hits from our students as well as hits from outside search engines. A total of 561 students, mostly freshmen when they joined, signed up.

The contents of the MLP were more varied than the Jaremaga Project. Aside from the short English essays on different topics, similar to the essays in the Jaremaga Project, students were sent English grammar quizzes with Japanese explanations and TOEIC/TOEFL exam strategies, also in Japanese. Materials were sent out from one to three times a week as email texts with embedded links so that once the passage was read, the students could access a web page and leave comments or take quizzes. In this way, the MLP had a feedback loop that was lacking in the Jaremaga Project.

2.3 Reader Involvement in Content Development: Feasibility Apparent from the Jaremaga Example

While the Jaremaga Project did not offer a similar web-based feedback loop, some subscribers started to send essays directly to the author via an email address added to the email magazine in July 2008. The essays which were appropriate in terms of topic and length were edited and sent out as part of the email magazine. As the number of contributions grew, it became possible to set aside Friday as the "Readers' Corner" using only reader contributions.

As of May 2013, there were over 5,000 subscribers, and the “Readers’ Corner” was in its third year. In that month, a questionnaire using google forms was sent out to the 61 readers who had contributed essays or long comments previously to investigate their motivation for writing. In the 24 responses, the reader-writers indicated that they were motivated by a need to communicate their own ideas, the desire to improve their English, and the satisfaction of seeing their work come out in the email magazine. One reader specifically mentioned enjoying reading the essays of other readers like herself. Reader contributions such as these indicated that reader involvement in content development was feasible.

3 Method

In the first stage of the new mobile learning project in 2013, students were hired as content developers and paid to develop English learning materials. This first stage, which finished in the spring of 2014, was followed by a second phase which calls for volunteers to contribute content. In this article we will report on the outcome of the first stage. Aside from the obvious difference of having student content developers, the 2013 project distinguished itself from its predecessors in its greater interactivity. There was also greater use of multimedia aids because reading accompanied by pictures and audio has been shown to be more effective than a text-only format.

3.1 Content Development Participants

Flyers were distributed to approximately 300 readers in June 2013 asking for participation as paid content creators. However, after one month, only five students had registered. As a result, in August, 2013, the authors started to verbally invite students who were thought to be interested in and capable of contributing to the project. By October 2013, a total of 22 students from the authors’ two universities had joined the content development team.

These students were grouped into four content teams according to their preferences: (1) the Essay Group, (2) the Grammar/Vocabulary Quiz Group, (3) the Joke, Riddle and Other Material Group, and (4) the Technical Group. Of 22 student content developers, 17 chose to join the Essay Group to write essays. The participants ranged from first-year to fourth-year students from a number of different non-English majors in Shimane and English majors in Nagoya. All the student content developers were female with the exception of the technical team member, the only male participant.

3.2 Process of Mobile Learning Content Development

Induction began with an orientation explaining the purpose of the project, the ethics of e-learning material development and the types of content that were expected. The Essay Group was told that essays should be written in easy English and could be on any topic they liked or were good at. The essay length would be 80-140 words. Essay group

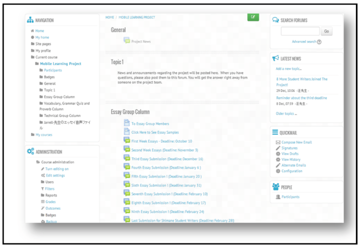

Fig. 1. Content submitted via Moodle forum

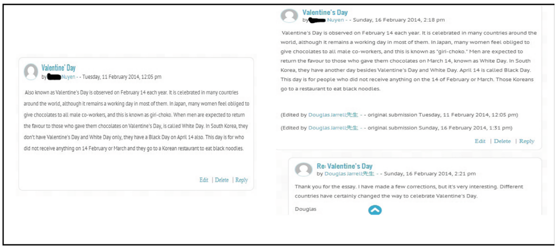

Fig. 2. Student-developed m-learning content – before and after teacher's editing

members were asked to write carefully in English but not worry about perfection as the essays would be edited by a native English teacher before being sent out.

Their work was submitted through a Moodle forum which also allowed communication with teachers and other developers to be realized using Moodle messages and the Moodle plugin, Quick Mail. Teachers could access the students' work and edit it in the forum. All of the student writers were able to see each other's work and the edited changes. In the original MLP, jokes and riddles were reported to be the most popular teacher-created materials [15]. Therefore, content in this project development included jokes and riddle writing, too (Figs. 1 and 2).

3.3 Data Connection and Analysis

Students started to submit materials in October, 2013. Every contribution was carefully edited before it was sent out to subscribers. Teachers were responsible for ensuring error–free, natural-sounding English. Content originality and reusability in a mobile learning environment were also verified (Figs. 3 and 4).

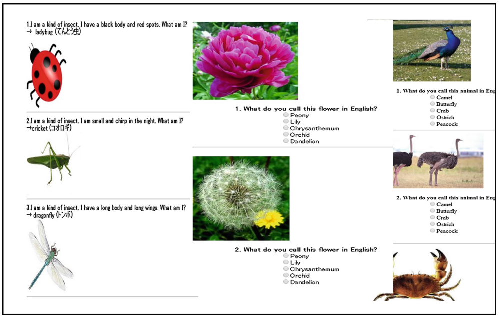

Fig. 3. Student contributions and editing –vocabulary quizzes (Original URL: https://ix1.interscc.jp/ic/entry/?i=smJJ8XrgvYc)

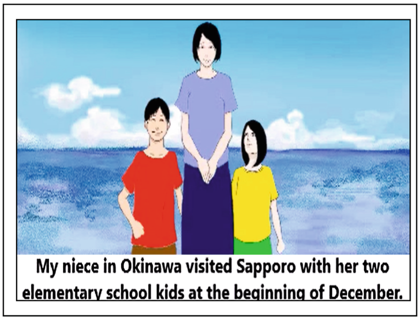

Fig. 4. Student-created animation (The other student-created animations are all available at: https://www.youtube.com/playlist?list=PLmpzzBGVSvERQhunegAPuF8ZAfu_DcmJw)

When the project ended in March 2014, we had received 52 contributions. The revised versions together with teachers' comments were available in the Moodle forum for all members to view. The forum was designed to allow student content developers to peer review or to engage in collaborative writing, although the only communications registered were between student and teacher. Data in three areas were collected:

1. Number of contributions and content features
2. Readers' attitudes and feedback toward student-developed content
3. Attitude and feedback of student content developers themselves

The Moodle system recorded the log-in history of every content developer. Readers' attitudes toward student-developed content were investigated in two ways: through a mobile web survey carried out in April 2014 with 12 questions asking about readers' general perceptions toward student-developed content and other aspects of the project, and by looking at the number of comments made by the readers on individual materials. We also investigated the attitudes of the 22 content developers in March 2014 by sending them a separate survey asking about their thoughts on the involvement in the project.

