Lecture Notes in Educational Technology

Jinbao Zhang
Junfeng Yang
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Tingwen Chang *Editors*

ICT in Education in Global Context

The Best Practices in K-12 Schools

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Preface

With technology integrated into education, various best practices in innovations of infusing technology into education have emerged in different parts of the world. However, there is a problem of scaling up these innovations to promote using technology in education for smart learning. With the purpose to promote innovative use of technology in education to scale-up educational innovations all over the world, this edited volume is composed of 14 best practice cases on technology enhanced educational innovations. Experts from Turkey, Tunisia, Cyprus, Italian, Malaysia, China, India, and Finland have contributed to these cases, providing the current state of the art in the use of technology in education in their counties. Topics cover the best practices of smart classroom building, effective use of tablets and interactive whiteboards, virtual learning environment, digital learning spaces, game-based learning, synchronous remote classroom, micro-lectures, and so on. The book therefore covers new emerging technologies and pedagogies in different countries for promoting learning effectiveness.

Chapter 1 by the editors provides a framework of Context-Input-Process-Output (CIPO) to analyze and evaluate the status of ICT in education in a region which is the basis of utilizing the cases of best practices in the local context. The key components of case studies for ICT in education are discussed and some suggestions are given to promote the scale-up of innovative cases for utilizing ICT in teaching and learning.

Chapter 2 by Petek Aşkar, Arif Altun, Nurettin Şimşek, and Selçuk Özdemir describes a pilot project with the purpose of evaluating the effectiveness of tablet PCs and interactive/smart whiteboard for 9th grade students and their teachers in Turkey. In the case, they found that (a) teachers think that interactive/smart whiteboard would have more impact, whereas students consider tablet PCs would have more impact and (b) students are more anxious about using tablet PCs and interactive whiteboards during instructional processes than teachers.

Chapter 3 by Sadegül Akbaba Altun and Hale Ilgazb provides students', teachers' and administrators' firsthand experiences on using tablet PCs in their schools from a qualitative paradigm in Turkey. It was found that students preferred tablet use for entertainment, communication, and educational purposes. Teachers had doubts about the educational benefits of tablet PCs. Administrators faced mainly the technical problems.

Chapter 4 by Dr. Riadh Besbes is a study from Tunisia entitled *Teaching and Learning Effectiveness Enhancement Project "TLEEP"*, with the aim to improve teaching and learning effectiveness within academic institutions by exploiting data mining methods on collected databases for educational knowledge extraction. It is claimed that the project's data mining strategy in the educational context could support and develop teachers' expertise, enhance and scaffold students' learning, and improve and raise the education system's performance.

Chapter 5 by Dr. Riadh Besbes introduces a project of *Learning Effectiveness Enhancement Project (LEEP) from* Tunisia, which creates productive, student-centered learning environments that have the following overarching objectives: improve ability to personalize learning and individual progress, enhance student engagement and motivation, strengthen teaching effectiveness, equip teachers and stakeholders with useful data that helps to shape interventions, sharpen educational policies, and lighting learning pathways.

Chapter 6 by Dr. Riadh Besbes introduces the project *Teaching Effectiveness Enhancement Project (TEEP)*. This study aims to improve teaching effectiveness within academic institutions by measuring observational data, collecting them in databases, and extracting knowledge from them using intelligent processes. An intelligent system is designed, able to help to assess in quantifiable terms, 35 educational concepts from teachers' practices, attitudes, and behaviors in learning contexts within the class session. This study finds that all processed results on educational concepts can be automatically generated by this system.

Chapter 7 by Vimala Judy Kamalodeen, Trinidad and Tobago investigates whether teachers are ready for the new digital learning spaces. Results show that teachers preferred asynchronous tools such as blogs over synchronous tools such as chats and chose to participate when and how they wanted. Findings also showed a preference to reading over writing.

Chapter 8 by Betul Yikici, Zehra Altinay, Fahriye Altinay, Gulyuz Debes, and Yusuf Deviren discusses how to develop teachers' ability through three cases in Cyprus. Awareness of ICT competence and digital literacy through trainings for all target groups are very essential in developing countries. It has been observed that teachers help each other for the new trends, which shows their enthusiasm. The education ministry should make mandatory in-service training activities for digital citizenship and digital literacy.

Chapter 9 by Earp, Jeffrey, and Dagnino Caponetto introduces pilot experiences performed in the MAGICAL project in game making for learning from Italy. They found the experience appeared to have particular benefits for enhancing learner motivation and engagement, and for triggering collaborative attitudes and behavior. They also found there was a need to ensure that the technological infrastructure is properly prepared and managed, and functions as expected; other lessons learned from the case were also discussed.

Chapter 10 by Mei Lick Cheok and Su Luan Wong introduces the study of teachers' experience by using FROG Virtual Learning Environment in Malaysia schools conducted by the Ministry of Education (MOE). After discussing the outcomes of the project, a few challenging areas that the MOE will still need to look into to ensure sustainability and scalability of the programme are put forward.

Chapter 11 by Hsien-Sheng Hsiao and Jyun-Chen Chen introduces a smart classroom project to spread inquiry-based nature science courses for elementary school in Taiwan. The research guides the concept of the standard operating procedure, which means everything has its standard operating procedure to ensure effectiveness and quality; this is also beneficial for large-scale promotion.

Chapter 12 by Mari Petrelius, Mikko-Jussi Laakso, Ilkka Jormanainen, and Erkki Sutinen introduces a case from Joensuu region in Finland, with the aim to improve teachers' ability to use ICT toward the level needed for the implementation of the new K12 curricula. The new Finnish K12 curricula is characterized by the use of ICT as both a tool and a learning outcome in all the subject areas.

Chapter 13 by Imran A. Zualkernan and Asad Karim describes the use of a host of learning technologies to provide just-in-time teacher training and mentoring and technology-based formative assessments to remote rural schools in Pakistan. The case study deals with improving numeracy skills for grade 5 students in government schools that have little or no ICT infrastructure.

Chapter 14 by Liang Yu and Shijian Chen introduces the case of Chengdu No. 7 online school in which Synchronous Remote Class (SRC) is one of the methods to solve the shortage of high quality teachers in rural areas in China. SRC uses the video conferencing system to connect K-12 classes in developed and undeveloped areas to share the high quality teacher's class with cyber face-to-face communication between classes.

Chapter 15 by Yongbin Hu, Jinbao Zhang and Ronghuai Huang introduces a typical government-led project "J class" microlecture project, which is an ICT in education project with the vision to provide quality learning resources, support individualized learning, and balance district-wide education in Putuo district, Shanghai.

ICT is playing a significant role in education in the digital age, and learning is being reshaped by various educational technology innovations. This book captures those innovations in the form of best practices from different parts of the world. Teachers, school administrators, policy makers, and also researchers from all over the world are expected to benefit from this book on how to integrate technology into teaching and learning in K-12 schools. It is also our editors' aim to achieve through our efforts.

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Contents

Chapter 1
Towards a Critical Understanding to the Best Practices of ICT in K-12 Education in Global Context

Jinbao Zhang, Junfeng Yang, Maiga Chang and Tingwen Chang

Abstract It is believed that ICT has a fundamental influence on the teaching and learning, and many best practices are emerging in different countries. However, there is a challenge on how to scale up these cases to reap the benefits of ICT in education in a large scale. This challenge motivates this book to critically understand the emerging best practices to promote ICT in education. First, the literatures on case studies of ICT in education was analyzed in this chapter; then the general development trends of ICT in Education was discussed; after that, an analysis and evaluation framework of CIPO (four dimensions of analysis and evalution—Context, Input, Process and ouput) was introduced. Finally, the key components of case studies for ICT in education were discussed and some suggestions were given to promote the scale up of innovative cases for utilizing ICT in teaching and learning.

Keywords Case study · ICT in education · Analysis and evaluation framework · Teachers' ICT competence · Learning environment · Patterns of innovative instruction

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1.1 Introduction

In realization of the potentials of ICT (information and communication technology) in education, many countries in the developing world, including the least developed countries, are making significant investments on developing their respective ICT in education plans and on bringing various ICT equipment and resources into schools. Even with extremely constrained financial resources, some countries are purchasing one laptop for every primary or secondary student (Kozma and Vota 2014). ICT holds promise in providing not only anywhere and anytime access to knowledge, but also equal opportunities for networking and communications that allow knowledge sharing, participation, and lifelong learning (UNESCO 2013). Inspired by a humanistic vision of education based on human rights and social justice, UNESCO affirms that the remarkable advances in ICT and the rapid expansion of internet connectivity have made today's world increasingly interconnected, and rendered knowledge and familiarity with ICT essential for every girl and boy, woman and man (UNESCO 2015).

Alongside the development of ICT in education, the role and capacity of teachers have become more critical than ever. It has been one of the big challenges, especially for developing countries, on how to enable teachers use and integrate appropriate technology into the teaching and learning process. The case study of best practice was regarded as an important method for promoting teacher ability for integrating ICT in their teaching. With the public investment for ICT in education, many best practices have been emerging in counties and regions. It is timely now to introduce some of the typical cases to scale up these innovations with the appropriate methods.

1.2 Literatures on Case Studies and Best Practices of ICT in Education

Case study is a common method of research on educational policy and issues. A case can be something relatively concrete such as an organization, a group or an individual, or something more abstract such as an event, a management decision or a change program. Robert K. Yin defines the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used (Yin 1984, p. 23).

Case study emphasize detailed contextual analysis of a limited number of events or conditions and their relationships. Case studies act as a valuable supplement, providing researchers and practitioners with opportunities to experience and respond to complex practice issues in a variety of professional settings. In the process, readers can reflect on relevant theories and techniques as they attempt to understand a real problem, develop a response, and consider the potential consequences.

There are many case studies in the field of research on Educational Technology or ICT in education. Based on the collective case study of five Asian countries in the Microsoft's Partners in Learning (PiL) initiative, Lim (2007) discusses the best practices and associated problems, and formulates lessons learned and recommendations for the sustainability and scalability of a public–private sector partnership. They found that the partnerships (at the local and national levels) are usually based on commonly agreed objectives and many have chosen to focus on building capacity of local stakeholders and end users. At the same time, the creation of partnerships with the local teacher education institutions is seen as a way to ensure sustainability and scalability of the initiative. Dr. Vivian H. Wright, project leader of The University of Alabama Computers and Applied Technology Program (2009), designed the resources, skills, and knowledge necessary to successfully integrate technology into everyday instruction, which included unique scenarios related to each topic with focus and discussion questions. The topics include teens and technology, ubiquitous computing, cyber ethics, podcasting, cyberbullying, social networking, cell phones, wikis, etc. The frameworks of case studies include five parts: background information, focus questions, case study, questions for discussion and references.

However, critics of the case study method believe that the study of a small number of cases can offer no grounds for establishing reliability or generality of findings. Others feel that the intense exposure to study of the case biases the findings. Yet researchers continue to use the case study research method with success in carefully planned and crafted studies of real-life situations, issues, and problems.

In management science, best practice, sometimes used as benchmarks, is a method or technique to show results superior to those achieved with other means. Sometimes a "best practice" is not applicable or is inappropriate for a particular organization's needs. When applying best practice to organizations, it is necessary to adapt and deal with the unique qualities of an organization. In order to understand cases of best practice for ICT in education, it is necessary to know the overall background of the case, as well as the overall status and trends of ICT in education.

As the principal contributor to the World Bank's EduTech blog, Trucano (2010) declares that if adopting "best practice" is fraught with difficulties, and "good practice" often noted but ignored, perhaps it is useful instead to look at "worst practice'". His essays and posts, exploring emerging research, good (and bad) practice examples from successful (and failed) projects, new technologies and initiatives, are widely referenced and cited by policymakers and practitioners alike. He blogged about worst practice in ICT use in education—nine worst practices in ICT for education includes: (1) Dump hardware in schools, hope for magic to happen; (2) Design for OECD learning environments; (3) Think about educational content only after you have rolled out your hardware; (4) Assume you can just import content from somewhere else; (5) Do not monitor, do not evaluate; (6) Make a big bet on an unproven technology (especially one based on a closed/proprietary standard) or single vendor, do not plan for how to avoid "lock-in" (7) Do not think about (or acknowledge) total cost of ownership/operation issues or calculations; (8) Assume away equity issues; (9) Do not train your teachers (nor your school headmasters, for that matter). We think it is necessary for everyone to avoid all common mistakes. After all, it is not completely true that school with full of technology is a fashion.

1.3 General International Status and Trends of ICT in Education

ICT resources are critically important for education, both because their use can improve teaching and learning processes and because they offer an opportunity for innovation in contents, methods and pedagogy. From 2013 to 2015, an international research on ICT in education entitled “International Development Research on ICT in Education” was organized by *Collaborative and Innovative Center for Educational Technology (CICET) of China*, and jointly supported by China’s Ministry of Education and Intel Corporation. The mission of the research is to trace the development ICT in education to look at the general status and trends from a global perspective. By now there are a series of reports released on the status and trends of ICT in education. In the report of year 2014, researchers collect more than 19 countries and regions’ documents on policy, initiatives, research projects, public–private cooperation, and innovative applications of technologies. There are ten main conclusions of international development research on ICT in education: (1) There are exponential increases in the emerging technologies and new ideas in recent years which have enabled the diversification of innovation in school education; (2) Lacking the design of learning activities and curriculum for digital natives in technology rich environment, combined with digital divide led to “learning crisis” in both developing and developed countries; (3) ICT in education has been imbedded in the national strategies by the majority of developed countries; the efforts for overall design of the development of ICT in education have been enhanced by the central governments of those countries; (4) Policies related to ICT in education vary significantly among different countries, which generally match the respective country’s stage of the development of ICT in education; (5) The research field of technology enhanced learning has integrated various areas including pedagogy, psychology, sociology, and information science; (6) Significant differences for ICT in education can be found in the different regions, which match the political, economic and social situation in that region; (7) Educational equity has become a major focus of national strategies for ICT in education in majority of the countries in the world; (8) Multiple investments guided by the governments and cost-sharing mechanisms by various stakeholders are the important factors for sustainable development of ICT in education; (9) Growth of IT industries focusing on education sector is critical for the development of ICT in education; (10) International organizations and academic communities promote global sharing of knowledge and practical experience of ICT in education, bridging the gap of educational philosophy among different countries and regions (Zhang et al. 2014).

In the 2015 report for "ICT in education in global context", the five themes were investigated: (1) deploying strategies of infrastructure in national and region's level; (2) development model of digital resources; (3) innovative instructional practices; (4) design and development of learning environment; and (5) teachers' leadership and capability development. Ten main findings were found in the 2015 report: (1) cloud platform, achieved shared service is the trend of construction and application in education; (2) learning device gradually diversified, but their application prospects are good; (3) new teaching and learning way, becoming more helpful impetus, act as an engine for education to innovate; (4) Internet supported micro quality resources promote teaching way of deep change; (5) construction digital resources content, and intelligent tool and integrative support service system is the trend for most countries to construct digital resources; (6) governments, enterprises and schools act as different roles in participating the construction of digital resources; (7) learning space in school will gradually change from single function of general classroom to multifunctional learning district; (8) Virtual learning environment rendering out different features for different customers; (9) establish need-oriented training system will be best choices for every country to ensure providing adequate support for teacher professional development; (10) Sound third party assessment mechanism can help to establish regulatory and effective development systems for teachers (Zhang et al. 2015).

As we all know, successful integration of ICT into education calls for understanding of the opportunities technology offers and of the needs emerging from the context of application. Unless innovation is truly embraced, technology is unlikely to become an integral part of the education system, but outside the prospect of effective teaching and learning improvements, the use of technology will not last over time (Bottino 2014). Fortunately, there are examples of educational systems, schools and education professionals finding solutions to the challenges, such as digital literacy, new learning environments, institutional change and professional development. The chapters in this book, except from this chapter, are all case study about recent year's best practice in different country. If only it were possible to share such knowledge efficiently, avoid much reinvention of wheels and repetition of history.

1.4 Analysis and Evaluation Framework of ICT in Education Based on CIPO Model

It is the pursuing goal for researches to look at ICT in education from a higher and more comprehensive perspective so as to have a positive impact on future theoretical research and practical activities. In this chapter, we set up an analysis and evaluation framework of ICT in education based on CIPO model which is adapted from CIPP model (Stuffiebeam 2003). See Fig. 1.1.

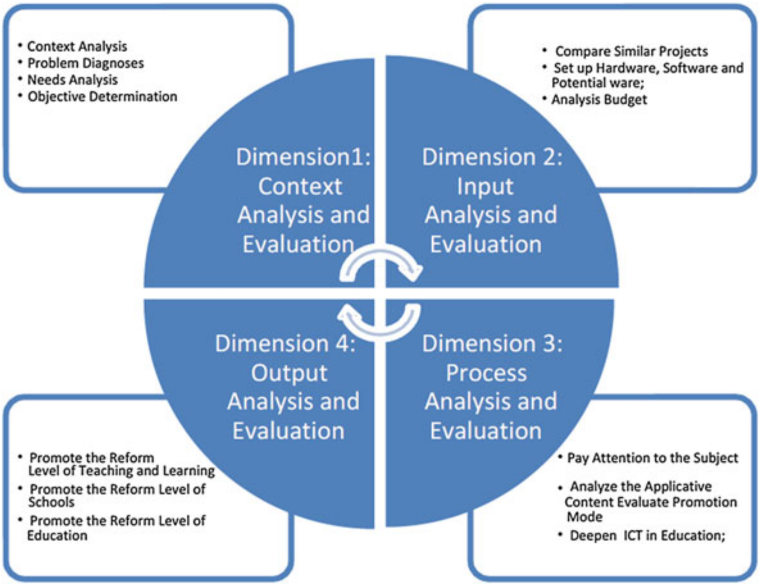

Fig. 1.1 Analysis and evaluation framework of ICT in education based on CIPO model

(1) Context: A combination of factors that affect the objectives, necessity and feasibility of ICT in education include the aspects of education, culture, economy, technology, institution and so on;
(2) Input: This is the part that a variety of ICT in education projects directly invest in, generally including hardware, software, service (including training) and support;
(3) Process: This includes involved participants (initiators, facilitators, change agents and policy makers), innovative contents (ideas, methods, tools and systems), diffusing mode (decision-making, adoption and dissemination) and sustaining the application and integration of ICT;
(4) Output: This focuses on analyzing the effectiveness for the reform at micro, meso and macro levels.

1.4.1 Analysis and Evaluation on Context of ICT in Education

For analyzing the factors of why all nations are eager to develop ICT in education, the external factors (such as globalization and diversity, demands from the development of education, science, technology, culture, society and economy) cannot be ignored. Globalization is the process of international integration arising from the interchange of world views, products, ideas, and other aspects of culture, which takes the economy as the guide, the values as the core, the politics as the supplement and the general culture as the main body. While the development of information society is the process transforming from the society dominated by the material production to that dominated by information industry. One of the main reasons for the countries all over the world to compete in investing in ICT in education is the inevitable product in the trend of globalization and the development of ICT, especially that the rapid development of information industry demands for opening up much broader market space for itself (Fig. 1.2).

Since the complex links existing between the development of economy, society and education, especially with the introduction of ICT, strong political overtones have been added to the development of ICT in education. Chinese government is actively adapting itself to the need of international competition in the circumstances of globalization, and also fully understands that informationization is the general trend of the development of the present world as well as the important power that promotes the economic and social reform. Education has been endowed with a key role in responding to the challenges of globalization and informationization by the Chinese government. The strategy of rejuvenating the country through science, technology and education and that of reinvigorating the country through human resource development have been clarified.

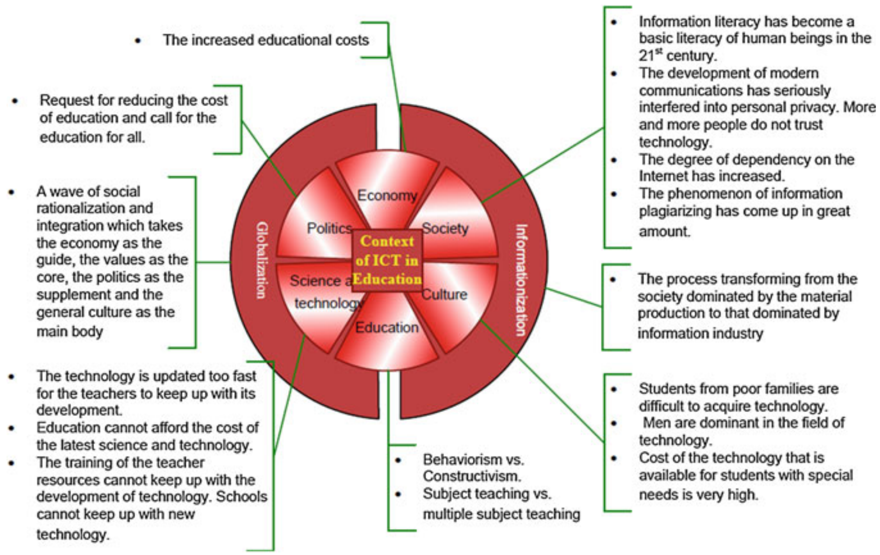

Fig. 1.2 Context of ICT in education

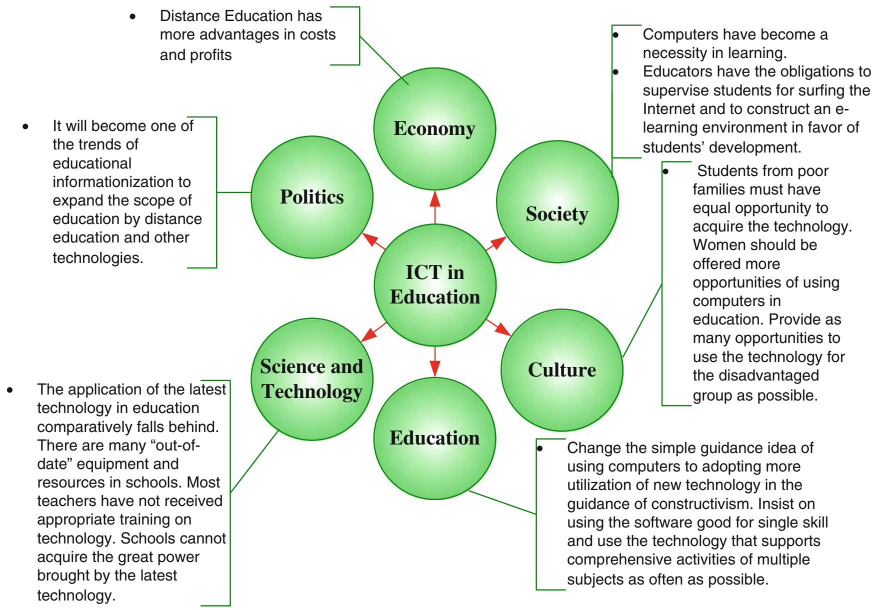

Fig. 1.3 Aims and tasks of ICT in education

By examining the relationships among various contradictions within education, we can also see that people have great expectations for ICT in education. From a macro perspective, the education in China faces the following four critical challenges, which are the lack of investment in education in general, extremely unbalanced development of education, unreasonable personnel structure and mode for talent training, and incomprehensive ideas of educational institutional reform. Those aspects are influencing the ideas and approaches of the educational reform and development in China.

Above all, the development of ICT in education has a strong historical and social background. It is the requirement of the nation in realizing economic development, social development, educational development and technology development and so on. In such a broad context, the implementation of ICT in education requires us to be aware of the related requirements generated by all aspects, to comprehensively review them and to design systematically so as to formulate the strategic objectives for the development of ICT in education (Fig. 1.3).

1.4.2 Analysis and Evaluation on Input of ICT in Education

A research report (OECD 2005) shows that the infrastructure of ICT in education is becoming more popularized both in developed and developing countries. There are four elements are very common known, i.e. "infrastructural construction", "information resources construction", "training for ICT talents" and "policies, regulations and standards of ICT"

1. "Infrastructural construction" refers to a variety of equipment, such as computer equipment, networking equipment, mobile devices, multimedia equipment, etc. On the premise of the constraint of funding for education, profit and funding are difficult to sustainable guarantee, so ICT in education is required to solve the problems, such as "effective input", "on-demand design", "strengthening the maintenance and management," "improving efficiency" and "enhancing profit".
2. "Information resources construction" can be divided into resources related to supporting teachers' instruction, recourses related to supporting students' learning and recourses related to supporting educational management. Digitization of information resources is an effective way of sharing educational resources of high quality, and also a necessary precondition to carry out the integration of information technology and curriculum in education. This aspect has received the amount of investment from the nation only second to the aspect of.
3. "Infrastructural construction". Over recent years, it has got a large amount of educational resources and established a number of focused educational resources databases. As the construction of educational resources is not simply digitalized, but concerns the needs of users, so the top priorities of current construction of information resources are how to get more investment to develop the themed educational resources with more specific focuses, how to strengthen the mechanism of resource sharing and opening up, including standards for resource construction in order to deliver more free resources to the units in need of them and how to build up a more intelligent resource searching and classification system.
4. "Training for ICT talents" includes not only IT teachers and other technical supporting staff, but also the informational literacy and ICT skills of subject teachers and school administrators, which is of great significance to ensure the smooth development of ICT in education and also is the important service in the investment of ICT in education. Training for ICT talents has to make great efforts to train IT teachers, subject teachers and students as well as to strengthen the building of multidisciplinary faculties.
5. "Policies, regulations and standards of ICT" includes the investment planning and financial policies of ICT in education, the incentive policies for encouraging the application of information technology, and various series of specifications and requirements for hardware, software and services, etc., which are important guarantees of ICT in education. However, the problems in this aspect are the coordination among national policies and the differences of systematic educational reform and the reform itself, which cannot be solved by a single reform approach.

"To build for use" is an incontestable truth. However, some people started to doubt the effectiveness of ICT in education. One important reason is the lack of measurement methods for the cost and profit of ICT in education. According to the research report by World Bank, currently there still lacks an effective measurement for the costs of the construction of ICT in education. Therefore, it is very necessary to focus on the research into the costs of ICT in education. Here are some research fields worth focusing

(1) The contents of total costs of ICT in education, such as opportunity costs, equipment costs, maintenance costs, ownership costs, calculation method, etc.
(2) Correlation study on the input and output of the investment in education in different regions, different phases and different educational methods. For example, which kind of ICT in education should be currently carried out in western China to produce maximum profit?
(3) The problem of costs for achieving the objectives with different technical plans and different forms of media. For example, cost differences in Internet access, cost differences between resources development and delivery and maintenance, etc.
(4) Research into the cost of specific forms of ICT in education. For example, the launching costs in distance education, the average cost of learners, the average cost of graduate students, as well as the problem of cost transferring and the enormous cost in the using and maintaining the donated computers.
(5) The impact of financing mechanisms of ICT in education on cost saving, such as the methods of government investment, public–private partnerships, local credit, personal credit, etc.

1.4.3 Analysis and Evaluation on Promotion Process of the Use of ICT in Education

Although the infrastructure is gradually popularized, the effect of application has not reached the required level. A very important reason is the lack of attention in promoting the application of ICT in education. In the past, the analysis of the application of ICT in education mainly focuses on the input elements of ICT in education, such as system design, equipment performances and maintenance, resource development, the quality of the users and so on, but seldom focuses on the process of application, which prevents the proper promotion of the application of ICT in education.

Based on the theory of Diffusion of Innovation by Rogers (1995) and Concern-Based Adoption Model by Hall et al. (2015), we divide the analysis and evaluation of the promotion process of the application of ICT in education into four aspects.

(1) The stakeholders of ICT in Education include all kinds of educational policy makers and administrators, initiators, facilitators and the ultimate users of the application of ICT in education. As the differences of roles, different stages in career (e.g., pre-service, in-service, and post-service), individual factors (such as life stages, families, hobbies, personal characteristics, life crisis, critical events, etc.), social factors (such as rules and regulations, management

methods, the public trusts, social expectations, experts' opinions, the units one works for, etc.), differences of innovation and degrees of risks (such as pioneers, early adopters, early majority, late majority, those who are left behind), differences of the adoption and decision-making process (such as autonomous decision-making, collegial decision-making and authorized decision-making), the communication and exchanges among the stakeholders of ICT in education has become the key to the application of ICT in education.

(2) The content of the application of ICT in education includes the application of information-oriented concepts of education and instruction (also known as "innovative concept"), methods of instructional design and instructional strategies (also known as "innovative technology"), information-based tools and information-based systems (also known as "innovative product") and so on in education. Because they are different in comparative advantages, compatibility, complexity, the features for observation and experimentation, there will be of great differences in the concrete promotion process, which has to draw the attention of all practitioners in the field of ICT in education.

(3) Promotion mode of ICT in education. It directly affects the speed and effects of the proliferation of the content of the application of ICT in education. The effects of dissemination and proliferation are affected by media channels (such as mass media, interpersonal communication, administrative orders, etc.), dissemination mode (such as point-to-point mode, vertical dissemination mode, horizontal dissemination mode, etc.), degrees of users' engagement in the innovation and development (such as function-oriented development, user-oriented development, demand-oriented development, reform-oriented development, etc.).

(4) Deepening information-oriented education. It is the key to realize sustainable development of ICT in education and ultimately realize the goal of ICT in education. Users experience three phases of "focusing on oneself", "focusing on work" and "focusing on the effects in cognition", experience eight phases of "unused", "orientation", "preparation", "rote implementation", "routinization", "specialization", "integration" and "update" in behaviour. Adjusting the promotional activities and process according to the users' feedback and providing necessary support for them are indispensable work in promoting ICT in education to a further development.

It should be pointed out that the concrete application of present ICT in education is often constrained by four aspects, which are the effectiveness of application, the specificity of application, the routinization of application and the conditions of application. Those problems have been affecting the whole process of the application of ICT, and they are also the four aspects of promoting the application of ICT in education.