In both surveys the system prevented duplicate responses. Students were encouraged to voice their real thinking about the project so they were not required to give their names.

4 Results

From October 1, 2013 to February 28, 2014, the project received a total of 52 mobile learning materials from the student content developers. Some students chose to ignore their original self-placement, and the majority of submissions (42) were essays, followed by essay animations (6), jokes (2) and quizzes (2). Of the 22 students who agreed to join the content development team initially, six never submitted anything by the end of the first stage. During the five months, four of the students submitted more than half the total materials, the most diligent contributor being a foreign student. Even when paid, most of the participants were not very active in content development (Table 1).

Table 1. Student-developed content - number of submissions in different categories

Content category	Essays	Jokes	Quizzes	Animations	Total
Number of submissions	42	2	2	6	52

Table 2. Number of submissions from individual content developers

Number of submissions	7	6	5	4	3	2	1	0
Number of content developers (Total: 22)	1	2	1	2	3	4	3	6

4.1 Readers' Perceptions

We asked readers about their perceptions of student-created content through a survey in Japanese which was carried out from April 5 to April 30, 2014. The survey link was sent to the 344 subscribers at that time. Only 36 responded, a response rate of 10 %, although the survey system did detect that many subscribers had opened the survey link and browsed the survey questions without answering the questionnaire. Of the total 12 questions, four directly concerned readers' attitudes towards student-created content. Question 1: What do you think of the idea of inviting students to write essays and quizzes? Question 2: How did you feel about student-developed learning content (edited by teachers) compared with teacher-created content? Question 3: Generally, how did you like the project after involving student content developers? Question 4: What did you think of the length of the learning content sent out every week?

The results of readers' perceptions are shown as follows (n = 36) (Figs. 5, 6, 7 and 8):

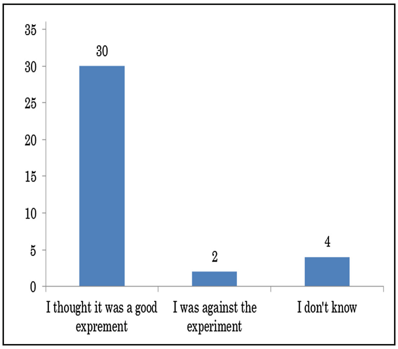

Fig. 5. Readers' attitudes towards the idea of involving students (Survey Question 1)

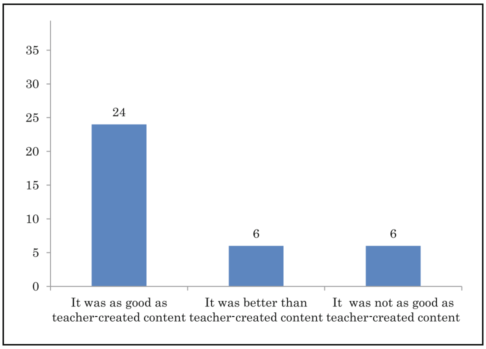

Fig. 6. Readers' attitudes towards student-developed content (Survey Question 2)

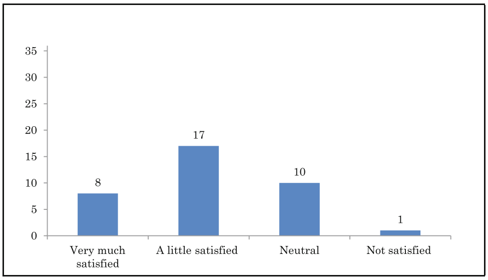

Fig. 7. Readers' attitudes towards the overall project after involving students (Survey Question 3)

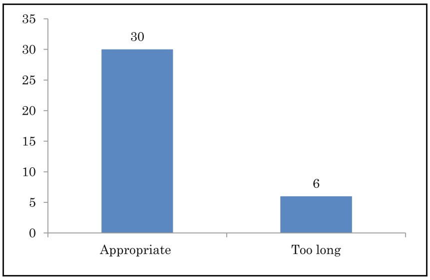

Fig. 8. Readers' attitudes towards the length of materials (Survey Question 4)

4.2 Content Developers' Perceptions

Although the project received positive feedback from readers about student-developed mobile learning content, the voices of student content developers themselves needed to be heard. What motivated them to join the content development team? Since they were paid, was money a major consideration? We surveyed all the 16 content developers who had contributed content, nine of whom responded to the survey (Table 3).

Table 3. What content developers think about their involvement

1. What was the major reason for your participation in the content development team?			
Reason	Good English practice	I was paid.	I learned from seeing the edited version.
Number of respondents	5	2	1
2. How much of the other students' content did you read in the submission system?			
How much	All the submissions by others	Some submissions	None
Number of respondents	1	7	
3. Why did most of you choose to write essays rather than develop other learning contents?			
Reason	Mobile learning essays are short and we are free to choose the topics. Essays are easy to write.	A native teachers carefully edits the essays.	Other
Number of respondents	6	3	1
4. In the content submissions, there were only two grammar quizzes. Why were you reluctant to make grammar quizzes?			
Reason	Don't know how to make a grammar quiz even with samples provided.	Hard to make an original grammar quiz.	Other
Number of respondents	1	5	1
5. In this project, you were requested to submit original content every 10 days. What did you think of the frequency?			
Attitude toward the frequency	Just appropriate	Too frequent	Other
Number of respondents	5	1	1
6. What do you think of the level of the learning content developed by yourselves?			
Attitude	Teacher-developed content is better	Student-developed content is better	Both are good
Number of respondents	5	2	1

5 Discussion

Data collected from both the content developers and the users has made it possible to judge the effectiveness of the project. Results of the data analysis highlight some aspects of the successes as well as the challenges of the project.

5.1 Successes

In terms of student-developed content, the readers seemed to have a favorable view of the project. 67 % of the students surveyed stated that they enjoyed content created by peers and viewed those materials as equal in quality to those produced by teachers, although it must be acknowledged that the materials had been previously edited by teachers. There was no indication that students avoided student-developed content. In fact, 83 % readers thought that student-created content was as good as that of the teachers, or even better. One reader commented: "It was stimulating to read our peers' essays or answer quizzes made by them." The same percentage of students (83 %) thought that the length of content created by students was suitable for reading on mobile phones.

The majority of student content developers who responded to the survey indicated that their reason for joining the content development team was for the English practice. Indeed, when preparing learning materials, the students needed to do careful background research and try even harder than usual to write in "correct" English. Knowing that their contributions would be sent out to a large audience, they tended to prepare their materials more seriously. Their submissions were sent to a Moodle forum where they were accessible to the other content developers during their different stages of editing. It is unclear whether this kind of exposure at the beginning stage was beneficial or detrimental to their willingness to produce content. However, most of the student content developers reported reading the submissions made by the other developers with interest, reflecting the attraction of student-produced content.

The essays written by students were mostly about topics familiar to all the students: traveling, cultural differences, campus life and events they participated in. This kind of essay appears to strike a responsive chord in the hearts of their peers. As the materials are carefully edited by teachers, the accuracy of the English also allows the essays to be used as examples of good language usage in the mobile learning content database..

Even though students were paid for content development, the cost was still much lower than hiring teachers. The 52 submissions on different subjects from student content developers reflect what current Japanese students think, what they do and what they are interested in. Student-created content has enhanced the stock of learning content for this project and it may encourage other students to voluntarily contribute content.

5.2 Challenges

Certain problems became apparent as the project progressed. Paying students minimum wage did not motivate them to become active in the content development. As Table 2 indicates, of 22 registered content developers, six never contributed anything. These six students did access the submission system and read the guidelines and samples, but they chose to be silent. During five months of the project implementation, 10 content developers produced no more than three materials each. The most prolific writer, who wrote a total of seven essays, was an international student who was happy to receive payment for "studying."

The reason for the low output of many content developers may be due to a number of reasons. First, compared to a part-time job, the earnings from the project are irregular, so this kind of activity cannot take the place of part-time work. Another reason, as one student mentioned, is the difficulty of making original grammar quizzes. The process of writing essays may also be more difficult than the students had imagined. Several of the non-contributors mentioned a lack of time and ideas. This suggests that student content developers may need more support in their efforts, especially when all communication is done by email rather than face-to-face.

While it is true that teachers can save time by having students develop content, editing students' work and checking ethical issues can still be time-consuming. For example, a joke created by a student turned out to be copied from a web site. By the time the problem was discovered, the joke had already been sent to subscribers and added to the project database.

An interesting finding from this project is that readers and material developers had different perceptions of student-produced content. Whereas 83 % of the readers considered student-created content as good as, or even better than, teacher-produced content, more than half of the content developers thought that teacher-made content was better than theirs. This kind of perception may be a psychological hurdle preventing content creators from taking full advantage of this writing opportunity.

6 Conclusion

Based on the objective data collected from the project technical system and subjective perception feedback from readers and student content developers, the research questions have been answered: it is possible and feasible to have students develop mobile learning content. With teacher's guidance and supervisions, students have been shown capable of developing suitable mobile learning materials. Money is not the only incentive driving content development; more content developers in the project indicated that their motivation came from the opportunity to use English and have it corrected by a teacher. It is clear that only a few subscribers have a negative attitude toward learning content developed by learner themselves, perhaps due to student-created content being topical and campus life related. Further student-involved development of mobile learning materials may be more cost-effective than employing teachers to create them.

Despite these merits, there are many challenges: students in general lack enthusiasm in responding to call-for-content-development even when offered payment. The students involved in content development may actively make contributions in the beginning of the project, but with the passage of time, their contributions dwindle. Sustaining student content development remains a big challenge. Student-created content can provide a welcome infusion of creative and interesting materials to the mobile learning project, but most of the contributed content needs to be edited and revised by the teacher, sometimes with a substantial investment of time and energy.

Overall, in terms of involving students in mobile learning content development, we have discovered a number of successes, but the challenges to creating a sustainable project are equally daunting. It is hoped that building on these successes and overcoming these challenges may provide a way forward in content development activities in general e-learning.

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Visualizing and Understanding the Digital Divide

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Abstract. The aim of the study is to visualize the status quo of the research on digital divide via co-citation analysis. A total of 494 papers were retrieved from the Web of Science database with full bibliographic records including authors, titles, abstracts, and reference lists. CiteSpace II was used to conduct visualization analysis about the research on digital divide by identifying the most influential authors, representative countries, and essential papers, as well as research hotspots, evolution path and research frontiers in the field of digital divide.

Keywords: Digital divide · Citespace II · Co-citation analysis

1 Introduction

It is widely acknowledged that information and communication technology (ICT) is changing the way we learn and live [1–3]. However, due to the uneven economic development among countries, the adoption of ICT has not been uniform throughout the world, which has created many socio-economic imbalance problems in the world [4]. This phenomenon is commonly referred to as the 'digital divide' issue [5–8]. Later scholars underlined that it "refers not just to differences in access," but also to "inequality among the Internet users in the extent to which they are able to reap benefits from their use of the technology" [7]. OECD defined digital divide as "the gap between individuals, households, businesses, and geographical areas at different socioeconomic levels with regard both to their opportunities to access ICTs and their use of the Internet for a wide variety of activities," which is a widely accepted definition of digital divide [9]. In order to alleviate the impact of unequal access to ICT, researchers all over the world have investigated the issue of digital divide from various aspects [10–12].

In China, digital divide has long been the concerns of researchers in educational field, since imbalanced access to ICT has led to education inequity between China' urban areas and rural areas. For instance, evidences from China have shown that students from rural or migrant schools score lower on all the Internet inequality

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indicators (digital access, autonomy of use, social support, Internet use and self-efficacy) and are therefore more disadvantaged in Internet usage status than their urban peers [13].

In order to provide insights into research about education equity in China, we tried to visualize the research domain of digital divide. More specifically, our study addressed the following research purposes: to identify the most influential research studies, representative authors and typical research outcomes in terms of their position in the citation and co-citation network, including the analysis of the research hotspots and the distribution of important countries; to illustrate the trace of the research in the field of digital divide, including revealing the law of the research evolution, as well as investigating the research frontiers.

2 Research Methodology

2.1 Data Collection

The input data sources used in this paper come from the Web of Science database which is published by the Institute for Scientific Information (ISI) in the USA. The data retrieval strategy in the present paper is the following: Topic = digital divide; Document Type = Article; Time Span = All years; Databases: Science Citation Index Expanded (SCI-EXPANDED), Social Science Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI), Conference Proceedings Citation Index-Science (CPCI-S), and Conference Proceedings Citation Index-Social Science &Humanities (CPCI-SSH). Moreover, the scope of subject was limited in "EDUCATION EDUCATIONAL RESEARCH", "COMPUTER SCIENCE", "PSYCHOLOGY", "TELECOMMUNI- CATIONS" and some other related subjects. In total, 494 papers were retrieved and downloaded with full bibliographic records including authors, titles, abstracts, and reference lists.