1.4.4 Analysis and Evaluation on Output of ICT in Education

The analysis of the output of ICT in education reflects people's attention to the effects of ICT in education. On the one hand, people are eager to know the status quo of its development; on the other hand, it is the evaluation of the degree to which the objectives have been achieved. Because people's expectations and purposes for ICT in education are different, the focuses on the analysis of the output of ICT in education are also not the same. According to the report by World Bank, there are no widely accepted criteria for evaluation of ICT in education at present. The United States and Europe utilize a set of standards for the technology use of students, teachers and school administrators. The International Society for Technology in Education (ISTE) came up with the National Education Technology Standards (NETS) Project (http://cnets.iste.org/) the primary goal of which is to enable stakeholders in PreK-12 education to develop national standards for the educational uses of technology that will facilitate school learning. (See attachment for more details on the ISTE NETS standards.) The fact that the other countries did not indicate any existing standards that can monitor the use of technology reflects the lack of qualitative indicators. Many countries merely focus on providing the technology that is making computers and Internet access available (UNESCO 2003). In addition, different countries have obvious differences in the evaluation indicators (shown as Table 1.1).

This paper argues that, although there are certain differences among the evaluation system developed by different countries or agencies, we cannot arbitrarily determine that the higher the level of evaluation is, the more comprehensive it will be. The starting point of selecting or developing their own evaluation indicators should be based on their own objectives, that is the purpose of the evaluation. According to the author's understanding, the analysis of the output of ICT in Education can be divided into three levels, which are "promoting the reform of teaching and learning", "promoting the reform of school" and "promoting the reform of education".

Table 1.1 Evaluation index levels and indicator types of the effects of ICT in education in some countries

Countries	Levels[a]	Qualitative evaluation indicator	Quantitative evaluation indicator
USA, Canada, Europe (Denmark, Sweden, Finland, Norway and UK), Australia, South Korea, South Africa	3	√	√
New Zealand	2	√	√
Japan, India, Malaysia, Thailand, Uzbekistan, Commonwealth of Independent States countries and Baltic States countries	2	√	
Indonesia, the Philippines, Vietnam, Slovenia	1	√	

[a]*Level 1* only includes input indicator; *Level 2* includes input and process indicators; *Level 3* includes input, process and output indicators

1. The Level of "Promoting the Reform of Teaching and Learning"

The ultimate objective of ICT in Education should lie in promoting the development of students and teachers' profession. Reflected in the output of ICT in Education, the teaching reform in the context of ICT in Education reflects changes in three aspects: (1) the roles of teachers and students; (2) instructional process and methods; and (3) evaluation process. Therefore, the analysis of this level should focus on above three aspects.

However, the research into the analysis of the output of the level of "promoting the reform of teaching and learning" shows that the popular four approaches of the application of ICT in American school education are still computer teaching, lesson preparation, instructional inquiry, as well as word processing and presentation. The successful mode of the integration of ICT in or out of school instruction is still unclear. In other words, further efforts are needed for promoting ICT in Education in the reform process of teaching and learning process (World Bank 2007).

The report by OECD points out that currently ICT is far from being the core of the learning process, although it is believed that ICT will have a positive impact on learning performances; and there is still a lack of evidence for a positive impact of ICT in Education on students' performances. However, some researches show that if ICT in Education is related to education, it will be much easier to have a positive impact on students' performances; and from the perspective of motivation, the application of ICT in education effectively encourages teachers and students. And some other researches finds that the opportunity of obtaining ICT will influence users' confidence and the utilization of ICT can enhance learners' autonomy. Those are part of the issues to be focused on when analyzing the output of ICT in education on this level (OECD 2005).

2. The Level of "Promoting the Reform of Schools"

ICT in education involves the reforms of school management, instructional working habits, and infrastructure and so on. However, any reform is bound to affect the school's cultural traditions, management system, and teachers' habit. Thus, a comprehensive reform is difficult to break through only by the school's own culture and system evolution. Unless someone with strong achievements in technology, theory and instruction, etc., strongly push it, together with the institutions and organizations with strong educational backgrounds, backgrounds of educational technology theory as well as technical problem-solving capacity that break the cultural inertia by external attacks in order to promote the reform of schools.

On the level of the reform of schools, data collection and decision support provided by ICT help to improve the scientific and planning school management, to promote the implementation of school-based management, to realize the "off centre-oriented" in the process of school management, and to realize openness and transparence of school administrative affairs. Therefore, those are important aspects of ICT in promoting the reform of schools.

Both OECD countries and those with low level of development have some successful experience about the utilization of ICT on the level of promoting the reform of schools. Some of the successful experience has been well documented, such as the series of reports on "Education for Tomorrow" by OECD. However, on the whole, successful experience or failure lessons of ICT in Education are rarely widely disseminated, or there are no easily acceptable approaches presented for decision makers; nor have they been clearly examined in the educational context related to the Millennium Development Goals. Therefore, there is still a lot of work to be done by ICT on the level of the reform of school management system.

3. The Level of "Promoting the Reform of Education"

On the level of promoting the reform of educational system, ICT in education will finally make the realization of the "Education for All" possible and help to reduce the uneven distribution of educational resources among different regions to achieve fair requirement for education. In addition, the enhancement of the degree of ICT will also contribute to the diversification of educational objectives and evaluation.

The report by World Bank points out that the utilization of ICT in improving the efficiency of educational organizations and educational system, including the application of it in anti-corruption work in the departments of education is currently the very period of high rate of return for developing countries (World Bank 2007).

Research report points out that on the level of the reform of educational system level, different countries have different government departments responsible for the work of ICT in education and successful policies for ICT in education need to take the main bodies of multiple interests into account. The report also shows that ICT does play a good role in the field of special education, such as in helping the handicapped, etc., which will contribute to the realization of educational equity, but the ICT itself has the possibility of expanding unfairness to lead to digital divide. In the areas with a higher marketing degree, ICT helps to the dissemination and sharing of educational contents.

1.5 Disscussion and Conclusion

The rationales of implementing ICT in education in developing countries include the use of educational ICT to support economic development, social progress, and education reform (Kozma and Vota 2014). Challenges existing in developing countries include limited electrical or Internet infrastructure in rural areas, limited availability of technically skilled support staff, the predominance of minority languages, and underqualified teaching staff. For most developing countries, the challenges of ICT in education include: (1) Affordability: recurrent budget to ensure universal access to ICT devices and online digital resources, and regularly update ICT in education; (2) Capacities: in making and managing sector-wide ICT in education policies; institutional and individual capacities in executing polices; (3) Inclusion: equal opportunities for the economically and/or demographically disadvantaged populations; (4) Content: ICT facilitates and complicates the content development and dissemination at the same time; OER and open textbooks holds potentials, but barriers remain huge and complex; (5) Quality assurance: quality of digital content/textbooks; reform of quality framework to embrace new ICT-enabled learning outcomes; quality of online learning (Fengchun 2013).

Various factors affect the development of ICT in education in different countries and regions. It is no wonder why some best practices in some place could not easily be transplanted to another success in another place. As various factors influence the success of ICT in education projects, it is often hard to describe a case of best practices. Therefore, all the cases in the book is structured of case overview, background, initiative description, outcomes, and conclusion, in order to provide a full picture of these best practices. The cases include various models of teacher training, technology-enriched environment and innovative instruction practices. However, it is necessary to clarify the limits of case studies. In General, the limitations of the case studies usually include the following: (1) it is difficult to deductive the finding; (2) technical limitations and biases of the researchers, and (3) a lot of time and effort spent. If we really want to learn about what does and does not work in a variety of countries and contexts, we need share, discuss or even apply these knowledge in real-world settings with others who may be considering using technology to improve both teacher training, teaching and learning.

Using the cases of best practices needs adaptation and re-innovation according the local context. The growing complexity of education and change of information technologies are forcing practitioners and researchers to forge new vertical and horizontal alliances and to seek greater flexibility and efficiency in responding to education changes. The adaptation process is leading educational organization towards greater and more strategically directed integration and networking with external agencies, and to the adoption of a sophisticated toolkit in their design and development activities to enhance developmental flexibility, speed and efficiency. While re-innovation, an extension of innovation, is renowned for its potential in creating competitive advantage with reduced cost, time implications or improvement of the effectiveness.

In this chapter, an analysis framework of ICT in education was developed to provide a tool to look at the development status of educational informatization in a region. It is necessary for readers (Policy makers, researchers, facilitators, practitioners, IT manufacturers, etc.) to consider the context when they want to adopt cases in their practice. The framework can serve as a good tool for understanding the context for adapting and re-innovating the best practices.

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Chapter 2
How Teachers and Students Depict Interactive Whiteboards and Tablet PCs in a 9th Grade Classroom?

Petek Aşkar, Arif Altun, Nurettin Şimşek and Selçuk Özdemir

Abstract This paper describes a pilot project with the purpose of evaluating the effectiveness of tablet PCs and interactive/smart whiteboard for 9th grade students and their teachers. The pilot study was designed to explore students' and teachers' perceived effectiveness of using tablet PCs and interactive/smart whiteboards. The participants included a total of 136 teachers from various state funded schools and 732 9th grade students, who were provided with tablet PCs and interactive/smart whiteboards and were trained in their use. A survey was distributed to the participants at the end of the semester. This paper describes the pilot project and the survey results. We observed that (a) teachers think that interactive/smart whiteboard would have more impact whereas students consider tablet PCs would have more, and (b) students are more anxious about using tablet PCs and interactive whiteboards during instructional processes than teachers.

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Keywords Tablet PC · Interactive/smart whiteboards · Instructional technology · Secondary education

2.1 Introduction

Integrating emerging ICT tools into school systems at the national level is always a challenge for governments at the decision-making level and for schools at the implementation level. Although the ministries of education have a keen interest in equipping schools with those technologies and empowering teachers with new competencies, there are various barriers and hurdles to successfully address those issues, leading mostly to another challenge which is another step in adjusting to change as the use of digital technologies in education rapidly changes and expands (Bates 2000; Duderstadt 1999).

Most of the time, students' effective learning experiences are (or should be) at the center of all these interventions in an education setting. The questions such as *what level of interaction is essential for effective learning? How technology can be used to facilitate effective interactions? And how can we achieve it?* are at the core of measuring the impact of such interventions. Addressing these questions, Moore (1989) outlined three types of interaction in terms of students' learning experiences: learner–content interaction, learner–instructor interaction, and learner–learner interaction.

According to Moore (1989), learner–content interaction refers to the process of "intellectually interacting with content" (p. 2) to make changes in learners' existing schema and understanding. Learner–instructor interaction addresses the issues such as increasing learners' motivation, attention, and stimulation for the subject matter in order to create a healthy and rich learning environment for the learners. Learner–learner interaction refers all types of interaction "between one learner and another learner, alone or in group settings." 18(p. 4). Hillman et al. (1994) goes further to add another type of interaction, learner–interface interaction, which refers to "a process of manipulating tools to accomplish a task" (p. 34).

In this study, students' learning experience with the tablet PC and interactive whiteboards is analyzed through these four types of interaction. In addition, similar approach was taken to elicit teachers' responses while implementing the use of tablet PCs and interactive/smart whiteboards. Finally, it was compared to what extend teachers' and students' perceptions show similarities and differences.

Earlier studies investigating the use of tablet PCs and interactive whiteboards indicate that both these technological tools have something to offer student learning at schools (some references will go here). The purpose of the pilot project described here was to observe and evaluate students' and teachers' applications of tablet PCs and Interactive whiteboards as well as to understand how they perceive the contribution of those tools to teaching and learning process in a classroom setting. The pilot study would help us answer questions such as

- How do teachers perceive the effectiveness of tablet PCs and interactive/smart whiteboards with regard to some variables related to interaction?
- What challenges/pitfalls are there in using these technological tools in educational settings?

2.2 Study Site

This study has been carried out in schools which were part of a broader piloting process of FATIH project, carried out by the Ministry of National Education (MoNE). The pilot phase of FATIH project was launched with the delivery of tablet PCs and LCD Interactive Boards to 52 schools across Turkey. High schools around the country have been equipped with LCD Interactive Boards, and 8.500 tablet PCs have been distributed in 52 schools in 17 provinces within a pilot program. In the expanded pilot phase 49,000 tablet PCs have been distributed to both students and teachers in 81 provinces. By the Ministry of National Education (see http://fatihprojesi.meb.gov.tr/tr/english.php for more information about FATIH project).

The study site included eight high schools from different geographical regions in Turkey: two schools in Ankara, five schools in Kastamonu, and one school in Karaman province. A total of 136 teachers, teaching the 9th graders at those schools, participated in the study. 50 % of the participating teachers were male ($n = 68$) and 47.1 % of them were females, whereas 2.9 % ($n = 4$) did not mention their genders. 5.1 % of the teachers were between 20 and 29 age intervals ($n = 7$); 56.6 % of them were between 30 and 39 age intervals ($n = 77$); 30.1 % of them were between 40 and 49 age intervals ($n = 41$); 5.9.1 % of them were between 50 and 59 age intervals ($n = 41$); and, 2.2 % were missing values ($n = 3$). Teachers' graduated schools included College of Education 44.9 % ($n = 61$), College of Science and Letters 50 % ($n = 68$), College of Theology 2.2 % ($n = 3$), Conservatory 0.7 % ($n = 1$), and undefined 2.2 % ($n = 3$). Demographics related to teachers' distribution across their teaching subject areas are presented in Table 2.1.

Teachers who have their own PCs were 94.1 % ($n = 128$), those who did not have were 4.4 % ($n = 6$), with 1.5 % ($n = 2$) no response; those who indicated that they used tablet PCs before were 3.5 % ($n = 32$), those who did not use were 73.5 % ($n = 100$), with 2.9 % ($n = 4$) no response; when teachers' computer use in years were analyzed, it was observed that 12.5 % of them had 16 or more years of experience ($n = 17$); 27.2 % of them had between 11 and 15 years ($n = 37$); 41.2 % of them had between 6 and 10 years ($n = 56$); 14.7 % of them had between 1 and 5 ($n = 20$), and 0.7 % of them ($n = 1$) never used a computer before. 3.7 % of the

Table 2.1 Teachers' distribution across subject areas

Subject areas	*n*	%
German	3	3.7
Physical education	1	0.7
Biology	8	5.9
Geography	7	5.1
Literature	1	0.7
Philosophy	2	1.5
Physics	3	2.2
Religious studies	2	1.4
English	5	3.7
Chemistry	4	2.9
Mathematics	12	8.8
Music	1	0.7
Teaching as a profession	2	1.5
Guidance and psych. counseling	2	1.5
Art	2	1.5
History	8	5.9
Turkish lang. and literature	17	12.5
Undefined	54	39.7
Total	136	100.0

teachers did not respond this item ($n = 5$). Teachers who had previous interactive/smart whiteboard experience were 33.8 % ($n = 46$), whereas those who never used them before were 65.4 % ($n = 89$), with 0.7 % no response ($n = 1$).

In addition to the teachers, a total of 732 9th grade students in those selected schools participated in the study. The distribution of students across schools is presented in the following figure (see Fig. 2.1).

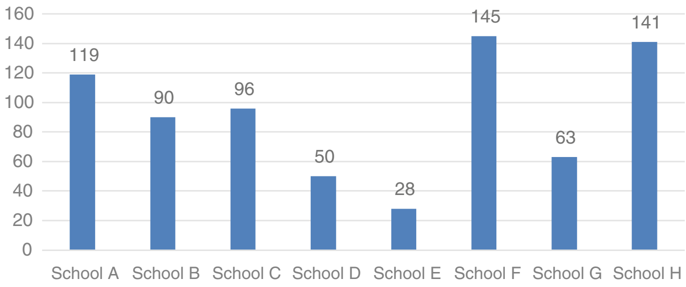

Fig. 2.1 Student participation across schools

2.3 Implementation Process

Piloting in the selected schools had been started at the beginning of Spring 2012 and took about 4 months, until the end of the school year. In order to better describe the piloting process, a detailed descriptive information regarding the implementation process will be summarized for each school.

School A is located in Kastamonu province with relatively low school achievement scores. 1/3 of students leave high school and move into vocational school after 9th grade due to either their low achievement, or repeating. At the time of the piloting, the school had a computer lab and interactive white board in the 9th graders' classroom. Tablet PCs were distributed to students by getting written consent from their parents. School B had classes with 30 or less students in each class. The school has a boarding option, where students were registered to the school from nearby cities and/or villages. Similarly, school C also had a boarding option for students. School administration embraced the vision for technology use at their schools. School D also provided boarding option, where students were coming from nearby cities. Before the implementation process, teachers brought their own computers and projection devices into their classes since there were not enough computers to use at the school. School E, which is the last school in Kastamonu region, was the most successful one in the province according to the nationwide exam statistics results. 60 % of the school students were boarding students and there was a housing option for 25 teachers, who stayed and provided extended study hours for boarding students after school hours. This school had a lab for each content area teaching, sports arena, and a rich library. Each class had laptops and projection devices which were provided by the school administrators. School F, located in Karaman, was a religious high school where boys and girls attended the school in two different buildings. The university entrance ratio was low for the school. Almost 60 % of the students were boarding students at the school. School G, which was rated in the top 10 Anatolian high school nationwide, was located in Ankara with considerably better physical conditions compared to the other schools. All classes were equipped with interactive whiteboards. The materials and orientation process is narrated below.

2.4 Materials and Orientation Process

During the piloting process, various digital platforms and materials were prepared either by the Ministry of Nation Education or SEBIT, an organization developing digital platforms and educational materials for K-12 education. The following table shows the materials utilized in the process.

During the piloting process, teachers were provided an in-service training about basics of PC use, effective uses of interactive boards, tablet PCs, and their educational uses. Within the basics of PC use module, teachers were trained on operating systems functions and MS Office and its functional uses. These training sessions were provided face-to-face by the Ministry of National Education for 30 h.

Tablet PCs and interactive/smart boards included users' guides, which included information about their technical specifications, their functions, as well as how-to visuals. In addition, another in-service training was provided for teachers which lasted 15 h during one week of training.

The third training program included educational use of interactive/smart boards and tablet PCs. This program included both theoretical and practical sessions. The theoretical part included the educational benefits and their functional use in classrooms. In the practice session, the program included lesson plans and the use of embedded software in tablet PCs. These software were browsers, classroom management system, word processing, spreadsheet, presentation, e-book reader, market application, and calendar application. Teachers were provided sample lesson plans with good practice samples and scenarios related to their content areas. These sessions were designed in a show-and-tell and discussion format, face-to-face, and lasted 15 h.

These sessions were completed in an intertwined manner in each meeting with teachers and time was extended when needed. In addition, an online help desk was made available for teachers synchronously. Teachers were expected to train their students accordingly during their class time.

2.4.1 Data Collection Tools

The data were collected through three different survey tools. The demographic survey tool was designed to gather teachers' personal characteristics, such as gender, age, how many years they have been using a computer, their subject matter, graduation information, whether they used a tablet PC and interactive/smart board before in their teachings, and whether they had a personal computer at home. The second (the effectiveness of using tablet PC and interactive/whiteboards in classroom settings: Teacher form) one was adapted from Askar, Koksal, & Yavuz (1992) to determine how teachers perceive the effectiveness of those emerging technologies when used in a classroom setting. This tool had the same variables to measure both for tablet PC and the interactive/smart board. They were mainly asked to compare their experiences in using the tablet PCs and interactive whiteboard to the environments where they did not use them nor these technologies were available. The third tool (the effectiveness of using tablet PC and interactive/whiteboards in classroom settings: Student form) was identical to the second except that they were addressed to students.

In those survey tools given both to teachers and students were 25 variables included. Those variables included interest in the subject matter, understanding the course, attention span to the course, amount of readings, help from teacher, fear, embarrassment, noise, self-evaluation, leisureliness, teacher–student interaction, student–student interaction, receiving awards, curiosity, trust, speed of learning, amount of vocabulary, willingness to study, success, liking the school, liking the course, amount of writing, participation to discussions, number of questions posed, and anxiety. Both students and teachers were asked to rate their perceived effectiveness with one of the three observations: increases, does not change, or decrease. For example, the first variable would be read by the participants as "In settings where tablet PCs are used, teacher–student interaction increases/does not change/decreases-," and the student checks the appropriate checkbox.

2.4.2 Data Analysis

Data were analyzed through descriptive statistics and significant tests. In order to determine whether students' and teachers' responses change, chi-square test was run, followed by Tamhane post hoc tests.

2.5 Students' and Teachers' Perceived Effectiveness of Using Interactive/Smart Whiteboards and Tablet PCs

The analyses of students' and teachers' perceived effectiveness of using interactive/smart whiteboards and tablet PCs were presented in Tables 2.2 and 2.3, respectively. As presented in Table 2.2, most of the students hold the belief that their interest in the subject matter, understanding the course, attention span to the course, help from teacher, self-evaluation, leisureliness, teacher–student interaction, student–student interaction, curiosity, trust, speed of learning, amount of vocabulary learnt, willingness to study, success, liking the school, liking the course, participation to discussions, and number of questions posed would decrease (ranges between 30 and 70 %); whereas, the amount of writing and noise levels would increase when the interactive/smart whiteboard were used in their classes. On the other hand, the amount of readings, fear, anxiety, and receiving rewards would not change.

Majority of teachers (ranges between 50 and 80 %) on the other hand, hold the belief that when the interactive/smart white whiteboard were used in the classrooms, students' interest in the subject matter, understanding the course, attention span to the course, noise, self-evaluation, leisureliness, teacher–student interaction, student–student interaction, curiosity, trust, speed of learning, amount of vocabulary, willingness to study, success, liking the school, liking the course, participation to discussions, and number of questions posed would decrease; whereas, seeking help from teachers, fear, receiving rewards, and anxiety would not change. Yet, their embarrassments and amount of reading and writing would increase. The percentages of the teachers in favor of the effectiveness of the interactive whiteboard ranges between 10 and 40 % (Table 2.4).

Table 2.2 Materials embedded in Tablet PCs

Component	Purpose
Educational Information Network (EIN) market	Portal where MoNE presents all its approved digital content and services
EIN internet browser	EIN Internet browser is provided for safe internet surfing and accessing the materials in the market
EIN bookcase	Books which were distributed by the MoNE free of charge in pdf format
Classroom management application	An application to be used by teachers to manage their courses by using their tablet PCs. With this application, teachers are able to start and end a class; integrate interactive whiteboards with their tablet PCs, can take attendance; rule certain restrictions such as locking students' tablet PCs, or their internet access; can take snapshots from interactive whiteboards or from any student's or their own tablet tos hare later; can view students' tablet views individually; and finally, can control interactive whiteboard remotely
Clickers	An application with which teachers could design their own interactive quizzes and polls, evaluate the results, and share what they like accordingly
Messaging	Teachers could send a message to their students
V-Book	An application to access subject and concepts with tablet PCs. Each V-Book included examples, interactive exercises, experiments, simulations, sample questions with answers, and diagnostic multiple choice questions for students to evaluate their learning process
	Students were given option to add web pages and bookmarks to their v-books. Search capability was also present in v-books
Z-Book	Z-book is an application to deliver textbooks prepared and distributed by the MoNE. In these z-books, content is enriched by simulations, interactive activities, videos, and interactive questions. Bokmarking, highlighting, note-taking were made available with z-books
Vitamin	Vitamin is a K-12 interactive e-content platform, including tutorials, library, study plans, and exams. Teachers can access the library to select and use appropriate content for their classes
	It is possible for teachers to design their lesson plans, share their plans, send questions and/or exams to their students, and monitor their students' progress. Students can access interactive activities, simulations, experiments, interactive activities, videos, and interactive questions
Support center	Upport center was an embedded application in tablet PCs, where many how-to materials were presented in video format
Vitamin teacher portal	A professional development portal for teachers. This portal hosts various asynchronous educational videos and live seminars

(continued)

Table 2.2 (continued)

Component	Purpose
Other applications	In addition to those applications mentioned above, tablet PCs included the following applications: • Kingsoft Office • Notes Mobile (MyScript) • RealCalc • Grapher • Sketch n Draw • Snapbucket • EBookDroid • Jorte Calendar • Mobo Player • Tangram

When the distributions of students' and teachers' responses were compared, teachers and students tend to differ in their perceptions of number of questions posed, the amount of writing, liking the school, success, willingness to study, speed of learning, trust, receiving awards, help from teacher, amount of readings, attention span to the course, interest in the subject matter, and understanding the course.

When students' responses to using tablet PCs were examined (see Table 2.3), it has been observed that most of the students hold the belief that their fear, embarrassment, noise level in the classroom, and the amount of writing would increase; whereas, no change would be observed in receiving awards. Yet, apart from those mentioned above, there will be a decrease in the rest of the statements (ranges between 34 and 78 %).

Majority of teachers on the other hand, hold the belief that when tablet PCs were used in the classrooms, students' fear, and the amount of writing and readings would increase; whereas, no change would be observed in students' participation to discussions, anxiety, receiving awards, embarrassments, and the seek for help from teachers. Yet, apart from those mentioned above, teachers are of the opinion that there will be a decrease in the rest of the statements (ranges between 36 and 78 %).

When the distributions of students' and teachers' responses were compared, teachers and students tend to differ in their perceptions of the amount of writing and reading, liking the school, willingness to study, amount of vocabulary learnt, noise level in the classroom, and the help from teachers. Overall, teachers think that interactive/smart whiteboard would have more impact whereas students consider tablet PCs would have more. According to teachers, interactive/smart whiteboard would have more negative impacts whereas students think that tablet PCs would have more negative impacts.

Comparison analyses indicate that students are more anxious about using tablet PCs and interactive whiteboards during instructional processes than teachers. When designing instructional materials and delivery tools, socio-cognitive factors, such as

Table 2.3 Descriptive and X^2 statistics results related to students' and teachers' perceived impacts on education with interactive/smart whiteboard

In a setting where interactive/smart whiteboard are used	Student						Teacher						Overall		
	Increases		Does not change		Decreases		Increases		Does not change		Decreases		X^2	p	Difference
	f	%	f	%	f	%	f	%	f	%	f	%			
1. Interest in the subject matter	79	11.1	110	15.4	525	73.5	0	0	13	14.9	74	85.1	11.015	0.004	**
2. Understanding the course	83	11.6	183	25.6	449	62.8	1	1.2	19	22.1	66	76.7	10.683	0.005	**
3. Attention span to the course	186	26.1	178	25	349	48.9	8	9.4	23	27.1	54	63.5	12.016	0.002	**
4. Amount of readings	176	24.8	279	39.2	256	36.0	34	41.5	30	36.6	18	22.0	12.088	0.002	**
5. Help from teacher	157	22.1	274	38.6	279	39.3	24	28.6	38	45.2	22	26.2	5.622	0.060	*
6. Fear	304	42.7	337	47.3	71	10.0	38	44.7	43	50.6	4	4.7	2.478	0.290	
7. Embarrassment	307	43.4	328	46.3	73	10.3	41	48.2	39	45.9	5	5.9	1.927	0.382	
8. Noise level in the classrom	302	42.2	187	26.2	226	31.6	28	32.6	28	32.6	30	34.9	3.177	0.204	
9. Self-evaluation	65	9.2	257	36.4	384	54.4	6	7.1	32	38.1	46	54.8	0.417	0.812	
10. Leisureliness	46	6.5	158	22.3	506	71.3	3	3.5	17	19.8	66	76.7	1.650	0.438	
11. Teacher-student interaction	184	25.8	193	27.0	337	47.2	16	18.2	23	26.1	49	55.7	3.004	0.223	
12. Student-student interaction	168	23.7	203	28.6	339	47.7	16	18.2	29	33.0	43	48.9	1.553	0.460	
13. Receiving awards	87	12.3	406	57.3	215	30.4	5	6.0	40	48.2	38	45.8	9.130	0.010	**
14. Curiosity	42	5.9	109	15.2	565	78.9	1	1.1	13	14.8	74	84.1	3.553	0.169	
15. Trust	57	8.0	292	40.9	365	51.1	2	2.4	27	32.1	55	65.5	7.574	0.023	**

(continued)

Table 2.3 (continued)

In a setting where interactive/smart whiteboard are used	Student						Teacher						Overall		
	Increases		Does not change		Decreases		Increases		Does not change		Decreases		X^2	p	Difference
	f	%	f	%	f	%	f	%	f	%	f	%			
16. Speed of learning	79	11.0	149	20.8	488	68.2	3	3.5	23	26.7	60	69.8	5.565	0.062	*
17. Amount of vocabulary	71	9.9	228	31.8	417	58.2	10	11.8	30	35.3	45	52.9	0.907	0.635	
18. Will to study	67	9.4	182	25.5	464	65.1	5	5.9	35	41.2	45	52.9	9.634	0.008	**
19. Success	64	9.0	235	33.1	412	57.9	1	1.2	31	36.9	52	61.9	6.141	0.046	**
20. Liking the school	28	3.9	199	27.9	485	68.1	1	1.1	33	37.9	53	60.9	4.911	0.086	*
21. Liking the course	35	4.9	212	29.9	463	65.2	2	2.3	28	31.8	58	65.9	1.298	0.523	
22. Amount of writing	460	65.1	149	21.1	98	13.9	64	76.2	15	17.9	5	6.0	5.385	0.068	*
23. Participation to discussions	98	13.7	293	41.0	323	45.2	16	18.8	26	30.6	43	50.6	3.935	0.140	
24. Number of questions posed	126	17.7	287	40.3	300	42.1	15	17.6	24	28.2	46	54.1	5.354	0.069	*
25. Anxiety	281	39.4	326	45.7	107	15.0	36	42.4	42	49.4	7	8.2	2.830	0.243	

Student n = 714
Teacher n = 85
*0.10
**0.05

Table 2.4 Descriptive and X^2 statistics results related to students' and teachers' perceived impacts on education with Tablet PCs

In a setting where tablet PCs are used	Student						Teacher						Overall		
	Increases		Does not change		Decreases		Increases		Does not change		Decreases		X^2	p	Difference
	f	%	f	%	f	%	f	%	f	%	f	%			
1. Interest in the subject matter	71	10.0	87	12.2	554	77.8	8	10.8	10	13.5	56	75.7	0.177	0.915	
2. Understanding the course	78	11.0	172	24.2	462	64.9	8	11.1	20	27.8	44	61.1	0.496	0.780	
3. Attention span to the course	164	23.0	171	24.0	377	52.9	13	18.1	18	25.0	41	56.9	0.940	0.625	
4. Amount of readings	152	21.4	270	38.0	288	40.6	37	50.7	24	32.9	12	16.4	34.02	0.000	**
5. Help from teacher	150	21.2	267	37.8	290	41.0	22	30.1	33	45.2	18	24.7	7.826	0.020	**
6. Fear	325	45.9	296	41.8	87	12.3	34	47.2	33	45.8	5	6.9	1.858	0.395	
7. Embarrassment	319	44.9	308	43.4	83	11.7	33	45.8	36	50.0	3	4.2	4.028	0.133	
8. Noise level in the classroom	291	41.1	204	28.8	213	30.1	23	31.9	18	25.0	31	43.1	5.210	0.074	*
9. Self-evaluation	66	9.4	278	39.4	361	51.2	10	14.1	30	42.3	31	43.7	2.325	0.313	
10. Leisureliness	50	7.1	160	22.6	497	70.3	4	5.5	18	24.7	51	69.9	0.363	0.834	
11. Teacher-student interaction	155	21.9	185	26.1	368	52.0	14	18.9	24	32.4	36	48.6	1.414	0.493	
12. Student-student interaction	139	19.6	197	27.8	372	52.5	14	19.2	23	31.5	36	49.3	0.457	0.796	
13. Receiving awards	84	11.8	381	53.7	244	34.4	6	8.5	35	49.3	30	42.3	2.013	0.365	
14. Curiosity	42	5.9	131	18.5	536	75.6	4	5.4	12	16.2	58	78.4	0.286	0.867	

(continued)

Table 2.4 (continued)

In a setting where tablet PCs are used	Student						Teacher						Overall		
	Increases		Does not change		Decreases		Increases		Does not change		Decreases		X^2	p	Difference
	f	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%			
15. Trust	56	7.9	253	35.7	400	56.4	5	7.0	23	32.4	43	60.6	0.453	0.797	
16. Speed of learning	74	10.4	144	20.3	493	69.3	8	11.1	20	27.8	44	61.1	2.444	0.295	
17. Amount of vocabulary	62	8.7	234	32.9	415	58.4	17	23.3	16	21.9	40	54.8	16.59	0.000	**
18. Will to study	68	9.6	165	23.3	476	67.1	7	9.9	28	39.4	36	50.7	9.475	0.009	**
19. Success	70	9.9	222	31.4	416	58.8	9	12.7	24	33.8	38	53.5	0.921	0.631	
20. Liking the school	29	4.1	194	27.3	487	68.6	1	1.4	33	45.8	38	52.8	11.38	0.003	**
21. Liking the course	39	5.5	214	30.4	450	64.0	5	6.8	29	39.2	40	54.1	2.864	0.239	
22. Amount of writing	412	58.4	157	22.2	137	19.4	56	75.7	13	17.6	5	6.8	9.905	0.007	**
23. Participation to discussions	104	14.7	308	43.6	294	41.6	11	15.3	35	48.6	26	36.1	0.868	0.648	
24. Number of questions posed	129	18.2	266	37.5	315	44.4	16	22.2	24	33.3	32	44.4	0.880	0.644	
25. Anxiety	267	37.6	314	44.2	130	18.3	30	42.3	33	46.5	8	11.3	2.255	0.324	

Student $n = 712$
Teacher $n = 74$
*0.10
**0.05

curiosity, student interaction, trust, and participation to the discussion should be emphasized and integrated into teaching process along with the content materials.