2.2 Research Tool

CiteSpace II was employed as the research tool in the present study, which is a java application developed by Dr. Chaomei Chen for analyzing and visualizing emerging trends and changes in scientific literature [14]. It can produce co-citation networks consisted of nodes and links. Created nodes could present institutions, articles, authors, terms, keywords and so on, and created links might represent co-citation or co-occurrence between them. We use it to carry out a multiple-perspective co-citation analysis with the purpose of identifying significant articles, authors, as well as to detect emerging research trends.

The general procedure of visualization analysis with CiteSpace II is outlined as follows: (1) identify a knowledge domain; (2) data collection; (3) extract noun phrases from titles, abstracts, descriptors and identifiers of citing articles in the dataset; (4) time slicing; (5) threshold selection; (6) pruning and merging; (7) select the layout styles; (8) visual inspection; (9) verify pivotal points; (10) reach the corresponding conclusions [15].

3 Results and Discussions

3.1 Analysis of Core Authors and Countries

Core Authors. We utilized CiteSpace II to analyze the cited frequencies of the authors and identify the core authors with high academic impact on the research field of digital divide. We selected “cited author” as the “node type” and set the threshold as (2, 2, 20), (4, 3, 20), (4, 3, 20), and proceeded the statistical analysis. In this study, we spot the top 10 authors whose papers have the highest cited reference, with results in Table 1.

Table 1. Analysis of core authors

Rank	Author	Cited frequency	Rank	Author	Cited frequency
1	Hargittai, E.	66	6	Dimaggio, P.	42
2	Korupp, S. E.	64	7	Warschauer, M.	41
3	Norris, P.	49	8	OECD	41
4	Davis, F. D.	48	9	Selwyn, N.	37
5	Venkatesh, V.	44	10	Rogers, E. M.	36

According to Table 1, we could know that only Hargittai’s and Korupp’s cited frequencies reached up to more than 60 times, and the remaining were all below 50 times, ranging from 36 to 49 times. Hargittai’s paper “From the ‘Digital Divide’ to ‘Digital Inequality’: Studying Internet Use as Penetration Increases” [16] was cited 66 times, and Korupp’s paper “Causes and Trends of the Digital Divide” [17] was cited 64 times, indicating that both of them have played prominent roles in the field of digital divide. Furthermore, Norris, Davis, Venkatesh [18] etc. also have significant impacts on the research of digital divide.

Core Countries. To conduct a cooperation network analysis in the field of digital divide, we selected “country” as the “node type”, set top N = 50. Finally, there existed 54 nodes and 36 lines, as shown in Fig. 1.

According to Table 2, in terms of the total amount of academic literatures published, USA occupies the top place with 173 pieces. England is ranked second with the number of 36, and China is closely after England, owning 35 pieces. The rest of the rank is successively Spain, Australia, Canada, etc. It is obvious that researchers in USA have paid the most attention to the research of digital divide, and dramatically widened the gap with other countries with regard to research papers.

In addition, Fig. 1 presented the cooperation situation of the literatures published in the world on the domain of digital divide, from which we know that there was a close relationship between the countries/regions except for Spain.

3.2 Analysis of Research Hotspots

Research hotspot can be explained as the scientific questions or topics investigated by a relatively large number of papers that are intrinsically linked during a period of time [14]. In general, they are usually belonged to high cited frequency terms. In this study,

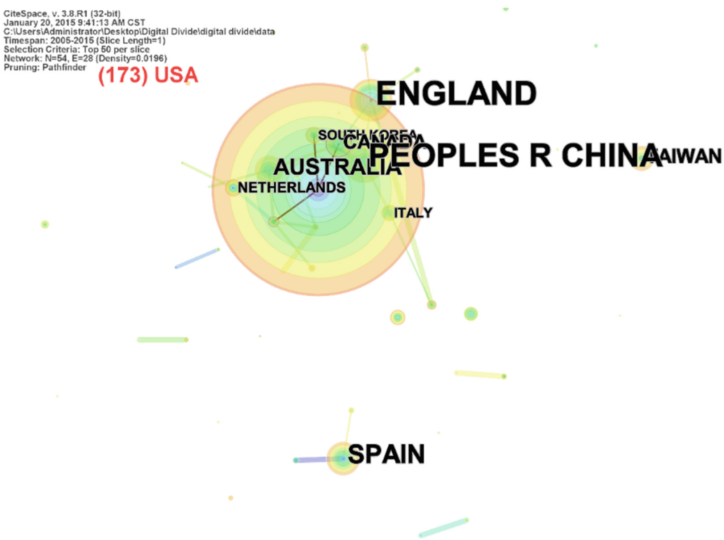

Fig. 1. Country distribution of the literature quantity

Table 2. Literature quantity of countries and regions

Rank	Literature Quantity	Country/ Region	Rank	Literature Quantity	Country/ Region
1	173	USA	6	21	Canada
2	36	England	7	21	Taiwan
3	35	China	8	15	Netherlands
4	28	Spain	9	14	Italy
5	24	Australia	10	14	South Korea

we set “keyword” as “node type”, top N = 50. Moreover, under the help of “Pathfinder”, the network map with 303 nodes and 868 lines was generated, as Fig. 2 showed.

In Fig. 2, the circular nodes represent keywords while node size stands for their frequency. The larger the nodes are, the more representative they are. It’s not difficult to see that “digital divide” was the largest node with the highest frequency of occurrence. In addition, Table 3 presented the top 10 keywords according to the cited frequency, which indicated the research hotspots of digital divide.

As can be seen from Table 3, according to cited times, except for “digital divide”, other hot keywords respectively are: internet, information, technology, adoption, access, information- technology, impact, model, broadband. It can be concluded that the main hotspots on digital divide might include: definition of digital divide; causes of digital divide; measurement of digital divide and impact of digital divide.

Definition of Digital Divide. Different organizations and individuals worldwide have ever defined “digital divide” for numerous times. It’s worth noting that fundamental changes have taken place in the understanding of “digital divide” within a short time. Hargittai (2003) pointed out that there existed significant Internet digital divide through

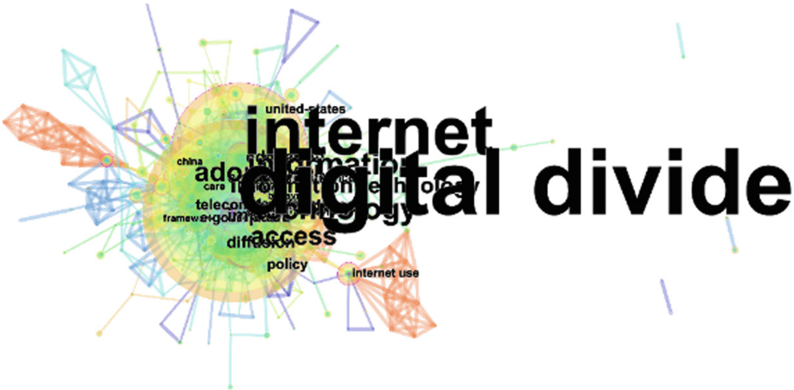

Fig. 2. Network map of research hotspots on digital divide

Table 3. Hotspots on digital divide

Rank	Frequency	Keyword	Rank	Frequency	Keyword
1	146	digital divide	6	41	access
2	109	Internet	7	35	information technology
3	49	information	8	29	impact
4	48	technology	9	29	model
5	43	adoption	10	26	broadband

the comparison of the annual Internet access, namely, inequalities in access to and use of the medium [16]. However, other researchers suggested that digital divide is more than an issue of access. It is a sociological phenomenon reflecting broader social, economic, cultural, and learning inequalities [19]. Keywords like “digital divide” and “access” in Table 2 exactly reflected the hotspots.

Causes of Digital Divide. The causes of digital divide is another hotspot according to the keywords including “Internet”, “broadband”, “technology” and “information technology”. For example, some scholars in particular pointed out that age is shown to be significantly associated with the use of Information and Communication Technologies [20]. Meanwhile, Quibria et al. (2003) stated that income, education and infrastructure are the most important variables with regard to the use of ICTs [21].

Measurement of Digital Divide. According to Table 2, it could be denoted that the measurement of digital divide is one of the research hotspots in the field of digital divide, since “model” was the keyword with high cited frequency. Actually, many institutions and researchers have attempted to take comprehensive measures to describe the level of regional information development, and expected to help put forward countermeasures and suggestions on narrowing digital divide. For example, Corrocher and Ordanini (2002) proposed a model for measuring the digital divide within a set of countries or geographical areas [22]. Wedasinghe and Wicramarachchi (2014) propose an ICT model to bridging the disability digital divide gap in Sri Lanka [23].

Impact of Digital Divide. The keyword "impact" exactly reflected the research hotspot in recent years with regard to digital divide. For instance, Lane (2009) identified that the open educational resources movement may actually widen rather than bridge the digital and educational divides between groups, both within and across national boundaries, through the increasing sophistication in technologies and the competencies expected of learners [24]. Lucky and Achebe (2013) conducted a study to evaluate the effect of digital divide on information accessibility among undergraduate students of Ahmadu Bello University [25].

3.3 Analysis of Research Evolution Path

The key node in network map is the node owning relatively high degree of centrality or cited frequency, at the same time, connecting two or more different clusters. It is possible that these nodes can be transition points from one period to another [14]. Through analyzing the evolution of the key literatures, we can obtain the evolution of the core theory in the field of digital divide to some degree. The present study employed CiteSpace II to conduct analysis of cited reference, generating a network map including 429 nodes and 1050 lines, which could be seen in Fig. 3. Among them, the key literatures represented by the nodes with high centrality could be seen as the "pivotal points" in the research evolution path of digital divide.

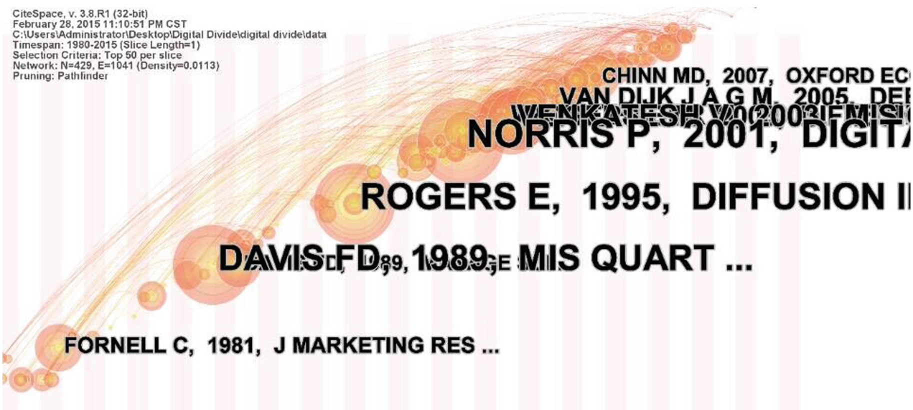

Fig. 3. Research evolution path of digital divide

We can obtain details for key literatures according to the narrative generating from CiteSpace II, shown in Table 4.

According to Fig. 3 and Table 4, we can know that there are 9 key nodes based on the "digital divide" presented in the network map. The 9 nodes represented key literatures containing major theoretical innovation and they play important roles in the research field of "digital divide". Based on the research evolution path, the authors classified the research of digital divide into three stages.

Table 4. Details of key literatures in digital divide

Rank	Author	Title	Year	Centrality
1	Fornell C	Evaluating Structural Equation Models with Unobservable Variables and Measurement Error	1981	0.11
2	Davis, F. D.	Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology	1989	0.16
3	Davis, F. D.	User Acceptance of Computer Technology: A Comparison of Two Theoretical Models	1989	0.11
4	Rogers, E. M.	Diffusion of Innovations (4th Edition)	1995	0.21
5	Norris, P.	Digital divide: Civic engagement, information poverty, and the Internet worldwide	2001	0.10
6	Venkatesh, V.	User acceptance of information technology: toward a unified view	2003	0.09
7	Warschauer, M.	Technology and social inclusion: Rethinking the digital divide	2004	0.20
8	van Dijk, J. A. G. M.	The deepening divide: Inequality in the information society	2005	0.10
9	Chinn, M. D.	The determinants of the global digital divide: a cross-country analysis of computer and internet penetration	2007	0.05

First Stage: Theory Foundation of Digital Divide. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology" published by Davis and "Diffusion of Innovations" published by Rogers were all belong to earlier literatures appeared in the digital divide evolution path. They respectively put forward Technology Acceptance Model and Diffusion of Innovation theories attempting to interpret the individual's behavior to accept a new technology and technical communication process. Davis emphasized that perceived ease of use and perceived usefulness will both affect individual behavior [26], meanwhile, Rogers pointed out that for a new technology, its diffusion degree would be slowly at first, however, when the number of users reaches a certain scale, it spreads significantly faster [27]. In a word, the theories of Technology Acceptance Model and Diffusion of Innovation have explained the access and acceptance of information technology, which provided theory foundation for the research of digital divide.