The study results also indicated that both teachers and students equally agree on four items that would decrease the overall impact. Yet, teachers emphasized that fear would stay still. In the survey tools, there were 25 items, upon which both teachers and students indicated either a positive or negative impacts on education. This finding clearly shows that those emerging technologies carry a lot of expectations for both students and teachers. Teachers would be advised to develop activities for students to address cognitive issues, such as attention, memory, and learning independent from content matters.

2.6 Conclusion and Discussion

The impact of tablet PCs and interactive/smart whiteboards in teaching and learning has been investigated in various school levels, including elementary (i.e., Kravcik et al. 2004; Jang et al. 2012), secondary (i.e., Alvarez et al. 2013), high schools (i.e., Betcher and Lee 2009), and universities (i.e., Eurell et al. 2005). When the results are reviewed for tablet PCs, it can be concluded that tablet PCs can help enhance students' note-taking ability (Eurell et al. 2005); improved their ability to organize class materials, and allowed them to integrate handwritten notes and course materials (e.g., Enriquez 2010); provided students individualized feedback and that such feedback was related to student engagement behavior (Xu 2010; McVey 2008); enhanced the learning environment for many mathematics students and that the technology engaged students with different learning styles (Fister and McCarthy 2008); enhanced classroom dynamics, teaching effectiveness, and student learning in science and engineering courses (Rogers and Cox 2008).

According to Lee (2010), the interactive/smart whiteboard revolutionized the classroom system. Yet, Lee (2010) observed at schools during school visits that teachers initially maintained their existing pedagogical style with the interactive whiteboards. Moreover, Lee (2010) also emphasized that teachers had employed the full spectrum of approaches from the strongly teacher-centric to strongly student-centric as well as beginning to explore new ways of using the technology as they practice it more. Citing Lee and Winzenried's study, Lee (2010) went further to add that variables articulated for successful implementation of instructional technologies are held true for integrating interactive/smart whiteboards: teacher acceptance, classroom availability, ongoing in-house support and development, quality infrastructure, funding, and most importantly quality leadership.

Another study by Somyurek et al. (2009) identified the problems hindering the effective and efficient use of smart boards in Turkish primary and secondary schools, as compared to previous ICT integration efforts by MoNE. Based on the data collected from both teachers and students, the researchers reported that the factors hindering the use of IWBs in education are correlated with factors occurring in previous ICT integration projects. In other words, the lessons learned from previous ICT projects were not applied to the smart board integration project. Furthermore, such large-scale projects draw public interest, as well. Therefore, the researchers point out the fact that before negative opinions spread "in the public mind, and before ICT in education loses its novelty to educational actors, necessary measures must be taken by institutions technical support, maintenance, and administrative cooperation" (p. 373).

Research about the effectiveness of interactive whiteboards usually addressed teachers' acceptance and schools' willingness to use the whiteboard. Teacher and student acceptance and use of the whiteboard were explored based on various models such as Technological Pedagogical Content Knowledge model (e.g., Jang and Tsai 2012) and/or various versions of Technology Acceptance Model (e.g., Türel 2011). The attractiveness of the whiteboard to the students, the enhanced student attendance, and how they help improve student behavior (Lee and Winzenried 2006) and the significant improvements in teacher efficiency (Becta 2007, p. 48) are also explored in detail. According to Lee (2010), enhancing the quality of teacher and student usage is the next major challenge. The results of this case study, therefore, is a contribution to the existing effectiveness research in exploring the perceived effectiveness of using two emerging technologies during a piloting period at various high schools. Based on the results of this case study, the following suggestions could be made;

Lessons Learnt:

- More effort is needed to improve interactions to change students' perceptions regarding fear, noise level in the classroom, and anxiety.
- Socio-cognitive variables, such as curiosity, student interactions, trust, and contribution to discussions, are to be integrated into curricula when designing instruction with Tablet PCs and interactive/smart whiteboard.
- Independent from course materials, teachers need to be trained in designing activities related to attention, memory and learning by using Tablet PCs and interactive/smart whiteboard.
- Teachers need more time to internalize tablet use in their classes before their students. Providing tablet PCs to teachers and students at the same time seemed to create synchronization problems.
- Applications embedded in tablet PCs need to be revisited based on teachers' expectations and needs.
- Teachers and other stakeholders should be well-informed much earlier in time before scaling up.
- Schools' infrastructures are crucial and support should be provided just-in-time and on-site for teachers.

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Arif Altun is a professor of computer education and instructional technologies at Hacettepe University, Ankara, Turkey. His current research areas include cognitive issues in learning with hypertext, designing personalized e-learning environments, computerizing neuro-psychological tests, and developing educational ontologies. He is currently running the ONTOLAB with a team of researchers to explore various cognitive processes in order to understand and develop sound instructional decisions for e-learning. He has been conducting research about technology integration at the classroom level by combining existing research findings to develop personalized learning experiences for individuals.

Dr. Nurettin Şimşek is a professor of educational technology and head of department at Ankara University Faculty of Educational Sciences, and member of Distance Education Commission at Higher Education Council. In generally, his researches include creation and management of technology-enriched teaching and learning environments. He is the editor in chief of Journal of Educational Sciences & Practice (ISSN 1303-6475) and president of Association for Educational Sciences & Practice.

Dr. Selçuk Özdemir married and having two daughters, has been working on the development and use of educational software since his undergraduate years. His focus is especially on creating self-learning environments where kids can gain skills of coding, 3D design, web design, robotic design/coding, and entrepreneurship. He is the founder of Bilişim Garaj Akademisi (ICT Garage Academy) (bilisimgarajakademisi.com), where the children between ages 7 and 16 can learn how to use computers and internet as a production and problem solving tool using online learning content.

Chapter 3
A Qualitative Case Study of Tablet Use in a High School in Turkey

Sadegül Akbaba Altun and Hale Ilgaz

Abstract Within the scope of FATIH project, tablet PCs have been distributed to teachers and students starting with pilot schools. The purpose of this study is to understand students', teachers', and administrators' first-hand experiences on using tablet PCs at their schools from a qualitative paradigm. A total of 101 students, 13 teachers, and 4 administrators participated in this study. Data were gathered through interview forms. Three different interview forms, which contained 12 open-ended questions for students, 10 questions for teachers, and 8 questions for administrators are prepared. Participants were asked to fill the interview forms. Data analyzed by descriptive and content analysis. It was found that students preferred tablet use for entertainment, communication, and educational purposes. Teachers had doubts about the educational benefits of tablet PCs. Administrators faced mainly the technical problems. One reason of this result may be attributed to introducing two novelties (interactive boards and tablet PCs) at the same time. Second, when teachers and students made comments about their experiences, they mainly compared tablet PCs with interactive whiteboards. These experiences might lead us to conclude that if you put two novelties together into the system at the same time, it is possible that one will fall under the shadow of another and will be preferred more than the other. Thus, it can be suggested that in order to have successful ICT integration, novelties can be introduced into the system one by one but aligned with each other, and with the curriculum.

Keywords Tablet PC · Teachers · Students · Administrators · Turkey

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3.1 Introduction

Computers have been introduced to schools in Turkey for more than three decades. In 1984, Turkey's Ministry of National Education (MoNE) first introduced computers to secondary schools. Then in 1991, national policy included computer-aided instruction. Later, in 1998, the MoNE received a loan from the World Bank to invest in a two-phase National Basic Education Program (BEP). As a comprehensive educational investment project, the objectives of the BEP were to expand 8-year compulsory education, to improve the quality of education, and to make basic education schools become learning centers of the community. In order to improve the quality of Turkey's education, one of the objectives of this development program was to ensure each student and teacher becomes at least literate in information and communication technology (ICT). With the completion of these projects almost all elementary schools equipped them with computers, printers, scanners, TVs, videos, multimedia software, and slides. All schools had the same number and type of IT tools, except for the number of computers. Laptop computers were supplied to primary education supervisors who were then trained on computer literacy, active learning, and teaching strategies. In addition, almost all elementary school teachers were trained on computer literacy in various in-service programs provided by the MoNE. Moreover, computer coordinators were trained (MEB 2004; Akbaba-Altun 2006).

After implementation of this project, many studies were conducted about the ICT integration in Turkey. Research results (Akbaba-Altun 2005, 2006; Karagöz 2004; Ünal and Öztürk 2012) and MoNE reports have indicated that IT classrooms were not being used effectively (Reg No: 13, 2002), and suggest some precautions to supervisors and administrators. Integration of computer technologies into education was a reform in the Turkish education system which was aiming at leading toward a knowledge society. However, without providing well-planned and up-to-date training programs for supervisors, school administrators, computer coordinators, and teachers, this process was mostly found to be ineffective (Akbaba-Altun 2006). In addition, lack of ICT-based teaching resources, the effect of traditional approaches on teachers' practices, inadequacies regarding in-service teacher training, and lack of time were reported as some barriers in front of ICT integration (Ünal and Öztürk 2012).

In 2005, MoNE changed elementary and secondary education curriculum with the emphasis on constructivist approach. With this curriculum change, in some subject areas ICT integration was placed to curriculum as attainment. But, still ICT has not been fully integrated into curriculum.

In 2010, MoNE stared another huge project which is called FATIH. FATIH Project has been initiated by the Ministry of Education nationwide in order to ensure all students access to equal opportunities in education and the information and communication technologies as well as to train individuals who have the skills required by the twenty-first century. The Project implemented by the Ministry of National Education has covered preschool, primary- and secondary-level schools.

LCD Interactive Boards and Internet network infrastructure is provided to 570.000 classrooms within the scope of the project, and tablet PCs are given to all teachers and students. Within the scope of FATIH Project, the infrastructure, hardware, education informatics network (EBA), and in-service training of teachers have been carried out in subprojects. First of all, it was started to be implemented as a pilot scheme in 2010–2011 academic year, and it was designed as a 5-year project. The main components of FATIH Project included the following activities:

1. Provision of hardware and software infrastructure
2. Ensuring educational e-content and managing
3. Effective usage of IT in education program
4. In-service training of teachers
5. Conscious, securely, manageable, and scalable use of IT (MEB 2015).

The foundations of the project have been based on the Strategy Document of the Higher Council of Science and Technology projecting toward the period 2003–2023. With the coordination of The Scientific and Technological Research Council of Turkey (TUBITAK), the strategy document has emphasized individual differences in education and in learning and in people-oriented education system in the Vision 2023 report (TÜBİTAK 2004).

In order to find solutions to possible upcoming problems and make the process a smooth transition, a pilot phase was carried out. When the studies regarding the piloting process were evaluated, it is observed that the attempts were initiated in the last quarter of 2012 by soliciting experiences of administrators, students, and parents (Günbayı and Yörük 2014; Kalelioğlu and Altın 2013; Güllüpınar et al. 2013; Keser and Çetinkaya 2013; Dursun et al. 2013). Many studies emphasized the need for school principals' technological leadership (Bailey 2000; Akbaba-Altun 2002, 2004, 2006; Anderson and Dexter 2005).

In a recent study conducted by Günbayı and Yörük (2014), it was intended to explore school administrators' views and opinions regarding the implementation process of FATIH project at schools. According to school principals, the perceived benefits of the project was regarded as highly beneficial for increasing self-efficacy and project outcomes; and more efforts were needed to make learning processes aligned with ICT tools. School administrators also stated that their organizations were moderately ready for this change so is the e-content.

In their qualitative study exploring school principals' opinions regarding FATIH project, Kalelioğlu and Altın (2013) reported that most school principals stated that they found the project to be an affirmative contribution to education. In another study conducted by Dursun et al. (2013), school principals had stated that teachers could not use the interactive whiteboards and tablets as effectively as they used to be due to the inefficiencies in e-content. In addition, school principals went further to add that this project should have been embraced because of its investments in infrastructure and their potential contribution to education.

In their study with teachers who took part in FATIH pilot process, Kurt et al (2013) pointed out that interactive whiteboards were the most heavily used tool among the others. In addition, the researchers had found out that teachers' interactive whiteboard use were correlated with teachers' initial interest, attitudes, their access frequencies in various materials and course materials, and their competencies in technology use. With the help of this project, teachers believed that, their schools became well-known, resulting in various visits from outside and increased demand in school registration rates. Teachers also reported that technology integration process created an interactive support culture in teacher–teacher, teacher–student, and student–student relations.

In another study, Güllüpınar et al. (2013) explored parents' views on pilot process at schools. The researchers concluded that parents held the belief of positive effects of ICT integration on condition that teachers integrate them rich in content and effective in organization to train future creative, explorative, and questioning generation.

Various research results indicate that the use of interactive whiteboards led positive attitudes (Öztan 2012; Koçak, 2013; Pamuk et al. 2013; Kurt et al. 2013; Sayır 2014; Devecioğlu and Kaymakçı 2014; Altın and Kalelioğlu 2015), whereas the use of tablet PCs produced mixed results.

In their research exploring secondary school students' views and expectations from tablet PCs, Kalelioğlu and Akbaba-Altun (2014) reported that almost all students were hesitant toward tablet PCs, were not informed enough, but excited and happy to receive a tablet PC. Pamuk et al. (2013) found that the use of tablet PCs was too low at schools. Kurt et al. (2013) reported that when students were interacting with their tablet PCs, they missed eye contact with their teachers, according to whom, this created classroom management issues.

As Altın and Kalelioğlu (2015) pointed out tablet PCs were not used purposefully in classes; e-content was not adequate both for interactive whiteboards and tablet PCs; therefore, they are useless, according to teachers. When considering the effective use of tablet PCs at classrooms, students also share teachers' views. Improper use of and lack of e-content in tablet PCs might lead such negative attitudes in students. In addition, students hold the belief that learning with tablet PCs prevented their recollection of learning, did not make learning easier, and did not increase their motivation toward the courses.

Within the scope of FATIH project, tablet PCs have been distributed to teachers and students starting with pilot schools. Since there are mixed results in tablet PC use, the purpose of this study is to understand students', teachers', and administrators' first-hand experiences on using tablet PCs at their schools from a qualitative paradigm.

3.2 Methodology

This study is designed as a case study to understand students', teachers', and administrators' perceptions regarding to using tablet PCs in learning environments. Case studies are used to describe an intervention or phenomenon and the real-life context in which it occurred while "how" or "why" questions are being posed (Yin 2003).

Table 3.1 Demographic data of participants

Students		*f*
Gender	Male	40
	Female	61
Age	14	3
	15	62
	16	34
	17	2
Teachers		*f*
Gender	Male	4
	Female	9
Length of service	0–3 years	1
	7–18 years	8
	19–30 years	4
Administrators		*f*
Gender	Male	4
	Female	–
Length of service	19–30 years	3
	30 and more years	1

3.2.1 Participants

A total of 101 students, 13 teachers, and 4 administrators participated in this study. The teachers' content areas were literature, chemistry, English, math, physics, and philosophy education. The administrators' background was literature, chemistry, and religious education. The participants' demographic data are presented in Table 3.1.

3.2.2 Data Collection and Analysis

Data were gathered through interviews forms. Three different interview forms, which contained 12 open-ended questions for students, 10 questions for teachers, and 8 questions for administrators, were prepared for students, teachers and administrators. Participants were asked to fill the interview forms. After data collection, first each group data were coded by both researchers. Then, those coded data were compared and emerged themes were determined.

Finally, two independent domain experts were asked to recode the data based on the emerging codes and themes. According to Creswell (2007), researchers are to obtain detailed field notes and transcribe these records carefully to increase the reliability, which refers to stability of responses to multiple coders of data sets. For this study, inter-coder agreement technique was used. Cohen's Kappa coefficient was calculated and found 0.72, which is within the range of acceptance (Krippendorff 2004; Landis and Koch 1977).

3.3 Findings

3.3.1 What Does "Tablet" Mean?

Students' perceptions related to the tablets were related to the physical characteristics and the intended use. Students have seen the tablets as a small and portable computer. Also, it has been seen that they described it as a communication and entertainment device, which helped them develop their lessons, enable them to play games, to surf the Internet, etc.

On the other hand, teachers' responses revealed the themes of use and their economical dimension. They have stated that the improper use would have no contribution to students' learning and that the students have used the tablets for the purpose of playing games. From an economical perspective, they stated that tablets led to unnecessary costs and the technical infrastructure of tablets was inadequate.

Administrators' opinions about the tablets are grouped in themes as outputs of use, classroom management and technical issues. They think that tablets would be useful if they were properly used, and the courses would have been performed more efficiently. They think that it would be useful, if teacher control is ensured. Moreover, the integration with other devices such as smart boards should be provided.

3.3.2 Why Are You Given a "Tablet PC"?

Students' responses regarding the reason for why they thought they had been given tablets were categorized under the following themes: the purpose of supporting learning, ergonomics, and equal opportunity". Students mostly think that the tablets have been distributed to help them learn. They also think that tablets have been distributed to make studying easier and more enjoyable, to teach lessons effectively, to help their homework, to contribute to education and to provide more visual learning by reaching different materials on the Internet. They see that tablets save students from carrying their heavyweight backpacks as they will not carry books. In addition, tablets will help them learn and provide equal opportunity for people whom economic situation is not good, and who cannot access technological devices such as tablets. One student stated his/her ideas on this subject as follows:

> Because, textbooks were doing too much weight. They all wanted to facilitate learning and to teach courses technologically by putting them in a tablet. [S-49]
>
> Tablet was given to facilitate our learning, now we will get information more easily. [S-30]

Teachers' opinions about the distributed tablets to students have been categorized in the following themes: diversity of material, access, and finding them unnecessary. Teachers have emphasized that visual support which tablets had provided and saving students from the weight and cost of books had been among the objectives of this distribution. Teachers also believed that the purpose of this distribution is to monetize the companies who provide those devices. Teachers' opinions on distribution of tablets are as follows:

> It is necessary for access to course tools via tablet and for use of a book contents. It is necessary for using internet for more extensive research. [T-9]
>
> It is to prevent waste arising from the book distribution, to benefit from the opportunities of technology in education. [T-11]

Also, administrators' opinions on distribution of tablets have situated under themes as quality education and contribution to courses. They think that it has been intended to provide easier access, to catch the era and to contribute to the courses with the tablets.

3.3.3 What Did You Do with "Tablet PC"?

When asked students what they did with the tablets distributed, it was observed that educational works and recreational use came forward. Use of tablets for educational purposes covers downloading textbooks from the market (called EBA) provided by the MoNE, downloading the materials in this site, making research by using the Internet for their homework, and studying by using the tablet. In the recreational use, students stated that they downloaded music, watched movies from the Internet, played games, surfed in the Internet, and used the social media devices. Two students using Internet for both their courses and their recreational purposes expressed what they did with the tablets as follows:

> I downloaded books into it, so I don't be tired because of carrying books. I played game by downloading. [S-93]
>
> I downloaded EBA market and the things about the course, and also I downloaded a simulation such as dictionary, etc. about some of courses. [S-99]

It was determined that teachers' opinions related to the things that students were doing with tablets were in the direction of the classroom activities and nonuse. According to the teachers' observations, students performed some activities such as downloading their textbooks, recording in the courses, downloading applications from EBA market, using the question bank, watching video from YouTube and accessing to the Internet in the courses. According to the data obtained from interviews, some of the teachers did not let students use tablets that were distributed.

Administrators' opinions on this subject were collected under the themes of classroom use and recreational use. In line with the teachers' opinions, administrators have agreed that tablets have been used for downloading books, downloading material from EBA market, surfing in the Internet, preparing presentation in the courses. In the recreational theme, activities of playing games, using social media software have been emphasized.

3.3.4 What Was Explained to You About "Tablet PC"?

In the scope of the project, during/before distributing tablets in the classroom, an informative presentation was made to the students. In this presentation, it was observed that students' answers to the question what things were told to them had focused on the use of tablets and the outcomes of their results, as a result of using them. It has been stated that it would provide ease in the courses with intended use of the tablets, information regarding the use format and the correct use, and that its benefits had been told. Remaining things in the minds of the students from these contact meetings are worth noting:

> That we use it for the courses that we need to charge it correctly. We should not damage. [S- 95]
>
> Nothing, everyone already knows how to use it. Only thing is that it was told us to use it for educational purposes, but we played game, of course. [S-63]

The interviews revealed that the training provided to the teachers had not reached everyone during the distribution of the tablets. Moreover, some teachers had been trained partially with either one of the tools. The following statement, for example, summarizes this situation well:

> I got smart board training. We haven't received any training related to the tablets. [T-6]

Meanwhile, administrators had been provided informative sessions regarding the class management and technical details. School administrators perceived that playing games should be addressed within the class management training. Integration of the smart boards should also include technical details.

3.3.5 What Do You Want to Say About the Distribution of "Tablet PC" to You?

Students emphasized that technical problems, problems about intended use, and its benefits are the main themes regarding the distribution of tablets. Students thought that tablets distributed to them might have been faster. Moreover, they believed that they were provided with a bad brand, and they were constantly disrupted when used. In addition, there were also some students who thought that tablets did not work due to the access limitation to the Internet; therefore, the distribution of the tablets led an unnecessary cost. Furthermore, in the questions related to the intended use, it has revealed that students used them for playing games, instead of using for the courses, and some of the students have considered that tablet prevented them from thinking and affected their sociability. Unlike the students thinking in this way, students who think that the distribution of tablet is useful and may be distributed earlier were also observed.

> In fact, a system which teachers can control us can be great, because they play in the course. But now, it is bad, we only use it for games. [S-70]

It caused my friends to take a break less than before and become asocial. [S-72]

Teachers' opinions on the distribution of tablet concentrated in three different dimensions such as themes of unnecessary costs, misuse, and necessity.

It is practical and useful, if used for good purposes, but I still think that it is a waste. [T-3].

I think it is necessary to capture the era. [T-13].

Administrators stated that, first, using technology correctly was important; second, it should be distributed to all schools; finally, the integration of smart boards into curricula should be provided.

3.3.6 How Did "Tablet PC" Affect Your Learning?

Students' responses to how tablet PCs affected their learning were grouped into three as positive, negative, and neutral. Statements such as "it had a positive effect, we can get information more quickly, it visualized, interest of the courses increased, and saves us from the weight of books" signaled that students perceived the introduction of tablet PCs into their learning experience as positive contribution. On the other hand, some students considered it as negative as represented in the statements like "it had a negative effect, lessons have listened less than before, and we follow the courses from the books more easily." There was another group of students who were neutral about this situation. It is remarkable that some of the students have wanted to follow the lessons from the printed books, and other ones have preferred to be free from the weight of the books and follow from the digital environment. Opinions of three students related to this question are as follows:

I can take notes fast. Therefore, both reading is so easy and I don't deal with a ton of paper. [S-95]

It affected in negative way. It encourages playing game. Inadequate security measures, inadequate tablet experience. [S-100]

There was no change in my learning. [S-58]

Teachers' opinions related to the effectiveness were grouped into two as positive and negative. If the tablets are used for their purposes, teachers think that it affects students to learn in a positive way; if they are used except for that purpose, it affects in a negative way. Teachers' opinions on the subject are as follows:

The correct usage would surely benefit. However, restrictions on the tablet force the use of it. [T-10]

An educational system which has been constructive, cooperative(studied by helping each other), considered the differences (level), based on autonomy, and teachers become leader affects in a positive way. But it affects in a negative way in an educational system such as ours, which the control of teachers is active, but teachers are passive. A child who has 13 courses (in the period) considers the tablet as a gateway. [T-3]

Also, administrators have stated that appropriate and conscious use of the tablets would affect learning in a positive way.

3.3.7 What Are the Advantages and Disadvantages of "Tablet PC"?

Question about advantages of using tablets has shown that students evaluated these advantages as educational, game-like, and prestigious. They consider saving from carrying books, noting on tablet instead of taking note by writing, and providing quick access to information as an educational advantage. As well as in students who considered playing games as the advantage, some students stated that they felt cooler than their other friends, and considered it as the advantage, as the distribution of tablet is only in their schools as follows:

> I had a good time playing the game. I followed the course from there by downloading the textbooks. [S-75]

When teachers' opinions have been examined, themes as material support, equality, and no-advantage have been come forward. While downloading books, watching video from EBA, using the question bank, downloading application headers take part under the material support. The opinion of providing equality of opportunity in the education takes part because of being taken a chance on access to a technological device for the students.

> It provides the equal opportunities in education, in the case of the intended use; economic benefits will help to protect the nature, because of the prevention of the paper waste. It will get support from the internet and information technology [T-11]

In the opinions of administrators on the advantages of tablets, themes of equality and educational benefits have been observed in line with the teachers. Codes specified on these themes are to be able to provide the equality of opportunity, escape from the weight of the books, and immediate access to information faster.

> I can say that it is particularly useful for the students who cannot access to the tablet (technology). Children of wealthy families have already used it. [Admin-2]

Time management, concern for health issues, and their negative effects on the possibility of reducing students' interest during the class hours are the other themes regarding the question on the disadvantages of the tablet use. Statements such as "much time is spent with the use of tablets, the internet use is too much, and reduction of working time and dealing with the technical problems" have indicated problems related to the time management. Many students think that tablets emit radiation; it will adversely affect their health. They stated that the use of tablet distracted them from books, led to skip their classes, used generally for recreational purposes such as games, music, etc., so it reduced the interest in the course. Answers of two students indicating the disadvantages are as follows:

> I think this subject varies from person to person. For example, those who played games very much, effected in a negative way. [S-89]
>
> They divert our attention, they emit radiation. We cannot study while looking it. [S-72]

Points that teachers considered as disadvantages came forefront as problems of class management and extracurricular use. In parallel with that, administrators have considered the problems on the class management as disadvantages, too.

3.3.8 Did You Have Any Problems When Using "Tablet PCs"?

Answers to the question of whether they experienced a problem during the day when they used the tablet have shown that the all students had experienced technical problems. These problems are that tablets work very slowly, a low-speed Internet connection, the lack of sensitivity of the touch screen, and immediate distortion of the buttons.

Problems of teachers were collected under two themes as managerial and technical. They have experienced problems, such as too much game playing by students, orientation to social media, and compliance issues with the smart board.

Administrators have also stated that they have had managerial and technical problems similar to teachers'.

3.3.9 How Problems Have Been Solved?

Answers given to question on how problems have been solved during using tablets have shown that they first received help from teachers, then, consulted for the professional help. However, answers in this context have shown that students had continued to have problems even if they had taken help, or their problems had not been solved. A situation experienced by a student demonstrated the importance of the technical support:

> Some of them were solved by technical service. But they sent back when the power key was broken down without repairing. [S-50]

Teachers' suggestions for the aforementioned problems were grouped into two themes: solutions for implementation and solution to technical problems. They considered that piloting process is very crucial and more training is needed. In technical terms, they proposed the infrastructure to be improved and the Internet not to be limited in use.

> I think that trainings should be given to teachers and students about the tablet. If the smart board has a direct connection to all tablets, an online course may be performed. But in my opinion, writing note on the notebook by making an effort provides both permanent and better learning. Tablet did not contribute to the education. [T-5]

Also, the solutions proposed by the administrators were collected under two themes as professional support and peer support. They consider that calling the service, ensuring the active use by interacting with the smart board, and utilizing from the knowledgeable students in technical problems should be maintained.

3.4 Conclusion and Discussions

This study is designed to explore the results of using tablet PCs in a pilot school within the scope of FATIH project carried out by the Ministry of National Education in Turkey. Students', teachers', and administrators' first-hand experiences on using tablet PCs at their school indicate that tablet PCs were perceived differently by the stakeholders, various problems were experienced, and some suggestions are made to overcome them. The following table summarizes the findings for students, teachers, and administrators (see, Table 3.2).

Students, teachers, and administrators all agreed on that students tended to use tablet PCs for edutainment purposes. The training provided for students included activities related to how to use the tablets rather than how to integrate them into their learning process. Students often experienced technical difficulties, including infrastructure problems, lack of communication between tablet PCs and interactive

Table 3.2 Findings for students, teachers, and administrators

	Perceived use	Activities	Problems	Solutions
Teachers	• Improper use would have no contribution • Led to unnecessary costs	Access to the Internet for • Educational purposes • Watching videos • Gaming	• Administrative • Technical	• Needs more pilot studies • In-service training should be provided
Student	• A communication tool • An entertainment tool • A support tool for courses	• Edutainment • Watching movies • Playing games • Downloading course materials from MoNE's website	• Lack of education on how to make the most out of tablet PCs for classroom use • Time management • Health issues • Diversion of attention	
Administrators	• Beneficial if teachers have the full control over		• Classroom management • Technical problems	• Should be distributed to all schools • Should be integrated with interactive smart boards • Professional Support • Peer support

whiteboards, screens, and charging. Both teachers and administrators also experienced technical and administrative problems. Majority of students hold positive attitudes partly because they had tablet PCs, whereas teachers tended to have negative attitudes toward tablets. Administrators, on the other hand, had more positive attitudes than teachers. Teachers had negative attitudes and disbelief probably due to lack of training provided in integrating tablets into their teaching curricula, and their inefficiency in resolving technical problems as they occurred. It is of course a paramount to provide infrastructure, investment, and sustainability. However, there is a need for ICT-integrated curricula and teachers and dedicated administrators who had been trained for it. Otherwise, learning will not be realized, but learners are entertained as a result of those endeavors.

With the FATIH project, two novelties, interactive whiteboards and tablet PCs, were introduced simultaneously to the system. When the research regarding FATIH project pilot implementation were reviewed, it is seen that while interactive whiteboards were embraced by teachers, tablet use yielded contradictory results, leading mainly to negative attitudes. Similarly, students shared the same experiences. One reason of this result may be attributed to introducing two novelties at the same time. Second, when teachers and students made comments about their experiences, they mainly compared tablet PCs with interactive whiteboards. Since they experienced fewer problems with interactive whiteboards, they found them more beneficial. With tablet PCs, infrastructure problems, charging issues, not enough activities to be carried out with tablet PCs in the classroom, classroom management issues when they attempted to use were among the major issues reported. These experiences might lead us to conclude that if you put two novelties together into the system at the same time, it is possible that one will fall under the shadow of another and preferred more than another. Thus, it can be suggested that in order to have successful ICT integration, novelties can be introduced into the system one by one but aligned with each other and with the curriculum. In order to make the ICT integration a success, first a well-planned guidance with strong committed technological leadership is a need. Second, all shareholders should be well informed and trained. Third, activities to form positive attitudes should be invoked. Fourth, infrastructure needs to be well established, and finally, ICT-integrated curriculum with student engagement activities should be ready.

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Chapter 4
Teaching and Learning Effectiveness Enhancement Project “TLEEP”

Riadh Besbes

Abstract The overall objective, to which the project will contribute, is to improve teaching and learning effectiveness within academic institutions by exploiting data mining methods on collected databases for educational knowledge extraction. These teaching and learning databases are accumulated from quantitative “measures” done through indoors classroom visits within academic institutions, online web access learners’ questionnaires answers, paper written statements’ analysis of academic exams in STEM education (science, technology, engineering, and mathematics), and online elementary grades seizure from written traces of learners’ performances within STEM exams. Findings of these processes, elaborated by researcher’s team within beneficiary organization, are disseminated through diversified publication and are the subject of multiple professional meetings, especially, teachers training sessions. The project’s data mining strategy in educational context will support and develop teachers’ expertise, enhance and scaffold students’ learning, improve, and raise education system’s performance. This is a project that combines data mining analysis methods with educational and cognitive sciences findings. It attempts to unify these two paradigms generally distant from each other. New strategies of educational assessment, training, and innovating are designed and are able to enhance significantly the effectiveness of teaching and learning performances in academic institutions such secondary schools. The use of these methods aims to identify and better understand the learner profiles, teaching practices characteristics, and context details in which teachers and learners act. These tools for decision support are exploited by the researcher, an educational inspector and expert in

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educational assessment, to generate, make available, and process databases on teaching practices, learning performances, and learners' profiles.

Keywords Knowledge extraction · Diagnostic-remediation loop · Profile recognition

4.1 Case Overview

4.1.1 Objectives

The overall objective, to which the project will contribute, is to improve teaching and learning effectiveness within academic institutions by exploiting data mining methods on collected databases for educational knowledge extraction. These teaching and learning databases are accumulated from quantitative "measures" done through indoors classroom visits within academic institutions, online web access learners' questionnaires answers, paper written statements' analysis of academic exams in STEM education (science, technology, engineering, and mathematics), and online elementary grades seizure from written traces of learners' performances within STEM exams. Findings of these processes, elaborated by researcher's team within beneficiary organization, are disseminated through diversified publication and are the subject of multiple professional meetings, especially, teachers training sessions. The project's data mining strategy in educational context will support and develop teachers' expertise, enhance and scaffold students' learning, improve, and raise education system's performance.

4.1.2 Target Groups

Secondary schools inspectors, teachers, and students within STEM disciplines.

4.1.3 Executive Summary

The project's data mining strategy in educational context will support and develop teachers' expertise, enhance and scaffold students' learning, improve and raise education system's performance. This is a project that combines data mining analysis methods with educational and cognitive sciences findings. It attempts to unify these two paradigms generally distant from each other. New strategies of educational assessment, training, and innovating are designed and are able to enhance significantly the effectiveness of teaching and learning performances in academic institutions such secondary schools. The use of these methods aims to identify and better understand the learner profiles, teaching practices characteristics, and context details in which teachers and learners act. These tools for decision support are exploited in order to generate, make available, and process databases on teaching practices, learning performances, and learners' profiles.

4.1.4 Government Policy for ICT in Education

One of the roles of the UNESCO Institute for Statistics (UIS), is to contribute to benchmarking and monitoring the integration of and access to ICT in education, through the establishment of internationally comparable and policy-relevant indicators. UNESCO reports have non negligible impact on illustrating the importance of ICT in education. Tunisian government begun to develop efforts in the issue of ICT's integration in education since the 1980s, enhancing infrastructure, and training human resources. Despite this policy related to the implementation and use of ICT in Tunisian primary and secondary education, it has not translated to practice. There are not enough recommendations for the integration of ICT in all subject areas across all grades. The contribution of ICT to quality teaching and learning is not adequately illustrated in classes, except for very few successful experiences. ICT issues related to teaching practice, and learning activities (including digital literacy, and issues of assessment), as well as teacher training need to be explored with a strategic view. A view that plans priorities and policies to concretize pedagogical actions leading to meaningful impacts on learning and positive students outcomes.

4.1.5 Purpose

The reason to implement this project is the findings about Tunisian educational system written in the Program for International Student Assessment (PISA) reports since more than seven sessions. Conceived by OECD (Organization for Economic Co-operation and Development) for the affiliate countries and their partners, PISA reviews the extent to which students near the end of compulsory education have acquired some of the knowledge and skills that are essential for full participation in modern societies, particularly reading, mathematics, and science. Indeed, the notion of literacy is the basis for its innovative approach which refers to the ability of learners to apply knowledge and skills in key subject areas and to analyze reason and communicate effectively as they pose, solve, and interpret problems in a variety of contexts. The results of the evaluations are distributed according to taxonomy of six levels of competence. Following the participation of a sample of 10,000 young Tunisian students (15 years old) every 2 years since 2001, this assessment shows that our young learners cannot do much with what they have learned in school. Effectively, in mathematics and according to PISA report, less than an average of 0.2 % of Tunisian's 15-year-olds can conceptualize, generalize, and creatively use information based on their own investigations and modeling of complex problem situations. They are able to apply insight and understanding and develop new approaches and strategies when addressing novel situations. In the OECD area, an average of 3 % of students reaches that level of performance. Performances in reading literacy, mathematics and science of our students show that the majority of our learners do not possess skills beyond level 2. This level is considered a threshold of competence at which students begin to demonstrate that they possess skills that enable them to participate effectively and productively in society. The high-level skills (level 5 and 6) are essential for innovation and thus promote economic growth and social development of the country, there is only a very small minority of our learners who reach level 5 and none possesses the skills of Level 6.

4.1.6 Expected Outcome

Linda Darling–Hammond and Charles E. Ducommun underscore the important assumption that, undoubtedly, teachers are the fulcrum that has the biggest impact and makes any school initiative leads toward success or failure. Hence the importance to consider for both teaching qualities and learning performance by means of useful policy system that should attract, prepare, support, and develop expert teachers who can teach in a more effective way. That Effectiveness depends on diagnosis relevance which varies directly with educational context complete observation. This complete observation leads us to be able to access in real time to relevant criteria for the recognition of actors' profiles in the teaching and learning process. These quantified indicators will constitute a raw data from which we can extract relevant and vital knowledge that will be the basis of our decisions. Our project's intelligent systems aim, through the arising analysis, to explore educational concepts using engineering research works. This open and deepen research in educational science. Our computing systems are able to generate in quantifiable terms an:

- Teaching practices profiles identification,
- Students learning styles identification,
- Early detection of learning disabilities and targeted assistance.
- Provide ongoing and specific teachers training,
- Controlling, with affinity, the teaching learning process efficiency,
- Provide databases generated by the global system,
- Promote the intelligent exploration of educational data,
- Promote effective management of academic systems,
- Guide in the implementation and monitoring of the reform work in teaching and learning processes.

4.2 Initiative Description

4.2.1 Features and Innovation

Quality, innovative aspects and credibility of the research.

4.2.1.1 Introduction

Learners are delighted when they act and interact in an autonomy supportive environment, feeling secure they spontaneously ask for rationales, discuss and defend their opinions, contribute deliberately in their knowledge construction. Innovative and well-grounded assessment ensures accountability and creates ways to improvements and future investments. This is possible when the system generates authentic, participatory, and grounded information. This information, captured then interpreted, reflects indeed the reality. In a cognitive ergonomics way we will process as described by Braverman, to ensure work conditions improvement, evaluators have to be enough responsible in feed the system by meaningful and rational data that reflect realities on educational fields. Based on the findings cited by Sammons and Ko, it is assumed that teaching is a multidimensional process and its multidimensionality can be explored and confirmed by using observation schedules and factor analysis. Medley defines the term "systematic observation" as "observations of classroom behavior made by a trained observer who records the behaviors according to an observation system. An "observation system," in turn, is a scheme that specifies both the events that the observer is to record and the procedure to be used in recording them … a quantitative method of measuring classroom behaviors from direct observations that specify both the events and behaviors that are to be observed and how they are to be recorded."

4.2.1.2 State-of-the-Art

Few studies look into the current changes in teaching and learning practices. Anne Jorro "Evaluation and Professional Development," says: "evaluate is necessarily considering how we will support, advise, exchange, to give recognition to encourage the involvement of the actor giving him the means to act." Louise Lafortune and Linda Allal also argue in their book "Professional Judgment in Evaluation" that "the professional judgment is a process that leads to a decision, which takes into account different considerations from his professional expertise (experience and training). This process requires rigor, coherence and transparency. In this sense, it involves gathering information through various means, the justification for the choice of means in place with the aims and intentions, and sharing the results of the approach in a regulatory perspective."

PISA report states that many of the world's best-performing education systems have moved from bureaucratic "command and control" environments toward school systems in which the people at the frontline have much more control of the way resources are used, people are deployed, the work is organized and the way in which the work gets done. As an important factor which the PISA report shows to be closely related to school performance when combined with effective accountability systems the provision of an environment in which teachers work together to frame what they believe to be good practice, conduct field-based research to confirm or disprove the approaches they develop. Educational policy stakeholders should, as it is advised by PISA report, exploit relevant criteria to assess, support, and prioritize the quality of teaching and learning.

4.2.1.3 Research Methodology and Approach

Educational data mining is an emerging discipline, concerned with developing intelligent methods to extract knowledge from different types of data within academia context. The use of these methods aims to identify and better understand the learner profiles, teaching practices characteristics, and context details in which both teachers and learners interact. Trochim and Donnelly affirm that "Evaluation is the systematic acquisition and assessment of information to provide useful feedback about some object." Education effectiveness is our project's "object," so our research methodology is about evaluation research approach. However, main project's actions involve collecting and converting data into numerical form so that statistical calculations can be made and conclusions drawn. These actions are the leverage of analysis to uncover the deeper meaning and significance of teachers and students behaviors and attitudes within classrooms. Thus, a pattern of meaning will be constructed on the basis of the collected data. Then, useful feedback is discussed with variety of audiences such as teachers, students, parents, administrators, and inspectors. As consequence, and to be pragmatic, we grant ourselves the freedom to use any of the methods, techniques, and procedures typically associated with quantitative and qualitative research. However, the data collected is analyzed in the appropriate manner. We will have the advantages of enabling triangulation by using variety of data sources (data triangulation), multiple perspectives to interpret the results (theory triangulation), and multiple methods to study our research problem (methodological triangulation).

Our first project's activities are about collecting learners' questionnaires answers, from associated academic institution, on learning styles. Susan M. Montgomery and al confirm that teachers are, in general, passionately committed to their discipline and are anxious to convey its significance and knowledge base to their students. Hopefully, a rational understanding of students' learning styles has a positive impact on their own teaching. In literature, Myers–Briggs type indicator, Kolb–McCarthy's learning cycle, and Felder–Silverman learning styles model have been widely used to classify students learning styles in multiple modalities and multiple disciplines. This classification encourages teachers to provide a variety of learning activities such each learning style is addressed. Multiple questionnaires are used online, within TLEEP project, to collect, record, and process students (also teachers) answers. Learning styles features are classified and consecutively, dissemination of different findings strengthens reflexive thoughts, and then training session on the issue will be positively needed. Indeed, it will lead to extract efficient and appropriate teaching and learning acts.

Our second project's activities are the continuous classroom visits for teaching and learning observation. There is a growing interest in moving beyond traditional measures of teacher qualifications to evaluate teachers' actual performance and effectiveness. These new investments in research and development initiative to design multiple ways of measuring teaching effectiveness can be leveraged to make major shifts in how evidence is assembled on prospective teachers and to forge the development of a nationally accessible teaching performance assessment. Knowing that the etymology of the term diagnosis means "knowledge through signs," the researcher has developed, through his thesis research work, an interactive grid as an observation instrument that help to track those "signs." The interactive grid contains sixty three pedagogical acts, which are generally manifested in most teaching and learning acts in classroom session. Those acts are subdivided in three sets. One first set of twenty-seven teaching and learning practices which are measured by their time durations, and then quantified by their rates according to the total session course duration. Another second set of twenty seven teachers and students' behaviors and attitudes are qualitatively measurable in terms of ratings on the Rensis Likert scale and are collected in six subsets. The final sets of nine measures are the durations of channels from which teachers choose to convey knowledge: they speak, they draw, they write, they show pictures or curves … thus, at the end of each class visit; 16 histograms are obtained from recorded data. These charts illustrate statistic rates of spent time on each teaching and learning acts, and quantified estimations of different manifested behaviors and attitudes in class session. At a more profound process level, and behind the interactive grid, an intelligent system is conceived by researcher with fuzzy logic technique. The system uses recorded data to generate quantitative assessment of thirty five educational concepts such as "Teacher's ability to change the course of events," "Autonomy support," "Maintain motivation," "Maintain interaction," "Communication"… As consequence, weaknesses origins within teaching and learning practices, acts, behaviors, and attitudes can be tracked. Feedback is, then, well justified and more constructive. Feedback is provided individually during a professional discussion, and globally during training sessions. Interpreted charts and educational assessed concept dissemination will offer reliable opportunities to entrench effective teaching and learning practices.

Our third project's activities are periodic statement's exam analysis and learners' written performance analysis. Taxonomy, defined by Legendre, is a systematic and hierarchical classification of target skills, independent of content objectives, clearly defined and arranged in a continuum of increasing complexity of development and in a logic natural progression of the learner. Bloom developed a taxonomy that classifies the cognitive learning into six levels of understanding. Cognitive knowledge covers the different modes of acquiring knowledge and ways of linking them and uses them. We distinguish six levels in this area. The acquisition of knowledge: This is the recall of specific facts or general, methods, or processes. It concerns essentially memory cognitive acts that retain the content and the form of information. Comprehension: The ability to organize data to achieve a certain result, to discover a new material by using content already known. Learner holds, therefore at this level, the content but he changes the form of information. Application: The ability to use general and abstract representations to treat specific and particular cases. Analysis: It is the separation of a whole into its constituent parts in order to explain it all. Synthesis: On the contrary, bring together several elements without previous relations between them, so as to make a coherent whole. Evaluation is the most complex level; it assumes that student mobilizes all his resources to be able to make judgments using internal or external criteria to an object. According to the previous described taxonomy, every STEM exam within the academic year is analyzed. Each question is classified according to its cognitive level. Thus, statistical accumulations of every cognitive question type will illustrate the rates partition of cognitive Bloom's taxonomy within each single exam. When they get their answers' papers, learners get to their granular grades seizures via a dedicated Website for students' results treatments. Then the system generates a detailed classification of learners' outcomes targeting detailed weaknesses and strengths of their performances. Global and individual statistical treatments reveal main learning features of every student and common "patterns" of learners' groups.

4.2.2 Overall Objectives and Milestones

Our project's wider objective is to improve teaching and learning effectiveness within academic institutions by exploiting data mining methods for educational knowledge extraction. As major key indicator of progress related to this wider objective, will be the global enhancement in students' performance and teachers' practices within STEM disciplines during academic year. Comparative analysis between teachers' practices effectiveness and students' detailed performances is the source of information that will measure the progress indicator. We will compare performances' data of actors who receive our feedback about previous observations and measures and those who do not receive it. Meanwhile, among project's actions three specific objectives shall be achieved. First, a complete data mining center for educational research will be conceived. Second, sufficient data on students' profiles in terms of weaknesses and strengths, will be provided. Third, teachers' practices inside classrooms at each partner institution will be statistically recorded as educational data and cognitively interpreted by teachers' reflexive thoughts, discussions and practices within training sessions.

4.3 Implementation Plan

4.3.1 How to Implementation Effectively?

For innovating in learning environments, OECD analysis has identified four modalities that are followed within TLEEP.

4.3.1.1 Exploiting Science, Knowledge, and Research and Development

Creating and sharing relevant knowledge are critical as are new methodologies of evaluation appropriate for learning innovation. The relevance of the diagnosis is highly dependent on the complete observation of the operative. The use of online questionnaires, computerized interactive grid as observation tool, exams pedagogical analysis, and students' performance, make an advance on the state of the art in this field. Indeed, the researcher should be able to quantify in real-time relevant criteria for the recognition of actors' profiles and the process of teaching and learning. Criteria for equity confer more justice and rigor with associated indicators to assess. These quantified indicators will constitute a generated raw data source from which he can extract relevant and vital knowledge. All processes are done under data mining treatments for decision support, recognition, and extraction educational features. This is the main project's interdisciplinary aspect that leads to exploit the power of data process algorithm to investigate pedagogical concepts.

4.3.1.2 Exploiting Science, Knowledge, and Research and Development

Technological advance: **What is the effect can teaching and learning achieve with the help of technology**?

Technology has enormous potential especially when it reshapes the different components. As innovative approach, the project activities reshape teaching and learning effectiveness assessment. An effectiveness that is quantified with the quantification of pedagogical concepts manifested in educational processes indoors classrooms. A collaboration opportunity rises here in the benefit of researcher from the Department of Environmental Sciences, Informatics and Statistics, in "Ca' Foscari" university. Indeed, the department provides innovative approaches to the analysis and management of information and environmental systems. Their research is structured around multiple laboratories and research centers and unfolds along a wide range of areas and directions. Collectively, they contribute to advance the understanding of the complexity of modern environmental and information systems, by developing the analytical models, the assessment principles and the engineering techniques required to provide effective answers to the scientific questions such systems raise, and to the technological challenges they create. These are exactly the answers which our project is looking for.

4.3.1.3 Modular Reorganization

Implementing professional learning and organizational routines can help to break old institutional habits, enhance visibility, and maintain learning as the central activity. Collegial wisdom is the original consequence of project's findings broadcast among professionals within different kind of meetings.

4.3.1.4 Networking and Sharing Knowledge

Networking is essential to create innovation across entire learning systems. Project's extracted knowledge dissemination through diversified channels as it is detailed in later section. A huge amount of information about the reality of teaching practices and learning performances inside classes will be available. Collected data contains valuable knowledge which can considerably affect educational policies in the right directions. Precisely thatis why project's sustainability is having a strong consensus, and will continue to have. It is a material impact on how the researcher, as assessor, will think and act. Once the researcher, as educational stakeholder, begin to pursue sustainability initiatives in assessment, he will tend to unearth opportunities to reduce teaching weaknesses, manage new targeted training sessions, and develop more innovative teaching effectiveness models. Thus, project's early innovative approach has several key characteristics: it incorporates a comprehensive and interpretable set of data into robust educational databases, which then integrate throughout all relevant aspects of analysis operations to extract valuable knowledge about the general teaching and learning effectiveness potential.

4.3.2 Who Are the Participators? (Including Collaborators)

At "Ca' Foscari" University of Venice, educational and cognitive science is the main expertise of the Department of Philosophy and Cultural Heritage where the researcher will receive his main theoretical training. Indeed, beneficial training about cognitive concepts will be easily provided. This Department focuses on the relationships between philosophy and social, psychological, cognitive, anthropological, and pedagogical sciences. Its mission is to significantly enhance knowledge and skills in education field, setting a goal of favoring exchanges and interrelations, on both a knowledge and methodology level, and to prepare convenient strategies and methods for the project. Those research modalities are increasingly innovative and capable of engaging relations of scientific collaboration at a national and international level. Within its Ph.D. Degrees, especially for Cognition and

Education Sciences, the department provides a high level of expertise in Cognitive psychology of learning. Indeed, the main themes that the researcher need for developing his research knowledge and skills are the competences of his supervisor built within his reach and long professional career. Pedagogy, training, educational research, and specialization for secondary school teaching …It is the best opportunity that any Researcher can ever have. Inside this adequate and rich academic environment, training activities for the benefit of researcher are established. Primarily, training-through-research under the direct supervision of Prof Margiotta at “Ca’ Foscari” University of Venice is provided. Defining research on main educational concepts especially those to be assessed in this project will be the first activity. Under his supervision, researcher will conceive research questionnaires for different educational profiles identification, apply convenient statistical parameters for educational quantified analysis, and write research articles that summarize and disseminate most important findings, are the other major training themes. Hands-on training activities for developing researcher’s scientific and transferable skills are also planned. In harmony with previous researcher’s skills, he will be trained on monitoring professional meetings; he will take up and exploit research results to conceive training sessions. Patent application training will be provided to researcher so that he can apply it for the teaching and learning effectiveness assessment computerized system used through the project. Since dissemination and outreach activities are essential for the project, training through organization of scientific and training events is provided, communication, public dissemination, and horizontal skills are also the target of intense training.

Training added value from partner organization: OECD Program for International Student Assessment (PISA) is broadening the discussion about improving national education systems beyond government and research institutions. The OECD Teaching and Learning International Survey (TALIS) is the largest international survey of teachers. TALIS emphasizes the themes that research tells us can influence effective teaching. Teachers report on their initial training and the professional development they receive, the feedback they get on their teaching, the climate in their classrooms and schools, their own satisfaction with their jobs, and their feelings about their professional abilities. All that knowledge gathered around worldwide academic institutions about learning and teaching is the essential interdisciplinary transfer of knowledge for training themes among the fellowship from OECD visits. The overall research training objectives for the researcher from PISA and TALIS programs are to master the provided robust international indicators and policy-relevant analysis on learning and teaching in a timely and cost-effective manner. These indicators will help the researcher to suggest and develop policies in his project to promote conditions for high-quality teaching and learning. Cross-country analyses will provide him the opportunity to compare countries facing similar challenges to learn about different policy approaches and their impact on the learning environment in schools. The guiding principles underlying the partner organization (OECD) training strategy are as follows: Education policy relevance, its clarity and a focus on most relevant indicators for participating countries. As value added, international comparisons should be a significant source of the project's benefits. The training sessions should yield information that is valid, reliable and comparable across participating countries, they are based on a rigorous review of the knowledge base. The researcher will be able to interpret OECD results in a meaningful way.

4.3.3 How Long Does It Last?

Two years.

4.4 Implementation Process

4.4.1 Implementation Process: Focus on Innovative Teaching Strategies

The experienced researcher has followed, during 2 years (2008–2010), a cognitive ergonomics master in faculty of medicine (Monastir, Tunisia). He justified, within his master research that his thesis work about this new approach to assess teaching and learning has a positive impact on teachers' practices. The research and training that he will follow in host organization will reenforce this fact. As an education inspector in his country, the experienced researcher will gain a precious training on cognitive theoretical basis. This research training will lead him, within his medium and long terms career, as policy education stakeholder and expert in his country to collaborate effectively in Tunisian education reform. OECD has two specific programs that converge to our project's objectives. The OECD Programme for International Student Assessment (PISA) is broadening the discussion about improving national education systems beyond government and research institutions. The OECD Teaching and Learning International Survey (TALIS) is the largest international survey of teachers. This organization will be a very convenient partner where experimentation will be done. Assigned to associated secondary schools in France, the three main project's actions will be realized and their results analyzed with the potential help of OECD educational analysts and experts. Also, the program TALIS did not mention any research report based on indoors classrooms data as it is done within our project's actions and that will be the project's contribution to European educational research field.

4.4.2 Process Management

Transfer of knowledge: The experienced researcher spent the last 7 years of his professional career as an educational inspector. He had the triple missions of evaluating, training, and innovating among secondary schools teaching and learning. Within these years he has used an interactive grid as an observation instrument among his classrooms visits. He was able, with this instrument, to quantify teaching and learning practices, acts, behaviors, and attitudes during class sessions. At the end of each class visit, 16 statistical curves are obtained and constituted the subject of professional discussions and training sessions. The collected database among those years is gathering more than 210 class visits for different disciplines, each one is constituted by more than 400 single data. Such data sets quantify 63 acts and behaviors for each class visit. This huge educational database and its various interpretations are the first part of acquired knowledge that the researcher can transfer to the host organization for deeper treatment. Among his thesis research work, he conceived a hierarchical fuzzy system for teaching effectiveness assessment. The Software is built with fuzzy logic technique and has a five levels hierarchy. The interactive grid is its main entrance interface from where inputs (quantified acts and behaviors) are seized. As hierarchical system's outputs, 35 educational concepts are assessed in order to identify major weaknesses and strengths of teaching and learning practices. The sources of weaknesses can be tracked within the system's hierarchy. The researcher believes that, this support of decision's system, is eligible to a patent, and that is the second part of acquired knowledge that the researcher can transfer to the host organization for deeper analysis and enhancement.

4.5 Outcomes

Management and Monitoring: To initiate planning work to establish an educational data mining center in "Ca' Foscari" Cognition and Education Sciences department. It will be done through information meetings with host organization's supervisor and partner organization's supervisor. Administrative and financial Management and monitoring activities will start from the first day until the end of the project.

Indoors visits: provide sufficient data on teaching and learning practices and behaviors. It will be done through visits experiments in associated institutions.

Data mining: proceed to data mining of the collected database. It will be done at "Ca' Foscari" Cognition and Education Sciences department.

Dissemination: Dissemination activities, included public engagement, will be organized and process different broadcast modalities such as training sessions, discussions meetings, newsletters, workshops, seminars, conferences, and journal articles.

Benefits for the stakeholders: Transfer of knowledge: The experienced researcher spent the last 7 years of his professional career as an educational inspector. He had the triple missions of evaluating, training, and innovating among secondary schools teaching and learning. Within these years he has used an interactive grid as an observation instrument among his classrooms visits. He was able, with this instrument, to quantify teaching and learning practices, acts, behaviors, and attitudes during class sessions. At the end of each class visit, sixteen statistical curves are obtained and constituted the subject of professional discussions and training sessions. The collected database among those years is gathering more than 210 class visits for different disciplines, each one is constituted by more than 400 single data. Such data sets quantify 63 acts and behaviors for each class visit. This huge educational database and its various interpretations are the first part of acquired knowledge that the researcher can transfer to the host organization for deeper treatment. Among his thesis research work, he conceived a hierarchical fuzzy system for teaching effectiveness assessment. The Software is built with fuzzy logic technique and has a five levels hierarchy. The interactive grid is its main entrance interface from where inputs (quantified acts and behaviors) are seized. As hierarchical system's outputs, 35 educational concepts are assessed in order to identify major weaknesses and strengths of teaching and learning practices. The sources of weaknesses can be tracked within the system's hierarchy. The researcher believes that, this support of decision's system, is eligible to a patent, and that is the second part of acquired knowledge that the researcher can transfer to the host organization for deeper analysis and enhancement.