Second Stage: Concept Elaboration of Digital Divide. The book published by Norris was regarded as the first academic research outcome in the field of digital divide that attracted worldwide attention. Norris (2001) identified a "global divide" evident between developing countries and industrialized nations, a familiar "social divide" between the haves and have-nots within each nation, and a "democratic divide" that splits those who do and do not use Internet resources to engage in public life [8]. And then Warschauer (2004) pointed out that digital divide is not limited to whether individuals have computers or not, but lie in whether the individuals have the ability to make full use of information technology to obtain meaningful social practice or not. Furthermore, Warschauer (2004) suggested that digital divide is no longer restricted in the level of pure technology, and it has been developed into a multidimensional problem that involves all aspect of human life [28].

Third Stage: Causes and Impact of Digital Divide. "The deepening divide: Inequality in the information society" published by van Dijk (2005) ranked eighth with the centrality of 0.10. In this paper, the author explained why the digital divide is still widening and deepening. Taken from an international perspective, the author offers full coverage of the literature and research and a theoretical framework from which to analyze and approach the issue of digital divide [6]. In addition, Chinn (2007) attempted to explore the determinants of the global digital divide through cross-country analysis of economy, population, infrastructure, and communications [29].

3.4 Analysis of Research Frontiers

In order to identify the potential research problem about digital divide, CiteSpace II was employed to obtain burst terms to represent the research frontiers of digital divide via the bursting detection algorithm, with the results presented in Table 5.

Table 5. Bursts terms with regard to digital divide

Rank	Bursts	Frontier Terms	Rank	Bursts	Frontier Terms
1	3.61	Information technology	4	2.63	China
2	2.99	digital divide	5	2.62	internet
3	2.75	policy	6	2.54	Developing countries

From Table 5, we could see that "policy" was one of the research frontier of digital divide. In fact, countries all around the world have realized the negative impact of digital divide, and the governments have been taking actions to eliminate digital divide through related policies. It is important to note that digital divide has been a globe social issue [30], however, developing countries, including China, were found to be the focus that attracted more attention of researchers worldwide since "China" and "developing countries" were identified as burst terms.

Information technology, which is directly connected to the issue of digital divide, was found to be the research frontier with the highest burst value. With the rapid development of information technology, the issue of digital divide might be more severe than ever. Therefore, nowadays, it is imperative to address the potential impact of information technology on greater inequalities of access to information technology.

4 Conclusions

This study employed CiteSpace II to conduct a comprehensive analysis of the research on digital divide, and led to a number of important findings. Firstly, the present study identified some of the most influential researchers in the field of digital divide, for example, Hargittai work has the highest cited frequency. In addition, USA is the core country that published much more studies about digital divide than any other countries in the world. The results of this study also showed that digital divide has become a common problem worldwide, and the world has been working together to deal with it. Secondly, this study investigated the main hotspots on digital divide and concluded four sub-domains with regard to the hotspots of digital divide: definition of digital divide; causes of digital divide; measurement of digital divide and impact of digital divide. Thirdly, the research evolution path of about digital divide was visualized via CiteSpace II and the "pivotal points" of the evolution path were identified in the current study. Additionally, research findings showed that there existed 9 key literatures which played important roles in the field of digital divide, and the authors classified the research of digital divide into three stages based on the evolution path. Finally, this study attempted to obtain the burst terms to show the research frontiers of digital divide, which might provide insight into future studies about digital divide.

5 Limitations

It should be noted that the present study was limited to the database of WOS, and other databases were excluded, especially studies written in Chinese were not analyzed. Future researches might carry out studies about research of digital divide in China using the database of CNKI and explored important authors, papers, research hotspots and evolution path about research on digital divide in China. Furthermore, comparative studies could be conducted to compare the similarities and differences of researches about digital divide in China and foreign countries.

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How Video Games Enhance Learning: A Discussion of James Paul Gee's Views in His Book *What Video Games Have to Teach Us About Learning and Literacy*

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Abstract. The function of video games for effective learning has long been under heated discussions and studies. James Paul Gee is one of the best well-known experts in the field of video games, and he studied video games from a new and comprehensive perspective. He believes that the theory of learning in good video games is relevant to the theories of learning in cognitive science. His book, *What Video Games Have to Teach Us about Learning and Literacy*, presents 36 learning principles in video games, and discusses how video games enhance learning. This paper is a summary of the main view points of his book, and makes the conclusion that video games can enhance learning based on the theory of learning and basic needs of human beings. Some critical comments on Gee's opinions are made.

Keywords: Video games · Learning · Game-based Learning · Educational game

1 Introduction

Educational game has gained more and more attention with the rapid development of Internet education (online education). Canadian scholar Jon Baggaley ever made an analysis of the *Horizon Report* that was issued from the year 2004 to 2012, and said that 37 new techniques have been presented, among which only 7 techniques could be confirmed by later reports and Game-based Learning ranks first [1]. Besides, there are huge amounts of evidences which demonstrate that applying video games in traditional teaching could contribute to improving learning interest and motivation. What's more, it could also help to develop students' creativity, and the ability of cooperative learning and solving problems [2–5].

In order to apply video games in learning, many scholars around the world dwell upon the studies of educational significance of video games. Gee is one of the most

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important scholars and he ever worked in University of Wisconsin, Madison, and now works in Arizona State University. His book *What Video Games Have to Teach Us about Learning and Literacy* has made a huge influence upon the study of the relationship of video games and learning [6]. Gee makes a comprehensive analysis of the educational significance of video games in his book *What Video Games Have to Teach Us about Learning and Literacy,* and presents his opinions about the learning and knowing. What's more, Gee also points out the limitations of school education and the corresponding strength of video games. Gee analyzes video games through the analysis of the learning principles, and claims that "the theory of learning in good video games is close to what I believe are the best theories of learning in cognitive science", and good theories of learning are embedded in the video games. What's more, the theory of learning good video games also fits with the modernity, high-technology development and globalization. It has gradually become a new art, and catches more and more attention. Indeed, the video-game industry has achieved a huge success, and makes as much as more money each year than the film industry. Game is also a reflection of the culture we live in, and it is a culture we can exert influences. So Gee understands video games from a more macro perspective, makes a comprehensive analysis of the process of learning, and discusses the significance video games could make for learning and its social impact.