4.6 Conclusion

4.6.1 Summary of Benefits

As an innovative analysis and integrated approach, TLEEP project aims promising strategies for changing learning environments, and for spreading and sustaining innovative practice on a wider scale. The research objectives focus on transforming teaching practices and learning environment to be most effective. These objectives, which lead as major principles to innovative learning environment, are listed below:

- Make learning and engagement central,
- Ensure that learning is social and often collaborative,
- Make teaching and learning highly attuned to learner motivations and emotions,
- Make learning acutely sensitive to individual differences,
- Adapt learning demand to each learner without excessive overload,
- Use assessment consistently with learning aims, with strong emphasis on formative feedback,
- Promote horizontal connectedness across activities and subjects, in and out of school.

4.6.2 Boundary and Limitation of the Initiative

Written traces (exams students’ copies) should be accessible to us in order to proceed for elementary grade seizure. Teachers may not accept easily to be assessed within their professional activities in class. Training sessions, and reflective meetings on their analyzed performances will motivate them to take part in this project. Academic stakeholders will facilitate all needed accesses since they are aware of the importance of such research findings and its impact on educational effectiveness.

4.6.3 Lessons Learned

The complementarity of the two organizations is a virtue in favor of the project activities. Indeed, OECD with its TALIS and PISA programs established from a great variety of quantified tests and questionnaires answers constitute a solid base for potential research on field. Cognition and Education Sciences department in “Ca’ Foscari” university is the leverage of project activities with its harmonious theoretical constructions in education sciences.

4.6.4 Future Direction/Plan

As perspective to this work, we believe that all processed results on educational concepts can be automatically generated by our system. So, we can enhance its functionality by making it able to search among its hierarchy the ultimate sources of effectiveness or points of weaknesses. We suggest exploring profile recognition approach of educational actors, by means of intelligent techniques able to adapt and evolve. We can also associate results from the analysis of students’ performances and from our teaching effectiveness system. This association leads to effectiveness enhancement by generating adequate guidelines based on practices adaptation and educational profiles fitting. The dynamic of teaching process, as recorded on Fig. 7, which shows the “movements” between each acts and practices throughout the duration of the class period, can be a subject of meaningful studies. Some patterns of teaching’s dynamic can be automatically characterized and treated.

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Author Biography

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Chapter 5
Learning Effectiveness Enhancement Project "LEEP"

Riadh Besbes

Abstract The overall objective, to which the project will contribute, is to improve teaching and learning effectiveness within academic institutions by exploiting data mining methods on collected databases for educational knowledge extraction. These teaching and learning databases are accumulated from quantitative "measures" done through indoor classroom visits within academic institutions, online web access learners' questionnaires and answers, paper written statements' analysis of academic exams in STEM education (science, technology, engineering, and mathematics), and online elementary grades seizure from written traces of learners' performances in STEM exams. Findings of these processes, elaborated by researcher's team within beneficiary organizations, are disseminated through diversified publication and are the subject of multiple professional meetings, especially, teachers' training sessions. The project's data mining strategy in educational context will support and develop teachers' expertise, enhance and scaffold students' learning, and improve and raise education system's performance. This is a project that combines data mining analysis methods with educational and cognitive science findings. It attempts to unify these two paradigms, generally distant from each other. New strategies of educational assessment, training, and innovating are designed and are able to enhance significantly the effectiveness of teaching and learning performances in academic institutions such as secondary schools. The use of these methods aims to identify and better understand the learners' profiles, teaching practices, characteristics, and context details in which teachers and learners act. These tools for decision support are exploited by the researcher, an educational

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inspector and expert in educational assessment, to generate, make available, and process databases on teaching practices, learning performances, and learners' profiles.

Keywords Blended learning · Assessment for learning · Knowledge extraction · Profile recognition

5.1 Case Overview

5.1.1 Objectives

Franklin Delano Roosevelt said, "We cannot always build the future for our youth. But we can build our youth for the future." Marc Prensky declared that all education should be based on actual student accomplishments in the real world. As one of the many consequences of this approach, student will be an active "partner" in better pedagogy rather than just a passive listener to a lecture. There is enough adaptable potential in ICT that can ensure an important principle that characterizes such educational direction: "general skills for all, individual examples for each student". Thus, well exploited technology is able to support keeping students usefully engaged and motivated in learning. Learning Effectiveness Enhancement Project should use the opportunity to create productive and student-centered learning environments that has overarching objectives: to improve ability to personalize learning and individual progress, to enhance student engagement and motivation, to strengthen teaching effectiveness, to equip teachers and stakeholders with useful data that helps to shape interventions, to sharpen educational policies, and to lighten the learning pathways.

5.1.2 Target Groups

Secondary school inspectors, teachers, and students of math, language, science, and social studies disciplines.

5.1.3 Executive Summary

The project's data mining strategy in educational context will enhance and scaffold students' learning and improve and raise education system's performance. This project facilitates educational and scientific management strategies design to evolve significantly the effectiveness of learning process. These strategies' designs are inspired from evolutionary and modular computer system treatments implemented in academic institutions and school Websites. Tools for decision support and consequence of research in data mining using intelligent recognition and extraction feature algorithms; these systems extract knowledge from learners’ performances in educational context. They generate and make available digital databases accumulated from quantitative evaluation. The use of these methods aims to identify and better understand the learner profiles and context details in which learners act. These tools for decision support are exploited in order to generate, make available, and process databases on learning performances and profiles.

5.2 Background

5.2.1 Government Policy for ICT in Education

One of the roles of the UNESCO Institute for Statistics (UIS) is to contribute to benchmarking and monitoring the integration of and access to ICT in education, through the establishment of internationally comparable and policy-relevant indicators. UNESCO reports have non negligible impact on illustrating the importance of ICT in education. The Tunisian government has begun to develop efforts in the issue of ICT’s integration in education since the 1980s, enhancing infrastructure and training human resources. Despite this policy related to the implementation and use of ICT in Tunisian primary and secondary education, it has not translated to practice. There are not enough recommendations for the integration of ICT in all subject areas across all grades. The contribution of ICT to quality teaching and learning is not adequately illustrated in classes, except for very few successful experiences. ICT issues related to teaching practices, and learning activities (including digital literacy and issues of assessment), as well as teachers training need to be explored with a strategic view; a view that plans priorities and policies to concretize pedagogical actions leading to meaningful impacts on learning and positive student outcomes.

5.2.2 Purpose

One of the important findings that emerged throughout our study and investigation in schools was the effective use of educational data as an instrument for transformation at every level of the system. The data was used both to identify underperformance and to target constructive feedback. The best schools emphasized data analysis and student target setting as the central components of their educational methodology. These schools have been guided for their work through the way they use data to set ambitious but realistic targets for each individual student. Teachers interviewed in our research regularly mentioned the use of data as a vital aspect of the approach to school improvement. Schools are using data increasingly well for their students' performance within their institutions. Consistent cross-subject approaches to data analysis and a focus on early intervention are immediately processed when the data suggested that students were not on track to fulfill their potential. Data analysis at school level enabled school leaders to understand which teachers were performing at a high or low level (Besbes). This information was then used to guide performance management and professional development. School leaders became particularly skilled at this type of data literacy. Local authority managers and teachers were all challenged to perform well in order to obtain better student data that was subject to rigorous analysis.

Our ICT system aims at improving pupils' exam results and making significant changes in the overall effectiveness of schools and the quality of teaching. However, the data analysis tends to generate in quantifiable terms:

– Students' learning style identification,
– Early detection of learning disabilities and targeted assistance,
– Provide ongoing and specific teachers training,
– Controlling, with affinity, the learning process efficiency,
– Provide databases generated by the global system,
– Promote intelligent exploration of educational data,
– Promote effective management of academic systems,
– Guide the implementation and monitoring of the reform work in teaching and learning processes.

5.3 Initiative Description

5.3.1 Features and Innovation

The first innovative process is exams educational analyses. It is done according to taxonomies developed by science education research (Bloom). Results are hosted on the project cloud Website within the academic institution. Learners proceed to granulate response grades seizures of their written examinations via the Website by exploiting a dedicated interactive grid for learners' result treatments. Then the system generates a detailed classification of learners' outcomes targeting detailed weaknesses and strengths of their performances. Global and individual statistical treatments reveal main learning features of every student and common "patterns" of learners' groups. This classification makes teachers discover their pupils' characteristics so that learners will be delighted when they act and interact in an autonomy supportive environment, feeling secure that they spontaneously ask for rationales, discuss, and defend their opinions, contributing deliberately in their knowledge construction. Innovative and well-grounded assessment ensures accountability and creates ways to improvements and future investments.

Hopefully, a rational understanding of students' learning styles has a positive impact on their own teaching. In literature, Myers–Briggs type indicator, Kolb–McCarthy's learning cycle, and Felder–Silverman learning styles model have been widely used to classify students' learning styles in multiple modalities and multiple disciplines. This classification encourages teachers to provide a variety of learning activities such that each learning style is addressed. Multiple questionnaires are used online, within the LEEP project, to collect, record, and process students' answers. Learning style features are classified and consecutively, dissemination of different findings strengthens reflexive thoughts, and then training session on the issue will be positively needed. Indeed, it will lead to extract efficient and appropriate teaching and learning acts.

5.3.2 *Mining Learning Styles*

Learning styles are groups of characteristic strengths and preferences in the ways they pursue to get and process information. Students have different learning styles; however, teaching effectively in any professional capacity requires working well in all learning style modes. According to Fielder's research work on learning style models, students deal with knowledge subjectively. Indeed, information is processed within four cognitive stages: input channels of information then its perception, how it is processed and understood. If learners can easily accept information flow through visual presentation, pictures, diagrams and flowcharts then they are identified to be visual learners. If they feel that information is conveniently conveyed through written and spoken explanation, they are verbal learners. When this information is concrete, practical, oriented towards facts and procedures, it is perceived by sensing learners. But when information is conceptual, innovative, oriented towards theories and meaning, it is perceived well by intuitive learners. At the processing stage, active students learn by trying things out and with others. Reflective learners process by thinking things through and work alone. For understanding stage, when students treat information in sequential way with small incremental steps, they are identified as sequential learners. They prefer presentations that proceed from the specific to the general; they are also inductive learners. Global learners are holistic, they learn in large leaps and they understand when they proceed from general to specific. They prefer presentations that proceed from the general to the specific, they are also deductive learners. Figure 5.1 shows an example of results obtained from the questionnaire and students' answers identifying their three preference rates. For this class, we see that visual preference is dominant, as a consequence, teachers' practice can adapt accordingly.

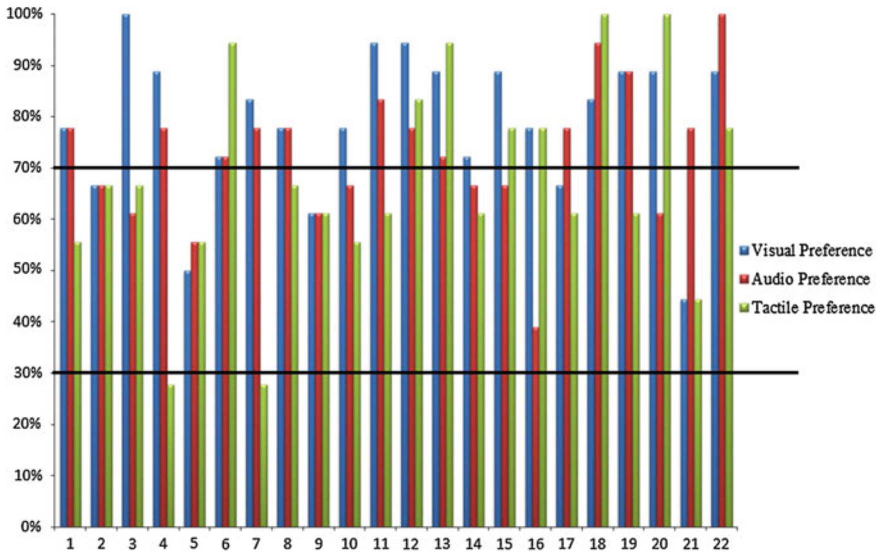

Fig. 5.1 Questionnaire results on class learning styles preferences

5.3.3 *Mining Examination Characteristics*

The pedagogical expert analyzes exams' content of STEM disciplines especially, mathematics and physical sciences. He affects each question with its elementary grade, and its code type according to Bloom's taxonomy, as clarified below. He identifies the assessed objectives and determines appropriate remedies corresponding to incorrect responses. As shown in Fig. 5.2, the results of his analysis will be the basis of subsequent treatments on the Websites. A specific goal of

Grade	Objective code	Objective statements	Remediation strategies
1,00	A_1	Directly calculate the charge and energy from their formulas	Memorize the formulas of the voltage across a capacitor and the energy stored by a capacitor
0,75	A_2	Write the chemical equation of the esterification reaction, and name the ester	To know that acids loose -OH and alcohols loose -H to form water and ester with the combination of remaining groups. Memorize the nomenclature of esters
1,00	B	Know how to use the tangent at the origin to determine R and E	τ is determined from the tangent at the origin of the curve i (t) and exploiting u_C (t) = 0.63 E you find E.
0,50	C_1	Write the differential equation from the Kirchhoff's mesh rule	Correctly apply the law of the Kirchhoff's mesh rule and replace i by Cdu_C / dt
0,25	C_2	Find the concentration of a solution from an initial sampling	Exploit the fact that a sample and original solution have same concentration

Fig. 5.2 The results of his analysis will be the basis of subsequent treatments on the Website

learning is defined as the formulation of what the learner will do, how he will behave to demonstrate that he has achieved the overall objective. By evaluation, teachers discover whether those objectives are achieved according to taxonomies of the cognitive domain. Taxonomy, defined by Legendre, is a systematic and hierarchical classification of target skills, independent of content objectives, clearly defined and arranged in a continuum of increasing complexity of development and in a logic natural progression of the learner. Bloom developed a taxonomy that classifies the cognitive learning into six levels of understanding as it will be described. Cognitive knowledge covers the different modes of acquiring knowledge and ways of linking them and uses them. We distinguish five levels in this area. The acquisition of knowledge [coded A1]: This is the recall of specific facts or general methods, or processes. It concerns essentially memory cognitive acts that retain the content and the form of information. Comprehension [coded A2]: The ability to organize data to achieve a certain result, to discover a new material by using content already known. Learner holds, therefore at this level, the content but he changes the form of information. Application [coded B]: The ability to use general and abstract representations to treat specific and particular cases. Analysis [coded C1]: It is the separation of a whole into its constituent parts in order to explain it all. Synthesis [coded C2]: On the contrary, bring together several elements without previous relations between them, so as to make a coherent whole. Evaluation is the most complex level; it assumes that student mobilizes all his resources to be able to make judgments using internal or external criteria to an object. Statistical distribution of the five question type rates according to content treatments of physical and chemistry sciences examination is illustrated in Fig. 5.3.

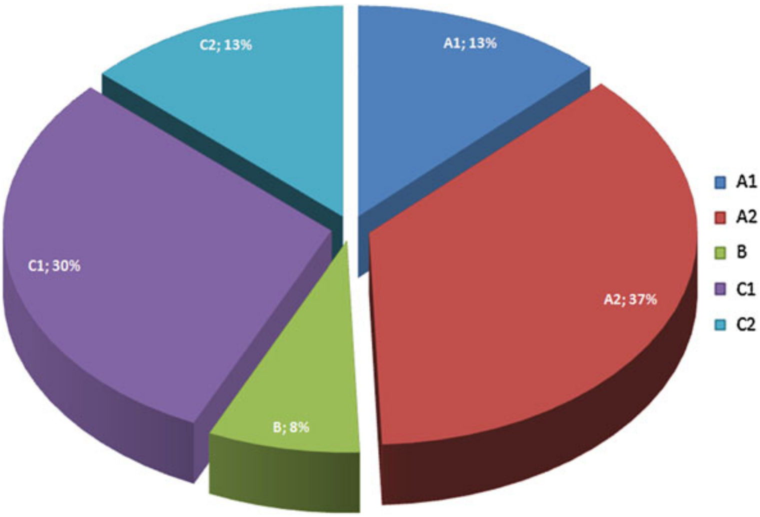

Fig. 5.3 Rates' distribution of the five cognitive types of questions according to Bloom's taxonomy

5.4 Outcomes

5.4.1 First Project's Results: Students Learning Styles

Histograms on Fig. 5.4 from assessment questionnaire analysis show that these class students possess high visual and auditory preferences. Visual learners prefer to learn by seeing charts, diagrams, illustrations, handouts, and videos. Their tendency is high for seeing information presented in a visual rather than in written form. Auditory students learn best by hearing information. They tend to get a great deal out of lectures and are good at remembering things they are told. However, their tactile capabilities are average. As consequence, their teachers are encouraged to convey knowledge by practical activities when opportunities arise. Kinesthetic students learn best by touching and doing. Hands-on experience is important for them.

5.4.2 Second Project's Results: Classrooms Observations

Teachers from three disciplines: mathematics, physics, and sciences are observed within indoor classroom sessions. They are observed while they are teaching the same students that we identify learning styles in previous section. Each teaching and learning observed act is measured by its time duration within class session. All acts are gathered in five educational categories. We see in Fig. 5.5, statistical results about the three visits within those five sets. We can interpret those results by the

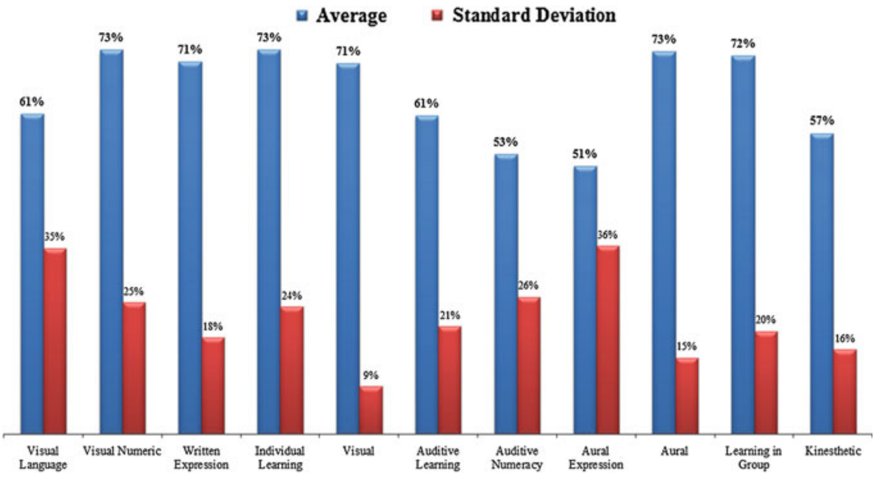

Fig. 5.4 Student learning styles results from visual-aural-kinesthetic self-assessment questionnaire on institution's Website

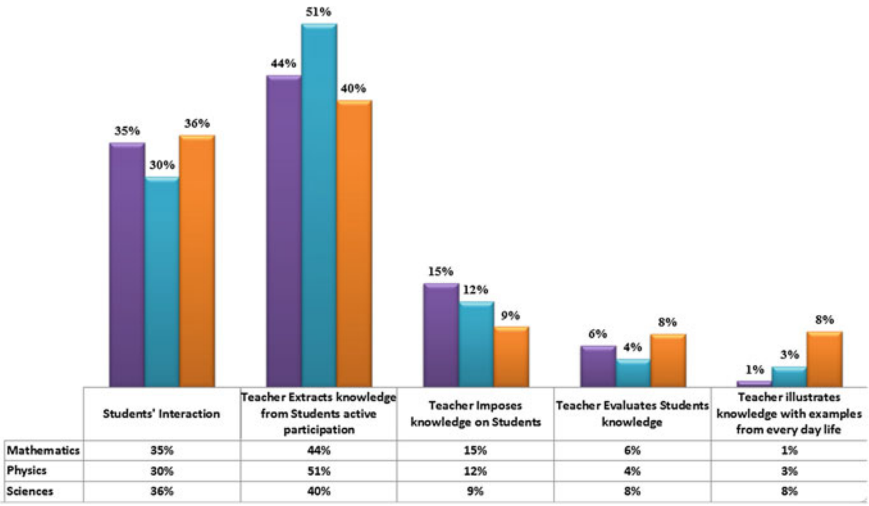

Fig. 5.5 Statistics on global teaching practices within MPS classrooms

following findings. Students interact well within their class in all observed disciplines a third of total duration. They answer their teacher’s questions, they ask their own questions, they suggest alternatives, and they provide rationales. Teachers, mostly, try to extract knowledge from their students within a four time longer duration than the imposition time duration. They spend enough time on evaluating students’ knowledge assimilation and they try to give examples from everyday life about the content they teach.

5.4.3 Third Project’s Results: Exams Analysis

Mathematics exam and its written performances are treated for the same class students. Figure 5.6 shows, within its first graphic (pie chart), the exam’s evaluated objectives partition. The second graphic (histograms) shows processed average correct answers’ rates. The pie chart visualizes the rate 7.5 % of the total exam questions that invoke memory for direct responses. Those questions are coded A1. The comprehension and application of mathematics contents on specific situation reach the rate of 37.5 % (coded A2). A rate of 12.5 % of exam’s questions evaluate students’ capabilities on graphical processes (coded Bgraph). Answers which need analysis, synthesis, and evaluation within the known and unknown situations have the rate of 42.5 % (C1 and C2). It is a relatively high rate according to students’ level and the official statements about those rates.

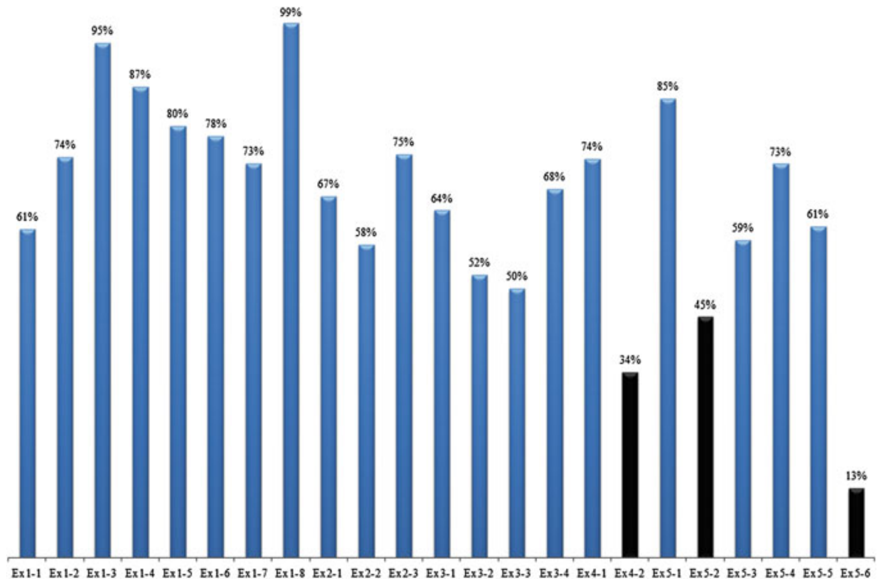

Fig. 5.6 Evaluated objectives partition and average correct answers' rates

As a main exam feature, progressive difficulty is clearly not well respected. We observe on second histograms of Fig. 5.3 that the increase in rate of correct answers is located in the first questions (Exercise 1: questions 1, 2, 3). Also, global results are very acceptable with right answer rates that are over 50 %.

5.5 Conclusion

Creating and sharing relevant knowledge are critical as are new methodologies of evaluation for learning innovation. The relevance of diagnosis is highly dependent on the complete observation of the operative. The use of online questionnaires, computerized interactive grid as observation tool, exams pedagogical analysis, and students' performance, make an advance on the state of the art in this field. Indeed, it needs educational diagnosis skills to quantify in real-time relevant criteria for the recognition of actors' profiles and the process of teaching and learning. Criteria for equity confer more justice and rigor with associated indicators to assess. These quantified indicators will constitute a generated raw data source from which we can extract relevant and vital knowledge. All processes are done under data mining treatments for decision support, recognition, and extraction of educational features. This is the project's main interdisciplinary aspect that leads to exploit the power of data process algorithm to investigate pedagogical concepts. As an innovative analysis and integrated approach, LEEP aims promising strategies for changing learning environments, and for spreading and sustaining innovative practice on a wider scale. The research program objectives focus on transforming teaching practices and learning environment to be most effective. These objectives, which lead as major principles to innovative learning environment, are listed as follows: to make learning and engagement central, to ensure that learning is social and often collaborative, to make teaching and learning highly attuned to learner motivations and emotions, to make learning acutely sensitive to individual differences, to adapt learning demand to each learner without excessive overload, to use assessment consistently with learning aims, with strong emphasis on formative feedback, to promote horizontal connectedness across activities and subjects, in and out of school.

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Chapter 6
Teaching Effectiveness Enhancement Project "TEEP"

Riadh Besbes

Abstract The overall objective, to which the project will contribute, is to improve teaching and learning effectiveness within academic institutions by exploiting data mining methods on collected databases for educational knowledge extraction. These teaching and learning databases are accumulated from quantitative "measures" done through indoor classroom visits within academic institutions, online web access learners' questionnaires answers, paper written statements' analysis of academic exams in STEM education (science, technology, engineering, and mathematics), and online elementary grades seizure from written traces of learners' performances within STEM exams. Findings of these processes, elaborated by researcher's team within beneficiary organization, are disseminated through diversified publication and are the subject of multiple professional meetings, especially, teachers training sessions. The project's data mining strategy in educational context will support and develop teachers' expertise, enhance and scaffold students' learning, and improve and raise education system's performance. This is a project that combines data mining analysis methods with educational and cognitive science findings. It attempts to unify these two paradigms generally distant from each other. New strategies of educational assessment, training, and innovating are designed and are able to enhance significantly the effectiveness of teaching and learning performances in academic institutions such as secondary schools. The use of these methods aims to identify and better understand the learner's profiles, teaching practices' characteristics, and context details in which teachers and learners act. These tools for decision support are exploited by the researcher, an

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educational inspector, and expert in educational assessment, to generate, make available, and process databases on teaching practices, learning performances, and learners' profiles.

Keywords Teaching effectiveness · Teachers' practices · Educational relevance · Sustainability

6.1 Case Overview

6.1.1 Objectives

This study aims to improve teaching effectiveness within academic institutions by measuring observational data, collecting them in databases, and extracting knowledge from them using intelligent processes. With educational use of ICT, the first contribution with this work was to move beyond traditional measures to assess teaching practices in schools' classrooms. These teaching databases are accumulated from quantitative and qualitative "measures" done through indoor classroom visits. Our basic flow of data was driven through the use of systematic observation protocols in classrooms. This is done with research-based interactive grid, constructed through gathered educational concepts from pedagogical bibliography. The interactive grid is used by educational experts through portable devices, to quantify teaching behaviors, acts, and attitudes among a number of dimensions. Our approach is to attempt to unify two paradigms generally far from each other: behavioral science in educational context which seeks to develop and verify theories that explain or predict human behavior, and design science. An intelligent system is designed, to assess in quantifiable terms, thirty five educational concepts from teachers' practices, attitudes, and behaviors in learning context within class session. This is done from seizure of quantitative inputs, in terms of time's durations, and qualitative ones, in terms of assessment on a Likert Rensis scale. Those pedagogical concepts are deeply related to indoor classrooms educational phenomena, and they are the determinants of teaching effectiveness. To build this hierarchy of pedagogical concepts, an engineering system is designed from different modules that implement those concepts' processes. Engineering modules are constructed with fuzzy logic techniques, an approach of artificial intelligence that is often used in systems for decision support, and it is handling of qualitative data in contexts characterized by imprecision and uncertainty. The educational processes are handled as highlighted by Canos: the use of linguistic variables is necessary to represent the qualitative expert's assessment in order to characterize the situation as the value of a linguistic variable. It reflects an imprecise aspect; thus rules of inference manipulate the linguistic variables to represent a particular reasoning similar to that of an expert. The functioning of this system is based on the collection

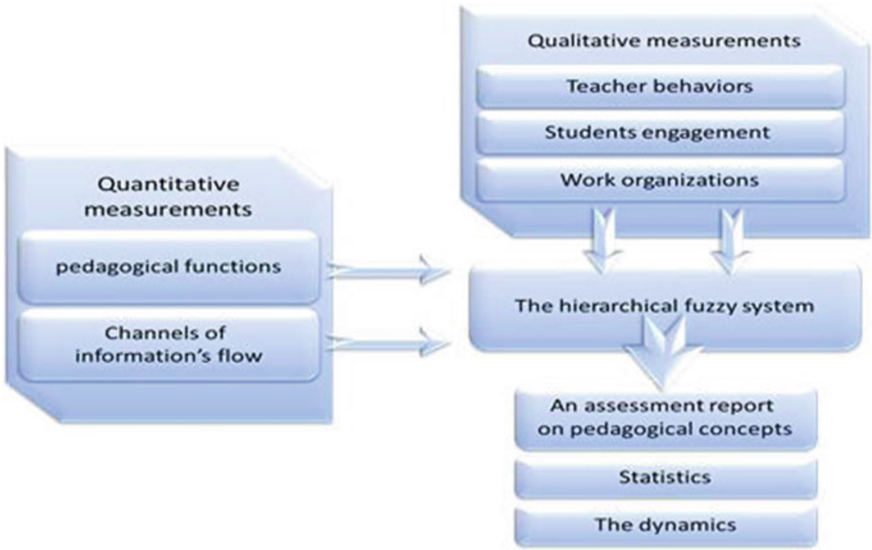

Fig. 6.1 System's block diagram

of information about teaching–learning acts in class session as shown in Fig. 6.1. The whole system generates a report containing the assessments of thirty-five pedagogical concepts beside statistics histograms and charts illustrating the dynamic evolution of teaching practices among the course session.