The following content is an analysis of the core ideas of the book, which is associated with our past study experiences.

2 Understanding of Experience and Identity in Learning

Experience and identity are the core concepts that Gee values in the analysis of learning. They are both the crucial determinants of the happening of learning, and they interact with each other.

2.1 Experience

Experience is one of the most important concepts that Gee values in the learning process. There is a dynamic system about social experiences and how we learn. He strongly believes that playing video games helps people to gain more various experiences. Your own experience with people in different social groups determines how you read or think in certain way. People's ways of thinking, behavior, goals and purposes of life vary, because they come from different social contexts, have different experiences and purposes, and share various values. Human learning is not just a result of brain working, but it is fully rooted in the material, social, and cultural context soil. There is a linkage between how and why we read, write and think to social and cultural practices.

At the same time, humans learn, think and solve problems by reflecting on their previous embodied experiences in the world. People need to connect the new knowledge with their past experiences, and such connection could help learners to understand the new knowledge. The social interactions and network among people also are built through experiences. So in Gee's mind, various experiences and social practices are the sources of learning, and determine the pattern of our thinking.

2.2 Identity

Our life experiences help to shape our identities in an explicit and subtle way. The shaping of identities requires life experiences, self-awareness, and the understanding of our relationship with the world. Each of us takes on a core identity that relates to all our other identities, such as a woman, feminist, wife, ethnic of a certain sort, biologist, Catholic, etc. And how we behave should match the social roles that we play, in the way that is expected by other people, laws, ethics, social principles and social stereotype. At the same time, specific way of reading and thinking also correlates to our way of being in the world, a certain sort of identity. The contributions or the responses that we make for the society and family are determined by the realization of our social identities, and the social identity helps us to contemplate who we are and what we should do for the society. Gee points out that "society as a whole is simply the web of these many different sorts of identities and their characteristic associated activities and practices". Each identity is associated with a given semiotic domain, including one's vision of morality and values. Every individual has different identities, and they are all associated with other people's semiotic domains.

3 How Video Games Enhance Learning?

3.1 How to Understand Video Games?

First of all, Gee understands the knowledge gaining from a modern perspective, and expands the category of literacy. He regards video game itself as a knowledge context, and takes playing video games as a way to gain knowledge. School education has its own limitations, but video games have their counter-strength.

3.1.1 Semiotic Domain

Gee expands the domain of literacy. He believes that in the modern world, language is not the only important communicational system. Images, symbols, graphs, diagrams, artifacts, and many other visual symbols are different ways of reading and writing, and they are all particularly significant. Gee understands the concept of "semiotic": "a fancy way of saying we want to talk about all sorts of different things that can take on meaning, such as images, sounds, gestures, movements, graphs, diagrams, equations, objects, even people like babies, midwives, and mothers, and not just words". People learn to solve a problem or behave in a certain way according to the identity they take on. This theory provides a refreshing approach for the understanding of learning, and the source of knowledge.

Considering to this theory, we actually learn to experience the world in many ways, and it seems that knowledge is accessible everywhere. It also provides a new perspective to understand learning and the function of video games. What's more, considering the playing behavior itself, the interaction among players and between the virtual world and players, playing video games could be regarded as a practice in the life world, and Gee presents that "Semiotic domain can be viewed internally as a type of content or externally in terms of people engaged in a set of social practices". Video games are good examples to present how learning and thinking work in any semiotic domain in a powerful and effective way.

3.1.2 Comparison to School Education

With regard to the learning process, school education owns some limitations for the achievement of interesting learning. School education evaluates students' abilities by standardized tests and skill-and-drill curricula. Gee argues that conscious knowledge is important for critical learning, and school does not honor the tacit and embodied knowledge people build up through practice and adaptation to change "on the spot" as it happens amid practice. The inability of comprehending the complex academic language of textbooks is also a problem that many students are faced with. Academic language does not provide embodied experiences for students to understand in a specific way.

The process of learning in participation and practices in certain situations creates more benefits for students, especially for the children, and helps them to gain more competence. In classrooms, students are just the acceptors of the knowledge that teachers present on the blackboard, and they cannot feel the knowledge without knowing the significance that the knowledge can make. However, the playing of video games shares different ways of learning from school education. Video games are interesting, and players know who they are and what they should do to achieve a purpose in the virtual world.

Players always develop the sense of participation in the process of playing. Stories are always embodied in the video games, which are related to the player's own choices and actions. The embodied nature of video-game stories is a crucial feature. Different from books and movies, the playing of video games requires the players to make emotional investments and make a difference onto that game, which creates a positive sense of participation. Making a specific relationship with the knowledge would definitely help to achieve learning and knowing, and video games provide an opportunity for the players to move as a character and their own actions and decisions can influence the results of the story. As far as the children's concerned, playing video games is a good opportunity for them to apply their school knowledge in practice, and gain knowledge in playing, Gee claims that "children cannot learn in a deep way if they have no opportunities to practice what they are learning".

3.2 Why We Need Video Games for Learning?

Based on his 36 learning principles, Gee highlights the following core concepts and benefits of video games, from the perspective learning.

3.2.1 Experience and Learning

Gee found that playing a video game is a "life-enhancing experience", and he argues that "video games are potentially particularly good places where people can learn to situate meanings through embodied experiences in a complex semiotic domain and meditate on the process". Players also have a deep emotional involvement in the experiences in the video games, because they make their own decision about which character that they want to play, and their values, hopes, and aspirations are endowed for the "character".

Game playing requires the player to learn and think in an unfamiliar way, and players need to devote lots of time and energy to make success in games. Gee believes that "a new form of learning and thinking was both frustrating and life enhancing". Gee also presents Jean Lave's theory about learning, a leading theorist of socially situated cognition: learning is not best judged by a change in minds (the traditional school measure), but by "changing participation in changing practices". In video games, there are many ways of participating, and players can change their practices as they want.

Video games make a special educational significance for learning in an attractive and interesting way. Good video games have more advanced learning modules, making something interesting happen to the learner. The feeling of achievement in a number of different ways is also an important incentive for the playing behavior, and video games also offer other rewards than the powerfully amplified outputs they give.