6.1.2 Target Groups

Secondary schools inspectors and teachers for all disciplines.

6.1.3 Executive Summary

Few studies look into the current changes of teaching practice. These practices result from the interaction of teachers with their learners in a particular context and are related to teachers' psychosocial characteristics, and their emotional and relational dimensions. So, for full characterization of the heterogeneous teachers' professional practices, the educational inspector mobilizes specific techniques, as an expert to design a professional opinion, an assessment that, first, aims at developing teachers' professional skills and also leads to the regulation. As stated in its manual "Evaluation and Professional Development," Anne Jorro confirm that "evaluate is necessarily considering how we will support, advise, exchange, to give recognition to encourage the involvement of teachers and giving them means to act." Louise Lafortune and Linda Allal also argue in their book "Professional Judgment in Evaluation" that "the professional judgment is a process that leads to a decision, which takes into account different considerations from professional expertise. This process requires rigor, coherence and transparency. In this sense, it involves gathering information through various means, the justification for the choice of means in place with the aims and intentions, and sharing the results of the approach in a regulatory perspective." Imminent reality shows that the quality of an education system cannot exceed the quality of its teachers and inspectors, since student learning is ultimately the product of what goes on in classrooms. National government stakeholders know that they have to pay attention to the kind of initial training that new recruited teachers receive before they begin to act in their classrooms; they have to identify precisely what kind of continuing training should teachers get; how they improve the performance of those who are struggling; and how they provide opportunities for the best performers to acquire more status and responsibility. PISA report states that many of the world's best-performing education systems have moved from bureaucratic "command and control" environments toward school systems in which the people at the frontline have much more control of the way resources are used, people are deployed, the work is organized, and the way in which the work gets done. As an important factor which PISA report shows to be closely related to school performance when combined with effective accountability systems the provision of an environment in which teachers work together to frame what they believe to be good practice, conduct field-based research to confirm, or disapprove the approaches they develop. This can be realized on field with an efficient coaching by an educational inspector that supports reliable training and who is capable as an expert to design a professional opinion, an assessment that, first, aimed at developing teachers' professional skills and leads to the regulation, and as educational policy stakeholders, insure benefits for every student from excellent learning opportunities.

6.2 Background

6.2.1 Social Context of Teachers–Inspectors Professional Relationships

In the educational field, in one hand, there is a huge disparity between the guidelines on teaching methods mentioned in official instructions and what is effectively practiced in classrooms. On the other hand, an exaggerated anxiety reigns on the professional relationship between the teachers and their inspector which is mainly caused by the conventional teachers' assessment which resembles to an insignificant rite. In short, there is a professional climate which is far from being valid and safe. Then, how could the educational inspector encourage reflexive practices and collaboration among teachers? How could he identify and measure the development of his teaching staff activities? How could he provide a training program which converges with teacher’s self-understanding and professional experiences that are important resources for his own training? And finally, how could the professional teaching’s assessment brings to teaching practices’ improvement in order to lead the majority of students to an increase in motivation to learn? We try to answer those questions by developing an innovative information system that combine behavioral science and design science. Indeed, we exploit theories that explain and predict human behaviors and we quantify them by the mean of organizational capabilities. Following this approach in order to validate the reliability of our system and to prove that it has enough sustainability to be a solution part of those alarming findings in our education system context, we proceed for this cognitive ergonomics’ intervention.

6.2.2 Purpose

We believe that assessment is essential to predict improve and maintain an acceptable level of teaching effectiveness. It ensures accountability and creates ways to improvements and future investments. This is possible when the system generates authentic, participatory, and grounded information. This information, captured then interpreted, reflects indeed the reality. In a cognitive ergonomics way we processed as described Braverman. To ensure work condition improvement, evaluators should not focus on legitimate stakeholders policies, and they have to be enough responsible to feed the system by meaningful and rational data that reflect realities on educational fields. It will not be easy, since teaching is a high cognitively complex behavior. Teachers are actors who should have in hand a set of alternative forms of representations, which can derive from research or have their origin in the wisdom of practice. Darling-Hammond defines effective assessments as those that categorize the content knowledge, teachers’ skills, and attitudes in teaching and learning fields. Those skills and behaviors rely on multiple sources of information collected over time in multiple contexts. They are assessed in reference to codified professional information standards. Linda Darling-Hammond and Charles E. Ducommun underscore the important assumption that, undoubtedly, teachers are the fulcrum that has the biggest impact and makes any school initiative leads toward success or failure. Hence, the importance to consider for both teacher and teaching qualities by means of useful policy system that should attract, prepare, support, and develop expert teachers who can teach in a more effective way. These effective teachers’ qualities are summarized in strong general intelligence, verbal ability, good mastering content, and pedagogical knowledge in their field of teaching especially an understanding of students learning styles and development, and how to evaluate and scaffold learning. Those are the main reasons leading to the necessity to improve traditional teachers’ qualifications measures. Milanowsky et al. mentioned that in the last 25 years many effective standards in teaching evaluations are developed. The use of such standards as a base of teaching practices assessments provides meaningful knowledge about both teachers' performances and students' achievements. These new investments in research to design new initiative and ways of assessing teaching effectiveness can offer valuable opportunities to gather information about general teaching performances at national scale. To achieve that goal, a common set of essential teaching skills attitudes and behaviors is defined and measured within a group of secondary schools teachers in Tunisia. In order to evaluate teaching effectiveness with efficient techniques, we designed a hierarchical system consisting of six levels. Layer_0 is an interactive grid gathering 36 quantitative and 27 qualitative input measures. The grid is used by expert on portable device to capture and categorize what is observed from teachers and learners inside classrooms. Our system generates statistical histograms and 35 educational concepts' evaluations that reflect the performances of teachers and their interactions with students. From our system's results, advices and guidelines on teaching practices and learners interaction quality can be easily extracted in order to correct weaknesses and sustain strengths.

6.2.3 Expected Outcome

We expect findings that provide complete educational profile identification by the means of adequate processes on collected database from inside classrooms. Those black boxes that many researches were not able to observe analyze or interpret its various pedagogical phenomena. According to our teaching effectiveness assessment system many results on educational concepts' evaluations and their interconnections are discovered. For example, the studied group of Tunisian teachers manifests a wide common use of control tone in communication with students, an average perception of control by learners among courses activities, and a huge lack of support to learners' autonomy. This is interpretable by the fact that teachers impose the methodology and within activities, learners execute instructions. "Perceived Control" is particularly interesting; it is a key principle from self-determination theory: individuals enjoy activities when they believe that they have control over some of their aspects. We see along the sample, and the whole database, that if this concept is assessed "Weak" then no other concept, within that teacher's record, is assessed "Strong." Beside this statement, we see also that if "Perceived Control" is assessed "Strong," then no other concept, within that teacher's record, is assessed "Weak." This leads us to conclude that "Perceived Control" is a cornerstone of the "Ability to Change the Course of Events" in particular and teaching effectiveness in general. About correlation among educational concepts, we see that the majority of teachers who had "Strong" "Ability to Change the Course of Events" are "autonomy supportive" and "Maintain Motivation" within their classes. More, when we see the whole database, those teachers personalize knowledge: uses examples from everyday life to concretize the knowledge and encourages their students to do the same. They master properly all taught knowledge, they analyze deeply all information, and their learners are highly cognitively engaged. When they proceed they convey a high concept to success.

6.3 Initiative Description

6.3.1 Features and Innovation

6.3.1.1 Uncertain and Noisy Data

There is no doubt that in educational context we are dealing with questionable data. Indeed, an item of data, such as acts’ time duration or scaled appreciation of a behavior, carries with it a level of uncertainty related to our confidence in the accuracy and precision of our measuring aptitude, the transmission medium’s clarity and stability, and, fundamentally, the properties of the data itself. By assuming that all numbers are fuzzy sets, we assign to each data a horizontal dimension that indicates the degree of ambiguity or noise in the data. This horizontal data’s diffusion represents its loss of crispness; it reflects our belief in its degree of certainty that can be also interpreted as ambient noise in the data. Here fuzziness is viewed as a property of the conceptual knowledge structures in our model, that is, as attributes associated with the vocabulary fuzzy sets. However, the fuzziness resides in the incoming data. The degree to which we are uncertain about a data point because of noise or the lack of quantitative or qualitative information induces a fuzzy membership function around the data point.

6.3.1.2 Module Flow Process

Our system is composed of 35 modules that are parts of the general hierarchy. For each one we proceed with this critical part of the fuzzy model evolution. It is about understanding the “mechanics” behind every module’s behavior and identifying the module dynamics in terms of the conventional system flow process: input-process-output model. As it is done in analysis techniques used by intelligent-systems knowledge engineers, the first task is defining what information flows into the module, what basic transformations are performed on the data, and what data elements are eventually outputs from the module. Since that each module is an educational concept, it has its profound meaning linked to educational context. Thus, the module’s inputs are in fact the factors that are correlated to that educational concept. But at which level certain inputs are more correlated to that concept than others? This is a reliability problem. Cronbach alpha is a coefficient of reliability; it is commonly used as a measure of the internal consistency or reliability. It evaluates how closely related set of items are as a group of a psychometric test score in a survey instrument. We calculated this coefficient for all inputs from the grid measures to gauge their reliability. Results showed that certain inputs are more reliable than others but they had all relatively high internal consistency. Considering that difference of reliability among inputs and the gray relational analysis, for Concepts inputs, fuzzy rules are performed according to these data. The result of fuzzy treatments is an assessment (in general: Weak, Average, or Strong) of the educational concept.

6.3.1.3 Fuzzy Modeling

Maeda and his colleagues state that the use of fuzzy techniques has been considered one of the key components of data mining systems because of the affinity with the human knowledge representation. Fuzzy modeling involves developing the best estimation surface for a formal system. Choosing the shape of the fuzzy set is undoubtedly a critical part of building a fuzzy model, since the shape of the fuzzy set determines the correspondence between data and the underlying concept. However, there are no fixed topologies for fuzzy sets, but to decide how to represent a fuzzy space, we focus on how each element out of the domain is mapped into the concept. The domain of the fuzzy region in the universe of discourse should also be elastic rather than restrictive. To determine the appropriate fuzzy membership functions to each Acts and Concepts, as done in Dunham and colleagues works, we evaluate the minimum, average, maximum, and root-mean-square standard deviation according to the data gathered in our database.

In modeling dynamic systems, the use of both triangular and trapezoidal functions can approximate their behaviors to nearly any degree of precision especially since variables are decomposed into overlapping arrays of triangular or trapezoidal regions. The endpoints of these variables are often expressed as "shouldered" sets (bisected trapezoids) or as linear fuzzy sets, which are actually bisected triangles. Deliberately, we avoid the use of irregular-shaped fuzzy sets in order to prevent unpredictable effects on the system's behavior that may be difficult to evaluate. Trapezoidal forms are simpler to specify, easier to visualize, and have the somewhat dubious advantage of mapping to fuzzy models in literature. We construct for all data, normalized fuzzy variables defined in [0;1] universe of discourse. As shown in Fig. 6.2, for each variable we determine three fuzzy membership functions for the linguistic terms: "Weak," "Average," and "Strong." By scanning the variable's universe of discourse we will justify our shouldered fuzzy sets choice. Below minimal variable's value (respectively, above maximal value), the data value is qualified to be weak and remains (respectively, qualified to be strong and remains), which is the first plateau (respectively, the last one). As the variable increases, a middle plateau is reached on "average" membership function, why is that? We note for major measurements that standard deviation generally shows a low dispersion from the average value; it indicates that the data points tend to be very close to the mean, that is why we decide to bracket the middle region. Fuzzy membership functions associated with different type's data, quantitative, or qualitative measures are characterized by variable thresholds. These thresholds are determined from

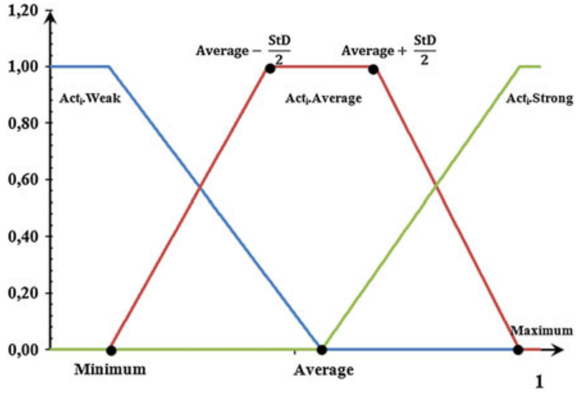

Fig. 6.2 Trapezoidal membership functions

statistical calculations of their minimums, averages, maximums, and standard deviations. So we can locate any new measures in respect of a history of measurements. The variability of these thresholds ensures the system's adaptability to the educational practices environment of specific teachers and specific students' profiles.

6.3.1.4 Process Component

The module's process component is conceived with a set of rules describing the behavior of the module's output, given the inputs that interact with the fuzzy set vocabulary. We enrich the final compositional step in building a fuzzy model by writing the rules that describe how the module operates and gives the concept's assessment. When the rules have been written and compiled, some beneficial practices have been considered when writing rules, such as grouping together all rules that set the same solution variable, arranging them for easy readability, using indentation to show the rule's structure, and using a naming convention to identify different classes of performance variables.

6.3.1.5 Defuzzification Method

For completing the design of our fuzzy module, defuzzification method for every solution variable was defined. Defuzzification selects the expected value of the solution variable from the consequent fuzzy region. The centroid method is chosen to be the defuzzification method for every module for these reasons. The centroid method is providing a consistent and well-balanced approach. It is sensitive to the height and width of the total fuzzy region. Expected values from the centroid defuzzification also tend to move smoothly from one observation to the next, unlike composite maximum or the average heights method that tends to jump erratically on widely noncontiguous and nonmonotonic input measures.

6.3.1.6 Hierarchical Structure

Recent research has shown that a hierarchical system's structure should be carefully considered. First, the input variables should be grouped into subgroups. Zeng and Keane introduced the concept of a natural hierarchical structure: when a function can be decomposed as a set of several lower dimensional functions or a system consists of several lower dimensional components. If there is a natural hierarchical structure for the function to be approximated, the model hierarchical structure should be consistent with this natural hierarchical structure. Otherwise, the structure of the hierarchical fuzzy system should be analyzed using human knowledge or by the grouping method proposed by Chung and Duan. Moreover, in hierarchical fuzzy systems, the intermediate outputs are artificial in nature in many cases and do not possess physical meaning. Thus, for fuzzy logic units, if they are used as the input variables of the next layer, which is the usual case, then the involved fuzzy rules in the middle layers of the hierarchical structure have little physical meaning and consequently are hard to design. This phenomenon becomes prominent as the number of layers grows larger in a hierarchical fuzzy system.

However, the strength of our system is its hierarchy, because it is the sense of the educational concepts' relation and meaning that we tend to assess. As consequence, each of all fuzzy units or modules is deeply interpretable and has its own meaning from psychological and social research. So, the involved fuzzy rules are designed from their educational interpretation.

The initial inputs are collected in class sessions. The inspector (educational expert) in the classroom observes the activities of the teacher with his students and identifies the acts of teaching and learning from those in the interactive grid that he has on the input interface running in his portable device. Among the practices of teaching and learning as detailed in Table 6.1, 63 acts are distributed among 3 groups as the first group assembles 9 acts measured in terms of temporal duration

Table 6.1 Detailed interactive grid

<table>
<tr><td colspan="6">The channels of information exchange (9 quantitative measurements)</td></tr>
<tr><td colspan="2">Writes in a readable format</td><td colspan="2">Encourages students to write summaries</td><td colspan="2">Uses symbols, images, curves …</td></tr>
<tr><td colspan="2">Turns ideas into symbols, curves…</td><td colspan="2">Use of tangible material</td><td colspan="2">Varying voice's intonation and intensity</td></tr>
<tr><td colspan="2">Expresses himself orally</td><td colspan="2">Keep eye contact with audience</td><td colspan="2">Silence</td></tr>
<tr><td colspan="6">Pedagogical functions (27 quantitative measurements)</td></tr>
<tr><td colspan="2">Learner's interaction</td><td>Imposition</td><td>Development</td><td>Customization</td><td>Evaluation</td></tr>
<tr><td colspan="2">4 Acts</td><td>6 Acts</td><td>11 Acts</td><td>2 Acts</td><td>4 Acts</td></tr>
<tr><td colspan="6">Six sets (27 qualitative measurements)</td></tr>
<tr><td>Teacher's involvement</td><td>Mastering taught knowledge</td><td>Methodological choices</td><td>Students' behavioral engagement</td><td>Students' emotional engagement</td><td>Students' cognitive engagement</td></tr>
<tr><td>8 Acts</td><td>4 Acts</td><td>4 Acts</td><td>4 Acts</td><td>4 Acts</td><td>3 Acts</td></tr>
</table>

that are the channels by which teacher is conveying information. The second group gathers 27 quantitative acts also measured in terms of temporal duration and categorized according to five educational functions which are explained below:

Learners' Interaction (4 Acts): These are verbal manifestations of the learners within their activities in class.
Imposition (6 Acts): These are the actions that the teacher shows to dominate the verbal and nonverbal activities by his instructions, recommendations, and orders.
Development (11 Acts): These are the actions that the teacher shows to coach and encourage students' contributions and voluntary initiatives. These are practices that lead learners to construct their own knowledge under the appropriate supervision of their teacher.
Customization (2 Acts): When the teacher uses examples from everyday life to concretize the knowledge and encourages his students to do the same. This pedagogical function is particularly influent on student's motivation.
Evaluation (4 Acts): Evaluation is carried out through internal or external procedures. The use of different types of questions is the common means by which teachers proceed to evaluation.

The third group of inputs is constituted by six sets of 27 qualitative attitudes or behavior measurements in terms of ratings on the Rensis Likert scale. Three sets of 16 measurements are relative to teacher's involvement, taught knowledge, and methodological choices. The remaining 11 measurements divided into three sets are relative to students' behavioral, emotional, and cognitive engagement. The proposed hierarchical fuzzy system structure with 5 layers hierarchy is presented in Table 6.2.

6.3.2 *Overall Objectives and Milestones*

Relative to what is known in the empirical literature about the value of observational systems for assessing teaching effectiveness, much less is known about the viability and efficacy of these methods for assessing the educational interactions in classrooms and its effect on students' engagement and performances. Moreover, a few observation assessment tools have been designed by combining empirically based strategies with key stakeholder feedback to ensure the developmental and cultural appropriateness of the resultant assessment tool, a practice that is increasingly being recognized as a key ingredient in the provision of best practice culturally competent research. Hence, there were several primary goals of the current article. First, the author sought to illustrate how educational psychology and sociology approach could be used within the context of hierarchy building and measurement development to assess educational actors within urban schools. Second, analyses were conducted to determine the initial educational concepts and associations of the new assessment system, the fuzzy hierarchical system for

Table 6.2 Detailed five hierarchy layers

Layer 1	*20 pedagogical concepts' modules*				
	Learner's Interaction	Imposition	Development	Customization	Evaluation
	Teacher commitment	Mastering taught knowledge	Communication language	Learner's behavioral engagement	Learner's emotional engagement
	Learner's cognitive engagement	Learning style: visual—verbal	Learning style: visual—non verbal	Learning style: tactile—kinesthetic	Learning style: auditory—verbal
	Perception	Processing	Understanding	Convey a concept to success	Methodological choices
Layer 2	*9 pedagogical concepts' modules*				
	Perceived competence	Perceived controllability		Perceived value	
	Feedback	Collective learners' commitment		Teaching method	
	Collecting information	Information analysis		Input of learning styles	
Layer 3	*2 pedagogical concepts' modules*				
	Maintain motivation			Maintain interaction	
Layer 4	*3 Pedagogical concepts' modules*				
	Teacher's autonomy support	Communication		Construction of learning; situations	
Layer 5	*1 pedagogical concepts' module*				
	Teacher's ability to change the course of events				

teaching effectiveness assessment. Specifically, the authors use systematic observation protocols in classroom with well-developed, research-based rubrics, gathered in an interactive grid, to quantify teaching behaviors, acts, and attitudes along a number of dimensions. They tried to prove the Darling-Hammond and Charles's assumption that "the more teachers are enabled to enact professional standards of practice in their classrooms, the more effective they are in supporting student learning." As such, it was hypothesized that teaching effectiveness ratio would be positively correlated with educational concepts such as "Ability to Change the Course of Events." Experimental results show that the proposed teaching effectiveness assessment scheme can correctly measure teaching performance according to their gathered data with the interactive observational grid. Significantly, the teaching effectiveness evaluation results were applied to extract knowledge about teaching and learning progress and identifying major educational concepts that constitute the fulcrum of teaching effectiveness. Finally, next steps in research and practice implications will be discussed.

6.4 Implementation Plan

6.4.1 What Is the Implementation Plan and Content?

Ergonomics science defines two important concepts that are task and activity. The task responds to the question: what should the teacher do during a class session? A real task is what is truly realized by the teacher. The activity answers the question: what does the teacher supposed to do? It is characterized by observable facts (behaviors, attitudes, verbal and nonverbal interactions, etc.) and unobservable facts which can be inferred by the observable facts. The activity is determined by multiple factors, both human (age, experience, degrees, etc.) and environmental (School, students' profiles, availability of material resources, etc.).

6.4.2 Context of the Study

A group of experienced teachers, having good social relationships with their colleagues within their institutions, had represented all educators of their discipline working in an urban public school district. The group states that the official instructions claimed a teaching method (called active teaching method) which is a cause of a lot of waste in valuable time. The contents' curriculum is so loaded that it is not possible to realize such activities with such teaching method. In addition, its specific techniques are fuzzy and cannot be tackled with ease, or adapted to the students' profiles. So it would be more convenient to reduce the official curriculum, reduce the number of students in classes, and provide the didactic materials to be quite available in schools. Furthermore, the level of pedagogical or scientific training session for teachers should increase, so that they gain a minimum profit from these trainings. As for the communication with the educational inspector, during the discussion that follows his visits in class is a unidirectional discourse, weakly justified, and not realistic. For his part, the inspector who is in charge of those urban public schools' teachers in the same district claims that most teachers avoid using the active teaching method among their professional practices in classrooms. They deliberately prefer operating the various practices of dogmatism to save time and also for the simplicity of these practices and lack of diligence in the use of constructive techniques. This has a negative effect on learner's motivation and consequently their academic performance. The recommendations provided in discussions with teachers, after the class visit, are moderately exploited and rarely used in classes.

6.4.3 Methodology

We first began by analyzing each one of these statements (demand) which is “the outcome of a story” and that reflects the relationships, which appear in this case adversarial, between the two protagonists, teachers, and their inspector. For this, as ergonomist we organize the general information collected during our interviews with teachers, inspector, and some administrative actors directly related to school activities. These data will be helpful for the ergonomics approach. The analysis will therefore focus on different dimensions. As Guerin advised, it will be necessary to choose the situations to be analyzed and then go “to the field.” Therefore, the process of teaching and the inspector’s professional practices should be explored and analyzed in different contexts: at the class level, when the discussion between the inspector and the teacher takes place after a class visit, and at the training sessions.

6.4.4 How to Implementation Effectively?

For innovating in learning environments, OECD analysis has identified four modalities that are followed within TEEP.

6.4.4.1 Exploiting Science, Knowledge, and Research and Development

Creating and sharing relevant knowledge are critical as are new methodologies of evaluation appropriate for learning innovation. The relevance of the diagnosis is highly dependent on the complete observation of the operative. The use of interactive grid as observation tool and the results of the teaching effectiveness enhancement hierarchical system are considered as an advance on the state-of-the-art in this field. Indeed, the researcher should be able to quantify in real-time relevant criteria for the recognition of actors’ profiles and the process of teaching. All processes are done under data mining treatments for decision support, recognition, and extraction educational features. This is the main project’s interdisciplinary aspect that leads to exploit the power of data process algorithm to investigate pedagogical concepts.

6.4.4.2 Technological Advance: What Is the Effect Can Teaching and Learning Achieve with the Help of Technology?

Technology has enormous potential especially when it reshapes the different components. As innovative approach, the project activities reshape teaching effectiveness and lead to its enhancement. A collaboration opportunity rises here in the benefit of researcher from the Department of Environmental Sciences, Informatics and Statistics, in "Ca' Foscari" university. Indeed, the department provides innovative approaches to the analysis and management of information and environmental systems. Their research is structured around multiple laboratories and research centers and unfolds along a wide range of areas and directions. Collectively, they contribute to advance the understanding of the complexity of modern environmental and information systems, by developing the analytical models, the assessment principles, and the engineering techniques required to provide effective answers to the scientific questions such systems raise, and to the technological challenges they create. These are exactly the answers which our project is looking for.

6.4.4.3 Modular Reorganization

Implementing professional learning and organizational routines can help to break old institutional habits, enhance visibility, and maintain learning as the central activity. Collegial wisdom is the original consequence of project's finding broadcast among professionals within different kinds of meetings.

6.4.4.4 Networking and Sharing Knowledge

Networking is essential to create innovation across entire learning systems. Projects extracted knowledge dissemination through diversified channels. A huge amount of information about the reality of teaching practices and learning performances inside classes will be available. Collected data contains valuable knowledge which can considerably affect educational policies in the right directions. Precisely, that is why project's sustainability is having a strong consensus, and will continue to have. It is a material impact on how the researcher, as assessor, will think and act. Once the researcher, as educational stakeholder, begin to pursue sustainability initiatives in assessment, he will tend to unearth opportunities to reduce teaching weaknesses, manage new targeted training sessions, and develop more innovative teaching effectiveness models.

6.4.5 Who Are the Participators?

Professor Mohamed JEMNI, Director of ICT in The Arab League Educational, Cultural and Scientific Organization—ALECSO, is a potential collaborator to this project, and by his supervision the project will have probably a sight on the Arab world.

Professor Demetrios G. Sampson, Ph.D. in Electronic Systems Engineering is a Professor of Digital Systems for Learning and Education at the Department of Digital Systems, University of Piraeus, Greece. Prof Sampson is a Research Fellow at the Information Technologies Institute (ITI), Centre of Research and Technology Hellas (CERTH), and an Adjunct Professor at the Faculty of Science and Technology, Athabasca University, Canada. His research work on Digital Systems and Services for Technology Supported Learning and Education can have an important impact on the efficiency of this project.

The whole ICT architecture conception is realized with the contribution of an Engineer and young researcher Seifeddine Besbes under the supervision of Professor Bekhisipho Twala, Ph.D. Head of Electrical and Electronic Engineering Science Department, Professor in Artificial Intelligence and Statistical Science, Faculty of Engineering and Built Environment, University of Johannesburgh.

Joint publications on this project are already published in some international conference especially about engineering education.

At “Ca’ Foscari” University of Venice, educational and cognitive science is the main expertise of the Department of Philosophy and Cultural Heritage where the researcher will receive his main theoretical training. Indeed, beneficial training about cognitive concepts will be easily provided under the direct supervision of Prof. Umburto Margiotta.

6.4.6 How Long Does It Last?

Two years.

6.5 Implementation Process

6.5.1 Implementation Process: Focus on Innovative Teaching Strategies

We first began by analyzing each one of these statements (demand) which is “the outcome of a story” and that reflects the relationships, which appear in this case adversarial, between the two protagonists, teachers, and their inspector. We process the general information collected during our interviews with teachers, inspector, and some administrative actors directly related to school activities. These data will be helpful for the ergonomics approach. The analysis will therefore focus on different dimensions. As Guerin advised, it will be necessary to choose the situations to be analyzed and then go “to the field.” Therefore, the process of teaching and the inspector’s professional practices should be explored and analyzed in different contexts: at the class level and when the discussion between the inspector and the teacher takes place after a class visit, and at the training sessions. For the analysis of teachers’ practices in classrooms we proceed to open observations within work situations. As a first approach, we opted for the visualization of statistical results in the forms of histograms in two-dimensional graphs. On the x-axis, the educational functions are named; on the y-axis the final cumulative rates of these functions are presented. For every educational function, we generate its own bar graphs that visualized the duration rate of every act. We will then focus on the identification of variability factors, its diversity, the evolutionary dynamics of the teachers’ activities, the conditions of realization of their work, and their results. These observations are complemented by verbalizations, within interview session between the visited teacher and his inspector. They will build the first explanatory links between working conditions and the problem.

6.5.2 Process Management

The next step is the formulation of a hypothesis that will explain the problem by making links between the characteristics of the activity (teaching practices) and the results with certain conditions of work completion. This hypothesis “consists of one or several statements about causal relationships among determinants (conditions under which the teaching process has occurred), the characteristics of the actual teaching practices and its impacts on learners performances”. Some authors suggest that teaching effectiveness has the most important impact on academic growth. So, our hypothesis is: “Instructions and suggestions developed following the diagnosis and analysis of teaching practices and students’ interactions registered in class session with our observation’s tool lead to an enhancement in teaching effectiveness and better professional relationships between teachers and inspectors.”

Analysis tasks

Our strategy was to produce by the actors (teachers and inspector) an understanding of the situation and build with them the means to make it evolve and transform. Thus, we tried to develop a process that addresses the interaction between two approaches, one focusing on the social context and the other on the production in order to “transform the work contributing to the design of the work situation”. Lebrun’s researches and official instructions specified in the guidelines that a teacher is able to be aware at every moment of the method he uses; it is a reflection on the practice in the educational field. It is an action’s plan, a rational way to organize some practices to achieve goals. We cannot speak about teaching method only if three conditions are met: a conscious project, homogeneity in practice, and predictability. The relevance of a method, as mentioned by Peterson, lies in the fact of saving the learner’s ability to surprise, it is a question of avoiding repressing, discouraging, and engraving. The attitudes and behaviors of the teacher (personality, education, etc.) are also efficiency factors in the educational field. Indeed, a teacher is not perceived by others, exclusively, in terms of knowledge, but also in terms of good manners. Loewenberg specifies that there are broad claims about what teachers need to know and how to relate content knowledge to the practice of teaching. He speaks about pedagogical content knowledge that Lee Shulman and his colleagues proposed as a bridge between content knowledge and teaching acts.

Thus, we will have the opportunity to validate our suggestions to improve working conditions through the reflexive reading records of teaching practices. We provide qualitative and quantitative evaluations during the interview sessions. In next section, we will present statistical results obtained with our interactive grid. Then we will see and analyze some interesting findings when we processed the measurements by executing our teaching effectiveness assessment system. It generated an estimated evaluations about the 35 pedagogical concepts distributed on its 5 layers. We will analyze some of these evaluations to identify the main weaknesses and strengths at educational concepts levels.

6.6 Outcomes

We began our validation work by an inspection visit at a secondary school from the same urban public schools district where we conduct our study. The teacher, aged 45, has an experience of 15 years and has a good reputation among his school administrators. The class is a terminal grade (baccalaureate), technical branch whose students are, in general, low motivated and difficult to control. The histograms of teacher's practices shown in Fig. 6.3 indicate a strong dominance of imposition acts which lasts 68 % of session class duration. However, information

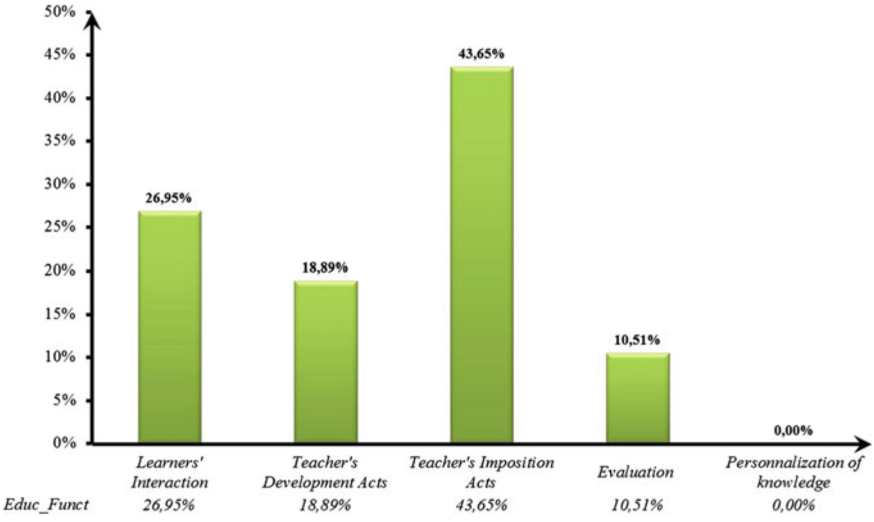

Fig. 6.3 Pedagogical functions' statistics

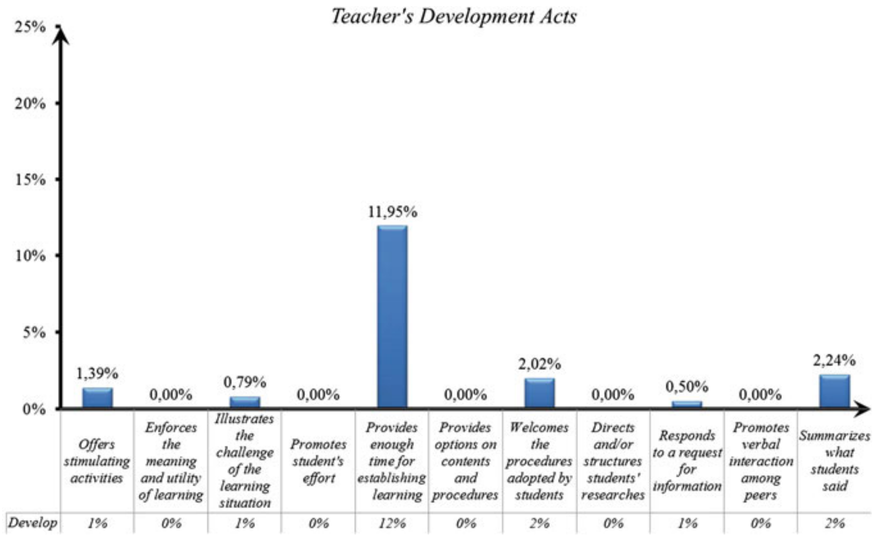

Fig. 6.4 Development acts' statistics

development which is a pedagogical function that focuses on teacher's acts that motivate students to construct their knowledge by different active means has a low rate of only 15 %. Students' interaction which we can measure with our system is low. Students interact weakly with their teacher; they only answer some of his questions among 10 % of course's duration. Knowledge customization is totally absent; no examples of everyday life have been discussed. The histogram in Fig. 6.4 represents the course time duration's relative rates of eleven developments' acts. This is the evidence that the development of practices of the teacher suffer from enormous lack of effectiveness. There is a total absence of six acts which constitute the levers of this educational function. The duration of this educational function is very short (6 min), that is why it is very difficult to engage a student from a technical section (or any other section) and with such low acts of information's development, the teacher fails to provide interesting activities or contents; he fails to captivate his students' attention, curiosity, and spontaneity. By means of those statistics, he has now the control keys of this important set of acts, and his weaknesses are identified. By his reflexive practices he is able to strongly enhance his effectiveness.

If we carry out a more detailed analysis by considering the average rates, in our database, of elementary acts of pedagogical functions, we see for the interaction in Fig. 6.5 that among 200 visits our learners are not adequately stimulated to ask questions or to seek further explanations and information (1.36 %). However, learners have an acceptable ability to show initiative (7.09 %) proving that they are willing to contribute to the construction of knowledge, except that they have not shown the capability to justify their opinions and suggestions. This high level of cognitive potential is almost absent in our classrooms. One question arises: what

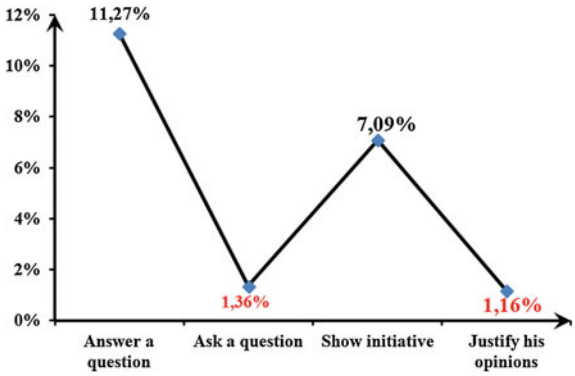

Fig. 6.5 Average global statistics on students' interaction

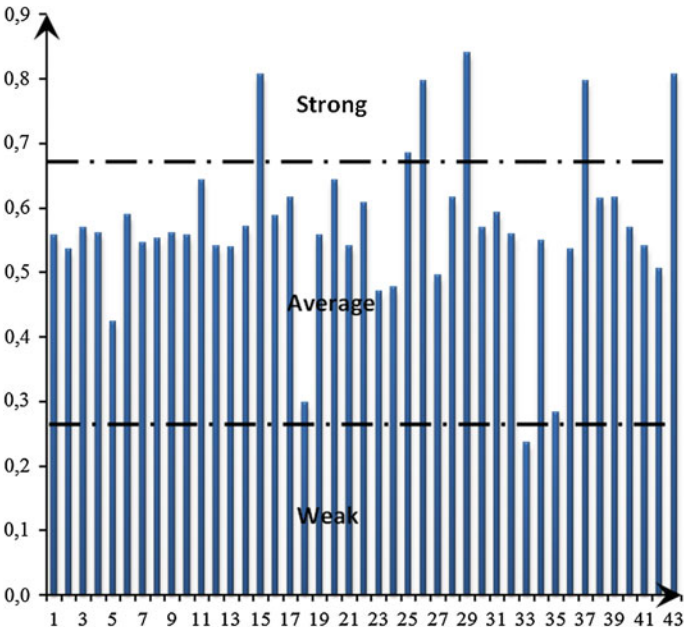

Fig. 6.6 "Ability to change" concept assessments

about the assessment practices of verbal performance of learners which has undoubtedly a strong correlation with their interactions?

The histogram in Fig. 6.6 presents the assessments results for 43 teachers about their ability to change the course of events. Defuzzification is graphically done for adequate thresholds. We see that few teachers are qualified to be able to change their students profile and most of teachers are assigned to "Average" assessment. One teacher, who is the same teacher (15) and (43) visited in two different classes within 8 months, retains his high level of performance during the two visits. The similarity of his evaluations proves the accuracy of our teaching effectiveness assessment system. The teacher (33), recorded statistics are presented earlier, is one of the few teachers who have no sufficient potential to make change in their students' profiles. We note that module "Ability to Change the Course of Events" differs greatly between the two teachers as expected. By exploring the concepts' inputs, we see that "Autonomy Supportive" is the main different cause between the two teachers. Teacher (15)(43) is assessed by our system that he is able to change the court of events with 87 % of certainty. Also, we infer from system assessment with 81 % of certainty that he supports his students' autonomy. He constructs properly the learning situations; however, his communication with his students is average. For teacher (33), he is assessed by our system that he is able to change the court of events with 24 % of certainty; it means he is not able to change. Also, we infer from system assessment with 41 % of certainty that he supports his students' autonomy: obviously, he is leading his classes with average latitude among students activities. His communication is average: he does not convey information with enough consideration to different students' learning styles. If we try to deepen our analysis by exploring lower layers, we found that teacher (33) do not provide enough time to his students in order to establish new knowledge (7 %). His language is controlling (16 %), he does not maintain his students' motivation (24 %), and his feedbacks are not enough constructive (30 %).

6.7 Conclusion

As perspective to this work, we believe that all processed results on educational concepts can be automatically generated by our system. So, we can enhance its functionality by making it able to search among its hierarchy the ultimate sources of effectiveness or points of weaknesses. We suggest exploring profile recognition approach of educational actors, by means of intelligent techniques able to adapt and evolve. We can also associate results from the analysis of students' performances and from our teaching effectiveness system. This association leads to effectiveness enhancement by generating adequate guidelines based on practices' adaptation and educational profiles' fitting. The dynamic of teaching process, as recorded on Fig. 6.7, which shows the "movements" between each acts and practices throughout the duration of the class period, can be a subject of meaningful studies. Some patterns of teaching's dynamic can be automatically characterized and treated. We believe that a highly reach field of knowledge is being explored. Huge amount of information about the reality of teaching practices and learning performances in our classes are now available. This data contains valuable knowledge which can considerably affect educational policies in the right directions. Precisely, this is why we believe that our system's sustainability is having a strong consensus, and will continue to have. It is a material impact on how assessors think and act. Once educational stakeholders begin to pursue sustainability initiatives in assessment,

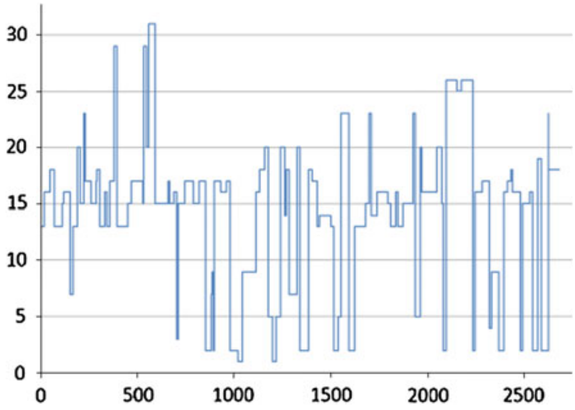

Fig. 6.7 Teaching practices dynamics through one class session

they tend to unearth opportunities to reduce teaching weaknesses, manage new targeted training sessions, and develop more innovative teaching effectiveness models. Thus, our early innovative approach has several key characteristics: it incorporate a comprehensive and interpretable set of data into robust educational databases, which then integrate throughout all relevant aspects of analysis operations to extract valuable knowledge about the general teaching effectiveness potential.

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Author Biography

Riadh Besbes Ph.D. in computerized engineering systems, conceived a fuzzy hierarchical system for teaching effectiveness assessment. He spent the last 8 years of his professional career as an educational inspector. He had the triple missions of evaluating, training, and innovating among secondary school teaching and learning. Within these years he has used his interactive grid as an observation instrument among his classroom visits. He was able, with this instrument, to quantify teaching and learning practices, acts, behaviors, and attitudes during class sessions. At the end of each class visit, 16 statistical curves were obtained and constituted the subject of professional discussions and training sessions. The software is built as an instrument to help identify and track causes of major weaknesses and strengths of teaching and learning practices.

Chapter 7
Are Teachers Ready for New Digital Learning Spaces: Case Study of an Online Social Networking Site for Secondary Teachers in Trinidad and Tobago

Vimala Judy Kamalodeen

Abstract Technology has been impacting the way people learn for some time and the rise of online learning has benefitted participants by allowing a degree of freedom in time and space that was not possible before Web 2.0. Nontraditional learning spaces (Brown in Educating the net generation. EDUCAUSE, pp. 2.1–2.20, Boulder, CO, 2005) have afforded students greater control of their learning but teachers in-service have embraced these new spaces much more reluctantly. There is a need for teachers to connect, share, and learn from others to improve their practice and minimize their isolation from each other (Darling–Hammond et al. in Professional learning in the learning profession: A status report on teacher development in the United States and abroad, 2009). This study focuses on an online social networking site for teachers in Trinidad and Tobago as they learn new technologies. This participatory action research study allowed secondary teachers to have a voice in the design of the site and data was captured directly from the site. Critical friends from the Curriculum and ICT Divisions of the Ministry of Education were included. Participation was observed and analyzed over the research period of April to August. Findings indicated that teachers from all parts of the country of a wide age range participated on the site through various Web 2.0 tools, such as blogs, wikis, and online chats. Analysis revealed that teachers preferred asynchronous tools such as blogs over synchronous tools such as chats and chose to participate when and how they wanted. Findings also showed a preference to reading over writing. Recommendations to expand the site to the Caribbean and to increase usability and sociability can allow further research of this social networking site as a learning space.

Keywords Online social networking sites · Digital learning spaces · Teachers' professional learning · Participation

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7.1 Background

In our increasingly technology-rich world, stakeholders, including policy makers and educators, recognize that focus on skill development of its young people is necessary to advance society. The World Bank (2013) points out that with globalization, nations must correspond with high urgency to building the capacity of efficiently employing ICT in education in response to the information revolution, and increasing demands for highly skilled labor. According to UNESCO (2002), Information and Communication Technology is defined as the combination of informatics technology (technological applications of informatics in society) with other related technologies, specifically communication technology. Therefore, the use of computer, laptops, Internet, emailing, chatting, websites online programs, and educational software falls under ICT. Hence, countries, including developing nations, have made ubiquitous technology a national priority and embarked on small and large-scale initiatives such as provision of wireless networks and laptop initiatives as instructional tools. Laptop integration in basic day-to-day activities includes banking, social networking, entertainment, communication, and increasingly, in education.

ICT in education in Trinidad and Tobago

Trinidad and Tobago is a twin-island republic in the southern Caribbean and its education system was inherited from British colonialism. It relies on oil and natural gas to fund its expenditure and there is a great focus on development of its people and its economy. In the last decade, successive governments have allotted increased funding to the education sector, which consists mainly of primary and secondary levels. Greater emphasis has also been placed on early childhood and higher education sectors. In 2013, the government of Trinidad and Tobago allocated $TT9.8B, its largest budgeting funding to the area of education.

Technology has been at the forefront of development priorities and the Ministry of Education of Trinidad and Tobago (MOE) has launched a number of initiatives over the last few decades. In the late 1990s, primary and secondary teachers were given a special incentive to purchase their own desktop and printer for home use while computer laboratories sprung up in primary and secondary schools on a tiered basis. In 2003 and onwards, the Secondary Education Modernization Programme (SEMP) saw the provision of networked laboratories to cater to larger class sizes and to meet the needs of students writing the Caribbean Examination Council CXC Information Technology syllabus. ICT technicians were hired for secondary schools to support and maintain these systems. School libraries and administrative rooms were also outfitted with computers.

The latest ICT e-connect and learn (eCAL) initiative was launched in 2010 to leverage the potential of ICT, through the provision of laptops to students entering Form one to enhance its education system. Its many goals include: “To enhance the learning environment for students; To improve the quality of instruction and support the infusion of ICT in teaching; To reduce the inequity in access to computers and information between wealthy and poor families; To raise student achievement through specific interventions; and to facilitate the development of collaborative teaching and learning between peers within the school, among schools and between teacher and student" (Ministry of Education, Government of Trinidad and Tobago, http://moe.edu.tt). To date, approximately 20,000 laptops have been distributed to secondary school students each year at an annual cost of TT$83 million. Initiatives for wired and wireless Internet access have also been attempted. Most of these initiatives have been handed down to schools by the government with minimal consultation with stakeholders in education.

In spite of all these technology initiatives, there has not yet been a change in educational attainment of students or in the way teachers use these technologies in the classroom. Teachers have complained of less than adequate training to use these technologies effectively. Over the years, training in Microsoft Partners in Learning (PALS) and Intel Teach project-based Learning plus widespread computer literacy certification mirrored the landscape of teacher professional development. Training took place at the Learning Resource centre of the MOE to pilot schools and selected teachers. It was anticipated that trained teachers would implement new initiatives and become change agents in schools. Technology-rich classrooms require teachers to constantly retool themselves, especially because of the rate of production and adoption of new technologies on the global and local landscape. Teachers are expected to be at least minimally competent in the use of Web 2.0 tools but they often lag behind their students in acquiring and mastering new tools and may even view these technologies as disruptive (Caillier and Riordan 2009). While abundant research points to the potential for technology to transform education (Farooq et al. 2007; Ray et al. 2011), teachers are slow to harness new ways to connect, learn and share experiences and knowledge. Teachers often complain of a lack of support after training workshops are over.

Traditional learning spaces have been articulated in the form of educational or professional development institutions. But resources are often inadequate to provide effective training (both human and financial) and there is a continued emphasis on the use of 'one-off' workshops at a central training centre. This may be attributed to a conventional top-down approach to professional development where training is handed out to teachers regardless of interest. This training approach often demotivates teachers from distant schools to attend and is also unpopular with teachers with very demanding work schedules. As such, teachers often become frustrated with professional development because it is ineffectual or requires large investments of time they do not have (Dede et al. 2009). In particular, teacher professional development programs for integrating technology have been accused of focussing on "how to operate the technology" than on pedagogy (Hew and Hara 2007; Lawless and Pellegrino 2007) and portray "a lack of knowledge of how teachers learn" (Lieberman 1995, p.75).

The literature reveals a persistent problem of teachers' classrooms being off-limits to their colleagues and this disadvantages them from learning from one another (Darling-Hammond et al. 2009; Lieberman and Mace 2008) which denies them the opportunity to work collaboratively either through observation or research or team-teaching. This often leads to teacher isolation and a further reluctance to learn new pedagogies and approaches. This points to a need to explore alternative ways of supporting teachers in classrooms and schools as they practice, especially as they attempt to use new technologies.

Current research points to the changing landscape of the ways learning takes place, especially because of the power of Web 2.0 tools. There is a view that all spaces are potentially learning spaces if they foster communication among participants (Oblinger 2006). Informal learning spaces may be described as those where “learners live and learn at their discretion” (Cattier 2006, p. 8.2) and where learners choose the time and space to do work that flows from formal learning spaces. This concept, advocated by Brown (2005), referred to nontraditional learning spaces for students (outside the classroom), in formal institutions, but which I now apply to spaces for teachers due to the suggestion that much learning takes place outside formal spaces. By their nature, Web 2.0 technologies, such as wikis, blogs, and other social networking applications allow for the crossing of boundaries related to space and time and afford the user opportunities to be engaged in “technology-based informal learning at home and in the community” (Selwyn 2007, p. 2). Learning is described as a social process (Harasim 2002) and ubiquitous social media utilize the power of Web 2.0 tools to bridge distances between people and to transfer control of learning from an instructor or trainer to the learner thus allowing the learner greater control over his/her learning. Given this shift in place of learning, research points to the creation of new learning spaces. Thus, the classroom, outside the classroom, as well as professional development halls and colleges, all situate knowledge and learning (Putnam and Borko 2000).

Advocates for teachers’ professional learning, including online environments, suggest that evaluations of outcomes be framed around “core features,” including “content focus, active learning, coherence, duration, and collective participation” (Desimone 2009, p. 183). Teachers can also benefit from sustained professional learning programs that are collaborative (Bruce et al. 2010) and the use of networked teacher communities are suggested (Lieberman and Mace 2008; Whitehouse 2011). While teacher networks are not new, online teacher networks are less prevalent. Collaboration among teachers across schools can encourage discussion and deepen teachers’ thinking of the complexities of teaching and continued focus on teachers’ work builds a culture of participation, foregrounds the importance of the nature of teaching, and highlights collaboration with one’s peers as a continued part of improving one’s practice ((Lieberman and Mace 2008, p. 79).

7.2 Initiative Description

As a provider of teacher professional development in integrating technology in the curriculum, a social networking site called TrinbagoTeachersUsingTechnology hosted by Spruz.com was launched. As with other social network sites, it supported social interactions among members, provided a user profile page and incorporated media-sharing in the form of video, photo, and files. A number of synchronous and asynchronous Web 2.0 tools are embedded in it. Web 2.0 technologies can extend the reach of teacher professional networks through broadband and cloud technologies, which can help to mitigate against teacher isolation and stagnation in learning. While there are global teacher networks, Trinidad and Tobago, as part of the Caribbean, has its own curriculum and context for lessons. With more than 17,000 primary and secondary teachers in Trinidad and Tobago alone, it is justifiable to design and launch a learning space that is customized for local needs and holds indigenous content and practices. As a priority, secondary teachers were targeted for this initiative as secondary schools are currently more advanced than primary in terms of technology infrastructure and resources.

Online social networking sites that harness the affordances of Web 2.0 tools (Brady et al. 2010; Davies and Merchant 2009; Greenhow et al. 2009; Ozkan and McKenzie 2008; Schlager et al. 2009) allow an opportunity to explore a new learning space for teachers. While much research focuses on student learning spaces, this study focuses on a space for teachers to connect, share, and learn. Online social networking is a new way for teachers to access professional development opportunities which allow for the embedding of asynchronous, synchronous, or blended learning tools that are inexpensive and scalable (Whitehouse 2011). Popular social networks like Facebook are considered primarily for making connections among people. As such, social networks are not currently viewed by educators as likely to promote professional learning (Anderson 2008), but much of the learning potential of Web 2.0 comes from the ability of its' participants to engage actively in constructing their own knowledge in a shared space, which can offer participants a flexible and "participatory experience of learning" (Selwyn 2008, p. 10) which does not have to take place in a formal setting like a seminar/conference room. Accessibility to colleagues and knowledge offers teachers an opportunity to engage in professional learning that is not otherwise possible with the realities of timetable schedules and transportation challenges.

This initiative explores teachers' participation in this online social networking site by looking at their activity on the site, their interactions and whether they made use of the flexibility afforded to them. The researcher privately funded this research with costs to host the site being quite low. In addition, the researcher acted as site designer and manager and so this also allows the researcher to explore the cost-effectiveness of the initiative for professional development for teachers.

Theoretical Considerations

I have looked at a number of theories related to both online learning and social learning and the impact of the Web on informal learning, but like other researchers (Merchant 2009), I still have not found a single theory that describes learning in a technology-mediated space like an online social network site. Research on the use of SNS for education purposes has pointed to the value of a socio-constructivist framework as described by Vygotsky (1978) and Lave and Wenger (1991). In particular, theories of learning such as online and social learning are important as it allows for exploration of teacher interactions in informal and nontraditional learning spaces. The emergence of constructivism and situated learning theories has led to a shift to examining learning rather than teaching. It allows for analysis of formal learning and to consider the impact of informal learning in teachers' daily lives. If professional learning is considered in nontraditional spaces, such as lunchrooms, homes and cafes, then it allows me to deliberate on online, networked spaces that allow flexibility in learning for teachers. Davies (2006) describes learning as participant interactions and sharing of social discourses, which entail reflection on their existing experiences. Artifacts of learning on a Flickr SNS contain images, comments and views, sources from the everyday, offline experiences of these members. Davies (2006, p. 219) describes this space as being in "a state of both constant affirmation and renewal, for contributions can be seen to both sustain the existing values as well as develop them." She does not describe the space in terms of community but draws upon Gee's (2004) ideas of affinity spaces and Bhaba's (1990). Third space to describe learning as easy and enabled through interactions among members in the space.

Web 2.0 tools emphasize participation over presentation, where conversation takes place in a different mode from traditional writing, almost as a new language, and "purposeful tinkerings that often form the basis of a situated understanding emerging from action not passivity" (Brown and Adler 2008, p. 14). The opportunity to upload new content or edit existing content allows participants to be self-publishers in a free space, thus enabling them to be both producers and consumers of knowledge that crosses traditional forms of learning especially for teachers.

Theories of adult learning also undergird this research. Initial work on understanding adult learning is credited to Knowles who developed the concept of andragogy, which is built on principles of pedagogy applicable to any adult learning situation. Knowles (1990 in Knowles et al. 2005, p. 57) created a set of assumptions about how adults learn which he used to develop educational programs for adults. The six assumptions of andragogy are that adults are autonomous, self-directed learners, they need to know why they are learning, they bring a wealth of experience to the educational setting, they enter educational settings ready to learn, they are problem-centered in their learning, and they are best motivated by internal factors.

7.3 Implementation Plan

The site is called TrinbagoTeachersUsingTechnology and is hosted as www.techtalk.spruz.com. It contains seven main webpages apart from the homepage to allow access to a range of activities. The screenshot in Fig. 7.1 shows the first part of the homepage with access to all other pages.

Fig. 7.1 Screenshot of first part of the homepage

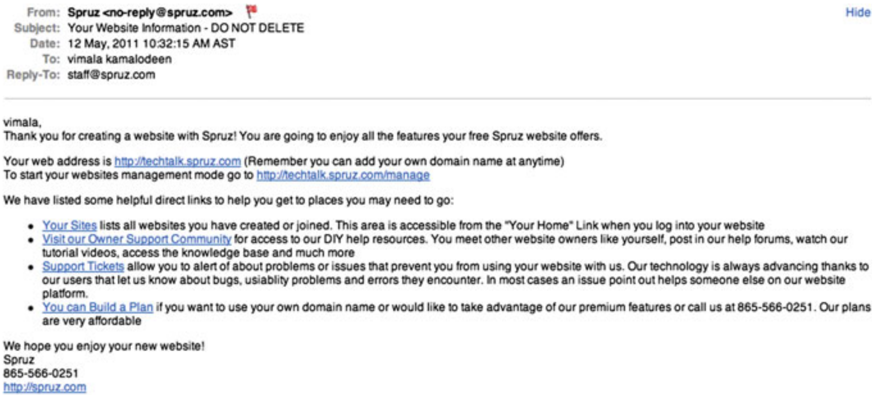
The homepage has a number of information pieces about the site and topics related to participation. There are number of summaries of activities within the site, such as blog summaries, discussion topic summaries, videos and photos summaries, participants' activity summary, search the site box and opinion polls widgets.

Spruz.com was selected over other educational platforms such as Edmodo or Ning! as it was more cost-effective, yet allowed a number of Web 2.0 tools to be embedded as well as good managerial function. This research was privately funded and needed to be affordable for implementation. Also there was a decision for teachers to access the site free upon registration.

It also allowed a high degree of customization, which is favored in education while still maximizing the potential for connectivity and data sharing that SNS are known for (Brady et al. 2010). Sometimes referred as the 'walled garden' approach to using SNS in education (Smith and Holcomb 2009), it allows site administration to control the learning environment of an SNS. The screenshot (Fig. 7.2) shows some options of the 'Manage Site' administrative tools available to the site administrator.

In addition to customization, I also found that Spruz offered site support and online help. In Fig. 7.3, I show a screenshot of the email that I received from spruz.com after I built the website addressed at http://techtalk.spruz.com.

Fig. 7.2 Manage site tool options



From: Spruz <no-reply@spruz.com>
Subject: Your Website Information - DO NOT DELETE
Date: 12 May, 2011 10:32:15 AM AST
To: vimala kamalodeen
Reply-To: staff@spruz.com

Hide

vimala,
Thank you for creating a website with Spruz! You are going to enjoy all the features your free Spruz website offers.

Your web address is http://techtalk.spruz.com (Remember you can add your own domain name at anytime)
To start your websites management mode go to http://techtalk.spruz.com/manage

We have listed some helpful direct links to help you get to places you may need to go:

- Your Sites lists all websites you have created or joined. This area is accessible from the "Your Home" Link when you log into your website
- Visit our Owner Support Community for access to our DIY help resources. You meet other website owners like yourself, post in our help forums, watch our tutorial videos, access the knowledge base and much more
- Support Tickets allow you to alert of about problems or issues that prevent you from using your website with us. Our technology is always advancing thanks to our users that let us know about bugs, usiablity problems and errors they encounter. In most cases an issue point out helps someone else on our website platform.
- You can Build a Plan if you want to use your own domain name or would like to take advantage of our premium features or call us at 865-566-0251. Our plans are very affordable

We hope you enjoy your new website!
Spruz
865-566-0251
http://spruz.com

Fig. 7.3 Welcome from Spruz when site was created

7.3.1 Site Design

As I had selected an online social networking site to explore possibilities of teacher learning, I had to customize the site to promote professional relationships and interactions. In order to do this the site webpages, member settings, activities, content, and site access and privacy were customized.