3.2.2 Projective Identities

Video games are an immensely entertaining and interactive technology built around identities, and help to bridge some of people's real-world identities to the virtual character that people play in the game. When people choose the character that they want to play at the beginning, they make decisions based on their preference and experiences, which correlate to their identity recognition and self-understanding in the real world. In video games, players can transcend the limitations of the real world, and do what they expect to do but cannot do in the real life. The atmosphere of video games is more ideal and satisfying, because players have the right to choose and behave in their ways. While people realize that they can exert an influence in a social world, a pleased and satisfied feeling is created, during which process players are developing their self-realization of their identities. At the same time, playing video games contributes to the development of self-consciousness and self-reflection. Gee says that "a good role-playing video game makes me think new thoughts about what I value and what I do not". The function of linking can also help children to know the world. Children need to build various associations in semiotic domains. This forming of associations is crucial not just to the development of the child's mind, and it also constitutes aspects of the child's emerging identity as a cultured being of a certain sort connected to a certain sort of family, social group, and community.

The projective identity is the interface between one's real-world identities and the virtual identity, and "it is the space in which the learner can transcend the limitations both of the virtual identity and the learner's own real-world identity". Within the context of the story, projective identity differs from the virtual identity and real-world identity, and it is a space that players can transcend both the limitations of the characters and themselves. It can motivate the learner to know that he or she has the capacity to take on the virtual identity as a real world identity. Through the projective identities, children are learning new values and new ways of being in the world based on the powerful juxtaposition of their real-world identities. The projective identity helps people to understand phenomena of the world, because their mind is dealing with lots of issues in the virtual world, such as peace, diversity, poverty and other social issues, and they should be devoted to finding the solutions of those issues. Besides dealing with different issues, people can play the game as different characters, each of which can be designed in different ways by your choices in the whole game. In the end, "by the time the game play starts in earnest, your own choices have shaped the sort of character you are going to be". What's more, the function of "shaping identities" of video games has been recognized by organizations.

Gee proposes that the "appreciative system" differentiates child learning from expert practitioner learning, and children can determine what they "like", what is a "good" result, only in terms of an appreciative system, including their set of goals, desires, feelings, and values. According to Gee's understanding, appreciative system is the place where the social, cultural, and the personal merge and come together as well. According to Gee's understanding, "critical learning" involves learning to think of semiotic domains as design spaces that manipulate us, and passive learning will not lead to much power and empowerment in the contemporary world. Gee holds the opinion that "Video games have the potential to lead to active and critical learning". In critical learning, people can reflect overtly on the goals, values, feelings, and the desires that compose appreciative system and make active and critical choices about the system, but people do not usually form appreciative systems by themselves. Video games help the players to form such appreciative system, on which players could overtly make reflections upon their own understanding and arrangements of the process of the games, as well as motivating the reflections about the players themselves and about the virtual world of the game.

3.2.3 Cooperative Learning

Gee puts lots of emphases on cooperative learning and the concept of "affinity group". He points out that much of the knowledge in an affinity group is tacit and distributed; knowledge is embodied in members' mental, social, and physical coordination with other members and with various tools, and technologies; and knowledge spread in the networks of relationships; such practice itself gives the group member their identity. From Gee's point of view, young people who play video games often experience a more intense affinity group. Compared to school education, they can gain more knowledge from other people and from various tools and technologies, and are more powerfully networked with each other. Players can build new knowledge in practice and in the interaction with other people, and different from the way of learning in classroom, people can learn relevant knowledge in the discussions when people talk in understandable words instead of college terminology. At the same time, the person-to-person way of knowledge gaining is also effective for it can easily catch the attention of learners, and people may have emotional involvement among groups, which is helpful for communication and knowledge learning. And affinity group members each have intensive knowledge, and can share deep and specialist knowledge. The creating of network helps to magnify the power of knowledge distribution of storing knowledge in other people, text, tools, and technologies. "Video game players can be part of a powerful network, if they so desire and know how", and they should know how to leverage the knowledge that is stored in other people and in various tools and technologies. Gee provides his own experience as an evidence for the function of improving cooperative learning of video games. He regards Half-Life, a video game, as a social achievement: "I had tapped into a large network of interconnected chat rooms and game sites that offer other people's knowledge and many tools with which to supplement myself".

What's more, cooperative learning perfectly echoes to the historical background: "new capitalism" was not going to make of every worker a "knowledge worker", and rather, the new global high-tech economy called for lots of service workers, who need good communication skills and a willingness to be cooperative and pliant. Thinking and reasoning are inherently social. The development of technology provides strong supports for the cooperative learning. Students could make conversations with experts and search the web for useful information with the help of modern computer and network technologies.

4 Social Impact

Video games also provide the players from lower social class with the opportunity to learn the values and perspectives of the various personae behind canonical literature, and make them to see their equality to wealthy elites, for they have as much capacity for greatness, truth, and morality as any hero, king, or rich person. Gee claims that "elites can use anything—canonical literature, the Bible, biology, or any other sort of text—to attempt to dupe people by trying to force them to read it in the elite's way", and video games are a new form of art, which will not replace books, but will sit beside them, interact with them, and change them and their role in society in various ways. In the virtual world, people can become the type of people they want to be.

5 Discussion

First of all, the expanding of the scope of literacy has a perfect echo to the new ways of learning in the era of Internet, which has brought huge change to all the aspects of our life, including learning. There are more and more videos that own the educational significance. In the new era, the reading of books is not the only source of knowledge gaining. Instead, the media of Internet provides different patterns of knowledge expression. People could know and think through listening speeches, sharing others' stories in Facebook, as well as playing a video game. We also have many ways to express ourselves, such as blog, Weixin, and virtual communities. Gee's opinions about literacy and semiotic domain help us to realize that we are gaining knowledge through various approaches and experiences, and make us know that playing video games or surfing the internet is not a waste of time. At this point, the expansion of the concept of literacy definitely contributes to the understanding of knowledge in the new era.

Gee's perspective of understanding of video games from the analysis of the learning theories is also thought-provoking. The discussion of the learning theories of video games provides powerful evidences for the educational significance of video games. Gee has clearly presented the relationship of the gaining of knowledge and video games. When the learning theories of video games are acknowledged, the importance of video games will catch more and more attention.

However, with regard to Gee's opinions about the limitations of school education, I could not totally agree with him. First of all, the academic language and complicated understanding are necessary for learning. Although, school education does not value the tacit knowledge, but considering the content design of the classes, certain processes, such as assessments and conceptualization, are necessary. What's more, the teaching strategies have been improved a lot, such as the cooperative and exploratory learning.

Gee talks about the limitation of school education and the strength of video games, but he does not point of how to apply the video games in classrooms. Scholars in the field of educational games have paid lots of attention upon the significance of educational games, but the approaches to apply the video games in classrooms needs further exploration. When we find that there is no conflict between video games and learning, we should talk about how to make use of video games in classroom to enhance learning.

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