7.3.2 Webpages

The site was designed to mirror spaces that were familiar to teachers in Trinidad and Tobago. Apart from the homepage, I customized the names of each of the remaining webpages as: the Teachers' Lounge, the Staffroom, Wiki, the Classroom, the Training Room, the Resource Room and the Limin' Corner. The Teachers' Lounge allowed access to members pages, blog and the events calendar, the Staffroom allowed access to Groups, Forums and Chat rooms, Wiki, the Classroom allowed access to upload videos, photos and My lessons pages, the Training Room allowed access to different training sessions, the Resource Room allowed access to

Sample Lessons and Trinbago lesson plans and the Limin' Corner allowed participants to play games, download widgets and other similar activities.

The following map shows the arrangement of the main pages into rooms with names that reflect a school climate.

A color scheme of blue and orange was selected to reflect that an attractive and vibrant Caribbean feel and selected activities and titles that appeared familiar to Trinbago teachers. I kept in mind that social networking technologies—including that of Web 2.0—can be best used for learning if the context is as authentic as possible (Lee and McLoughlin 2008; Dede 2008).

7.3.3 *New Membership and Registration*

Once an invitation has been sent to a potential new member, the person makes a request to join the website. An approval by the site administrator is required (see Figs. 7.4 and 7.5) and a welcome email is automatically sent (see Figs. 7.4, 7.5 and 7.6). Once a profile is created, members could access all pages and activities and add new content and post comments. They could also add other colleagues to their network to get activity updates. Members could have issued invitations to potential new members as well. In this way, membership was increased both by those that I

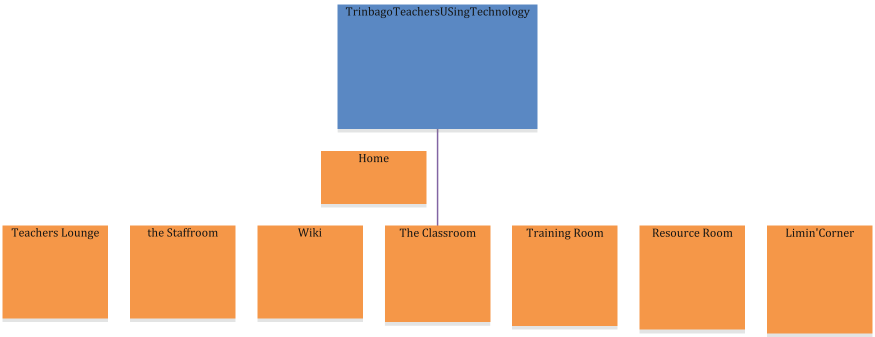
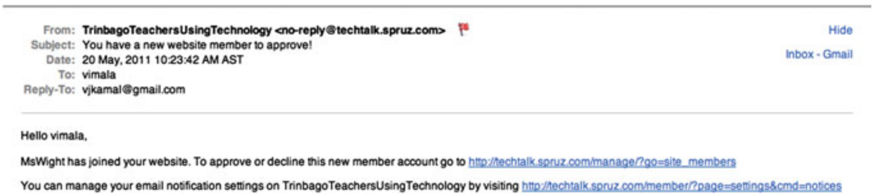


Fig. 7.4 Site map


From: TrinbagoTeachersUsingTechnology <no-reply@techtalk.spruz.com>
Subject: You have a new website member to approve!
Date: 20 May, 2011 10:23:42 AM AST
To: vimala
Reply-To: vjkamal@gmail.com

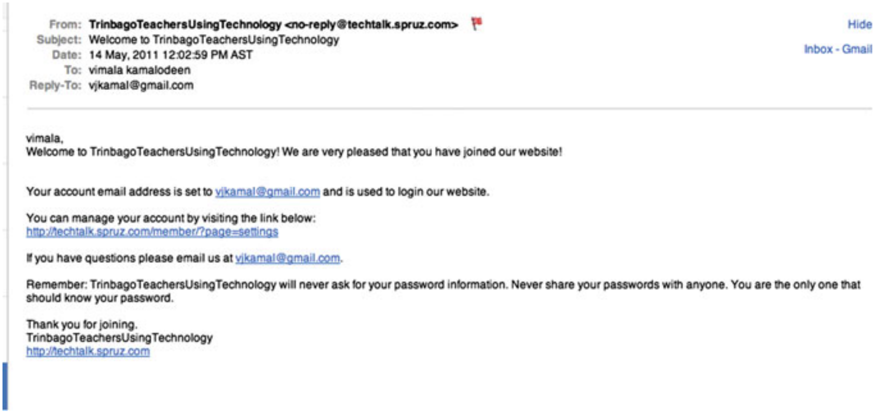
Hide
Inbox - Gmail

Hello vimala,

MsWight has joined your website. To approve or decline this new member account go to http://techtalk.spruz.com/manage/?go=site_members

You can manage your email notification settings on TrinbagoTeachersUsingTechnology by visiting http://techtalk.spruz.com/member/?page=settings&cmd=notices

Fig. 7.5 Screenshot showing new website membership approval screen


From: TrinbagoTeachersUsingTechnology <no-reply@techtalk.spruz.com>
Subject: Welcome to TrinbagoTeachersUsingTechnology
Date: 14 May, 2011 12:02:59 PM AST
To: vimala kamalodeen
Reply-To: vjkamal@gmail.com

Hide
Inbox - Gmail

vimala,
Welcome to TrinbagoTeachersUsingTechnology! We are very pleased that you have joined our website!

Your account email address is set to vjkamal@gmail.com and is used to login our website.

You can manage your account by visiting the link below:
http://techtalk.spruz.com/member/?page=settings

If you have questions please email us at vjkamal@gmail.com.

Remember: TrinbagoTeachersUsingTechnology will never ask for your password information. Never share your passwords with anyone. You are the only one that should know your password.

Thank you for joining.
TrinbagoTeachersUsingTechnology
http://techtalk.spruz.com

Fig. 7.6 Screenshot showing the welcome email to a new member

had invited initially and later on by members themselves. This allowed greater sociability and site ownership by members.

7.3.4 *Selection of Content*

Content was selected for the site that was related to integrating technology into the teaching/learning environment. As moderator of the site, I initiated discussions and uploaded content, which I hoped, was of interest to teacher participants. I created lesson plan samples and designed a template to allow for lesson plans to be uploaded online. Participants had the option of adding new content or posting comments to existing content.

7.3.5 *Dealing with Self-Presentation*

In order for members to 'see' each other, they set up a user profile, which lies at the core of the SNS. I designed the user profile to capture information about the teacher that could reflect their professional identity. Registration on the site required the creation of this profile, which allowed for the uploading of a profile photo as well as text. Profiles included information about school, location, subject areas taught, etc. and added details in an 'About me' section. Only certain information, such as username, photo and location to be made public, was allowed as making profile information available is highly sensitive (boyd and Ellison 2007) and allowed my site to distinguish itself from others. The screenshot below (see Fig. 7.7) shows part of the page that allows the customization of member profiles.

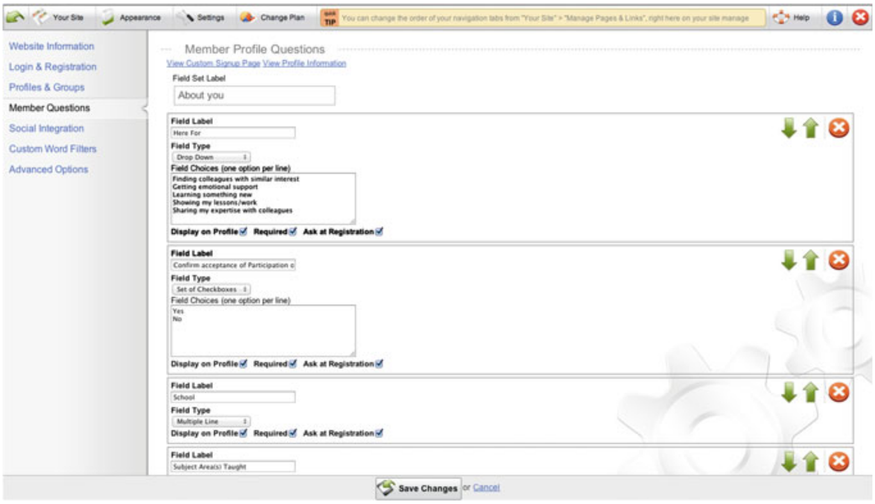


Fig. 7.7 Member profile page customization

In order to emphasize self-presentation as professional teachers, I used the term ‘colleague/s’ to describe members’ friends. ‘Friending’ is a well-known concept in popular social networks and I sought to distinguish my site from these sites. I had selected Spruz.com for this level of customization and Fig. 7.8 shows how I accomplished this.

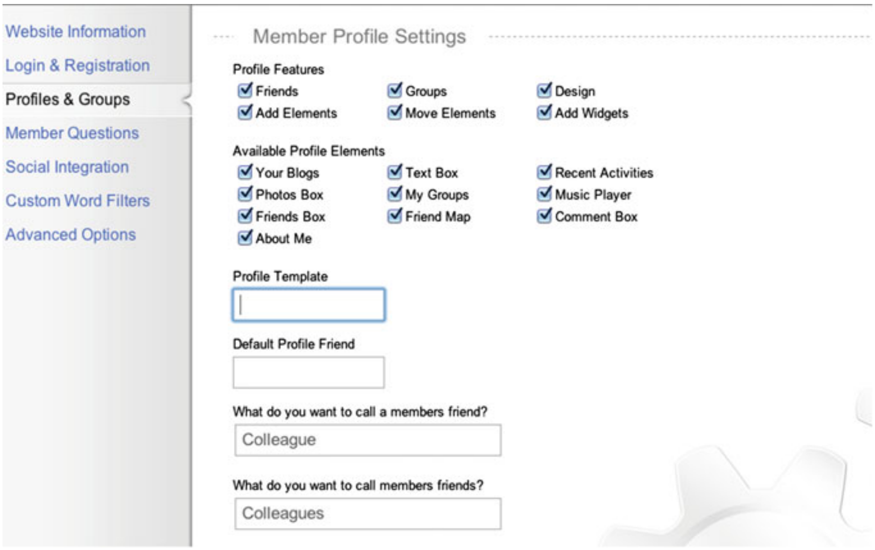


Fig. 7.8 Customization of member profile settings

7.3.6 Selection of Tools

Synchronous tools are those that occur in real time (chats, wikis), whereas the asynchronous tools are those that occur at different times (emails, blogs, forums, online courses, etc.). Web 2.0 tools may be distinguished by the delay in response time in an online conversion. Blogs, email, media-sharing, and online discussion forums all allow the participant to post replies or start new conversations on their own time while online chats and webinars allow for real-time conversations. While SNS are considered as a Web 2.0 tool in its own right, SNS allow the embedding of most synchronous and asynchronous tools. A number of studies, over the past decade, have focused on using a single Web 2.0 tool with a view to investigate the affordances of that tool in the selected scenario while more recent studies look at grouping one or more of Web 2.0 tools under the umbrella of asynchronous or synchronous tools (Gunawardena et al. 2009).

Emails were integral to the communication system between site administration and members. They are familiar and easy to use and research suggests email communication advantages the user due to the ease and speed and flexibility for sending files, meeting reminders, and a variety of other types of information (Wainer et al. 2011). Blogs, also called weblogs, were one of the first Web 2.0 tools to be used in education. According to Edublog (http://www.edublog.com), some of the best educational uses of blogs are to share material, news, links and more, encourage publication, share media, gather feedback, and facilitate online discussions. I included blogs since research shows considerable use for blogs, or weblogs, in classroom settings and other studies point to advantages in teacher education: individual reflection, fostering online discussions, building learning communities, building digital portfolios, and developing a class management system (Lin 2008; Deng and Yuen 2011; Loving et al. 2007). Likewise, online discussion forums, which organize posts by themes called threads, were incorporated, as they could have advantaged teachers in several ways. These include an ease of responses due to the lack of constraints of time and space (Borko et al. 2009) and allowance of inexperienced in-service teachers to access guidance and mentoring and engagement in a more participatory and collaborative learning environment (Brown and Munger 2010). Since distance learning evolved into e-learning, there is an abundance of literature on the use of online courses for professional development in all areas of professional work including education. As such I decided to create some online courses for members on the site to access and selected content that I thought was relevant to members' interests and allowed interaction among participants (Ostashewski and Reid 2010).

While research supports the inclusion of asynchronous tools because of the potential for flexibility in time and space and opportunities for reflection, critics claim that a "lack of natural social interaction causes "feelings of isolation" among participants" (Wang 2008, p. 59) and that the lack of scheduled interactions can mean that learners fall behind because they do not allocate time for the necessary learning activities (Cheung and Hew 2010). As such, I considered the inclusion of wikis and online chats. A wiki is an interactive tool that allows for collaboration and I had to create a new page from the homepage to facilitate it. I also included online chats and access to Google docs. Online chats were facilitated offsite through Google chat as the chat feature that was embedded on the site was not working well. Through the use of gmail addresses, access was enabled to Google docs for furthering collaborative work.

7.3.7 Site Access and Privacy Concerns

The website www.techtalk.spruz.com is hosted by a publicly accessible www.spruz.com platform and is locatable using any search engine on the Internet. I am the registered owner of the site and the only one with administrative rights. All webpages can be viewed freely but only registered members can add/post comments or upload new content. Teacher participants signed consent forms prior to joining the site to allow for upload of photo, videos etc.

7.3.8 Usability and Sociability

In designing this website, usability, and sociability (Preece and Schneiderman 2009) were focused on to promote site participation. While Web 2.0 tools afford users a number of benefits that are both social and cognitive (Selwyn 2008), the concept of affordances can be distinguished as “real” and “perceived” and it is the “perceived affordances that determine usability” (Norman 1998 cited in Lee and McLoughlin 2008, p. 3827). As such, a number of different activities were designed using both synchronous and asynchronous tools. To increase sociability (Preece and Schneiderman 2009), I used a familiar design of an SNS, and tried to attract teachers with a similar interest in using technology in the classroom to the site. In phase 2 of my research, I provided links on Facebook and Twitter pages and included familiar Facebook features such as the ‘like’ and ‘Rate it’ buttons, horizontal active scroll bars and online chat features. Spruz features member integration with Skysa, a website toolbar that I added to my website and featured apps that worked with my website membership, such as chat room and instant messaging applications (apps) to name a few.

The aim of the inclusion of these Web 2.0 tools was to promote participation in site activities, which could afford teachers access to learning opportunities independent of geography, institution, and time; allow a shift in control of learning to the teacher and facilitate interactions among teachers who shared a common interest.

7.4 Implementation Process

I selected action research methodology as I wished to investigate specifically how teachers would respond to an online social networking site as a learning space. This methodology allowed me the freedom to select approaches such as a mixed-method approach to data collection and analysis, which included social network analysis, discourse analysis and Google Analytics tool. Data collected in this study was captured automatically on the site through threaded discussions in activities, such as blogs, discussion forums, and live chats. A key area of this research was to ensure that ethical guidelines were followed and all permissions for data collection and presentation were obtained.

The research took place over the third term of the academic year April-June and over the July/August vacation period. This time frame was selected, as this third term of the academic year is more flexible for teachers due to students sitting external examinations. The action research was three-phased over the 5-month period with the first phase involving a focus group of critical friends who would suggest content and site design. In the second phase, the site was launched and maintained for 6 weeks. Invitations were sent out to secondary teachers who were considered to be at least minimally competent with technology. In the third phase, an online questionnaire was used to obtain the opinions of participants and invitees to further improve assess the site's design in terms of sociability and usability. The site expanded reach through Facebook and Twitter links and updates. At the end of this phase, interviews were conducted with selected participants based on levels of participation over the period. Three phases were selected to ensure that the plan, review, act, and reflect stages of action research (Kemmis 1983) could have been implemented effectively.

Phase 1: Set up Website. Design activities and send out invitations to teachers and MOE officials. Seek input from critical friends from the Ministry of Education-Curriculum Division and ICT Division- on design.
Phase 2: Launch Website, observe participation for four weeks and seek opinions on site from participants.
Phase 3: Redesign website according to useful suggestions and observe participation until the end of the school term. Reflect on the term's participation and seek opinions on the site for next cycle. Use combined online survey of site participation and a face-to-face meeting with critical friends and selected participants to interrogate certain aspects of existing data and trends, such as reasons for low or nonparticipation.

The inclusion of research participants in the decision-making process acts as a democratizing force (Smith 1999) and foregrounds the voices of Trinidad and Tobago teachers (Lincoln and Gonzalez y Gonzalez 2008), who were previously voiceless in traditional modes of professional development. Further, both the researcher and participants are from the local setting. I am suggesting that action research is a decolonizing methodology and is appropriate for my study set in postcolonial Trinidad and Tobago. While there is an expectation that educational reform requires teachers to be agents of change, they must be "empowered to do so" (Feraria 2008, p. 277).

Participants

Teacher participants in this study were those who had previously submitted for the eCAL competition initiated by the Ministry of Education and included two teachers who had advanced to represent the country at the International competition in Washington, DC. These teachers were selected to be invited to participate at the start of the study as it was felt that they were already using technology in the classroom and would have at least entry-level technology integration skills. The participants in this study were teachers and middle managers at secondary schools in Trinidad including one Vice Principal and two Heads of Department. Participants came from all seven geographic districts in Trinidad. No teachers from Tobago participated even though they were sent invitations. There was a fair spread across all curricular areas with Technology Education/Information Technology specialization being more common than others. There was a fair balance between male and female participants. It was expected that these initial participants would invite their friends and colleagues to participate over time.

7.5 Outcomes

This study sought to determine whether teachers would participate in a specially designed online social networking site and consider it as a digital learning space. Outcomes on participation are described by first, a summary on participants, samples of participation on designed activities and what learning was afforded and third by analyzing differences in participation to determine teachers readiness for the site as a digital learning space. Data was automatically captured from the site TrinbagoTeachersUsingTechnology, accessed by www.techtalk.spruz.com, and from Google analytics in order to generate themes from the data. Screenshots of website data are used extensively and methods of social network analysis used where appropriate.

7.5.1 Participant Data

Google Analytics tool shows that there were 156 unique visitors to the site in the research period, with 77 %, being return visitors. This number is higher than the number of registered participants (34) as the site is publicly accessible. Registered participants developed profiles that indicated the reason for joining the site. The most popular reason given was to 'learn something new.' They also uploaded other forms of professional data. Most participants used their real name as their user name

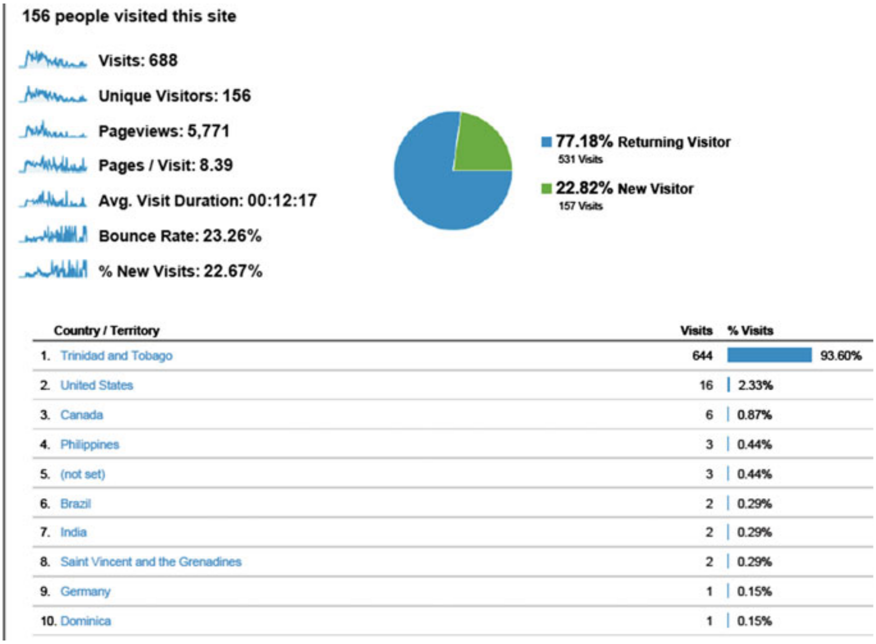


Fig. 7.9 Summary of visitors to site

but generally, did not choose to upload a profile photo. Visitors came from more than 10 countries but the majority came from Trinidad and Tobago. More participants came from urban schools than rural, were twice as likely to be female than male and was between 24 and 60 years old (Fig. 7.9).

7.5.2 Teacher Participation on the Site

The site allowed the embedding of a number of synchronous and asynchronous Web 2.0 tools, which allowed teachers to participate as they wished. Some site activities allow for a history of participation activity, which allows participant details to be recorded automatically. In this section, findings from selected samples of site activities are presented to show how participation in that activity could potentially benefit the participant. The following 11 activities were explored: file sharing, blog postings, enrolling in an online course, taking part in an opinion poll, forum postings, adding new colleagues, signing in and participating in an online chat, creating a user profile, creating/editing content on a wiki, and media-sharing and Google docs collaboration. Participation also differed by the ways that participants chose to show their presence on the site. Logging in allowed participants to post comments or participate in a collaborative event. Most participants contributed to the site in writing text, but also used videos, photos hyperlinks, emoticons (in chats), or responses to online polls.

An examination of the activities seemed to point to why teachers participated in a certain activity and the learning that they gained through this participation. These were knowledge sharing, knowledge/information seeking, opinion sharing, opinion seeking, experience sharing, seek or give emotional support, self-presentation, exploring new ideas, and reflecting on classroom practice (Hew and Hara 2007; Hur and Brush 2009; Pardo and Nussbaum-Beach 2011).

7.5.2.1 Activity: Lesson Plan File Sharing

In the Resource Room, participants have an opportunity to upload and download lesson plan files. The image below shows that Annoushka uploaded a lesson plan file by clicking the 'add file' option. The site data shows the date of upload lesson plan 'Introduction to MS Word' under the tag Technology Education, the number of downloads and file editing options. Adding a file implies adding content to the site, which in turn allows the participant the opportunity to share knowledge. The activity of file download implies that participants consumed content and was performed by someone seeking knowledge of lesson plans. The screenshot below shows the items of data that led to potential benefits of knowledge seeking and knowledge sharing, two aspects of knowledge building (Fig. 7.10).

7.5.2.2 Activity: Blog Posting

Participants added content to various blogs and this sample shows the adding of content in a new blog post by Lusha under the category 'my lessons' followed by

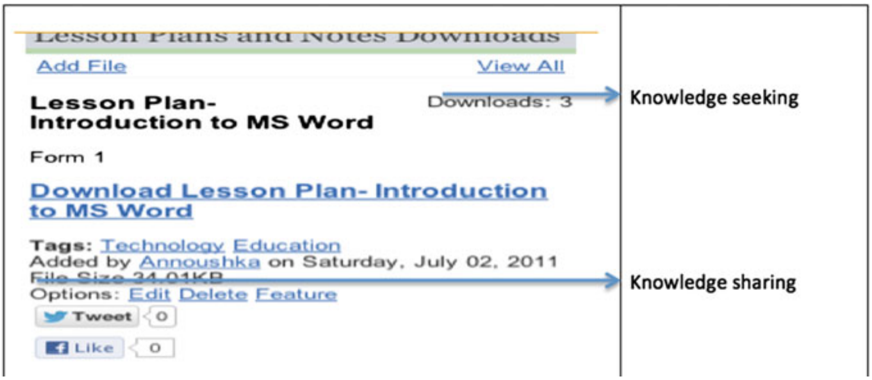


Fig. 7.10 File download

an added comment to the post by Yemi-J. It seems as though Lusha wanted to reach out and connect with other colleagues with a title ‘My first google docs document’ and introduced her thoughts. There were 21 views of this post. In this blogpost, Lusha talked about a plan she has for her Form Ones, which indicates she is reflecting on her practice. In the second paragraph, she explored her plan and continued to reflect on her practice. In the third paragraph, Lusha shared an opinion on Google Docs, and then proceeded to share details of the plan with a hyperlink. Thus, she was sharing a piece of knowledge that she had on the topic. She concluded the post by saying ‘I welcome your comments’ which suggests that she was actively seeking the opinions of her colleagues. In the posted comment, Yemi-J started off using “I think this is a great idea!…” indicating her willingness to give Lusha emotional support to her post. She continued the post by giving her opinion on Lusha’s plan (Fig. 7.11).

7.5.2.3 Activity: Online Course Enrollment

Participants enrolled in available online courses listed in the Training Room. Courses are hosted on udemy.com, a free online course platform where I built three courses, Google docs, Lesson Planning, and Differentiated Classrooms. These courses address current topics in professional development for teachers and while initially set to private, are now publicly accessible on the web. The number of enrolled participants is indicated in the image below. Participants seeking knowledge on these topics can benefit from enrollment. The course platform allowed the facilitator to engage participants by sending messages or tasks. Students could connect with colleagues by sharing opinions on the course (Fig. 7.12).

7.5.2.4 Activity: Forum Discussion

Angel started a new topic under the forum category ‘technology.’ The forum is different from a blog tool as it allows a number of queries/comments to be posted to a moderator for that section under pre-created categories. The Forum page has a Curriculum, Technology, and Pedagogy category with a moderator for each section. In this topic, there are eight replies but I have included one set of comments by MsWight in order to complete the analysis. The forum allowed the participants to ‘talk’ with others on the topic of concern. In the first line, Angel expressed a concern as she reflected on her practice, shared some knowledge about the topic that she learnt in school and sought to share this concern with her colleagues and seek knowledge about this concern from them. In a response, her colleague shared her feelings on the topic with “Same here!” to give emotional support and continued to add new information to the topic as well as her opinion “I see no indication that it is still a thought” (Fig. 7.13).

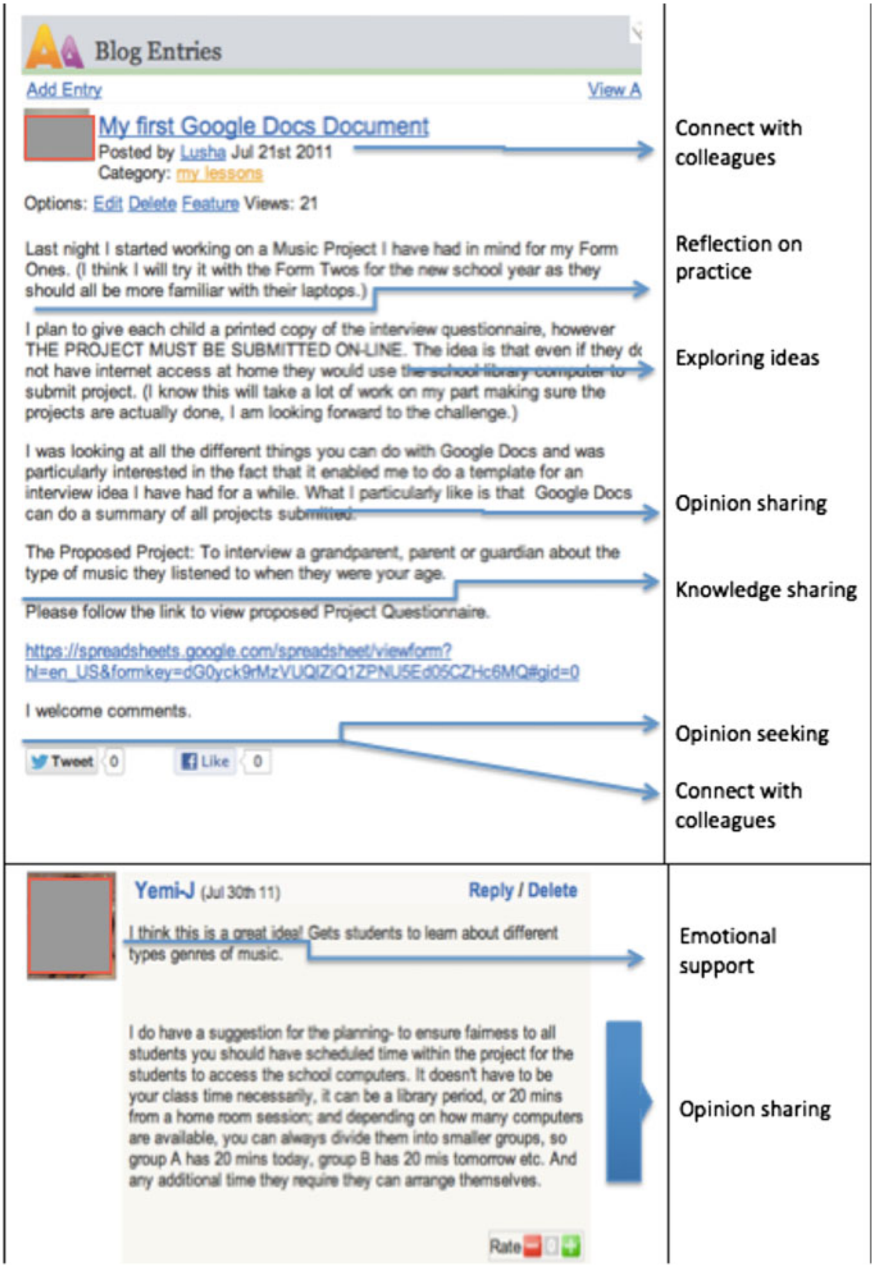


Fig. 7.11 Blog post called "My first Google docs document"

Fig. 7.12 Screenshot of online course

7.5.2.5 Activity: Participate in an Online Chat

The chatroom was located in the staffroom but did not allow for automated transcripts so I used Google chat instead. The following conversation took place between Yemi-J and myself. The example below is part of that chat and allows synchronous talk to take place. By responding to the salutation with 'hello" allows connections to be made with another colleague. Further along the conversation, Yemi-J reflected on her practice by saying "I haven't put much on it (her wiki) now, I am reconceptualising.." and 'tags are important." She offers emotional support with "lol hey we all need a break" (Fig. 7.14).

Fig. 7.13 Discussion forum

7.5.2.6 Activity: Create a User Profile

Participants are requested to create a user profile upon registration, which can only be accessed by me. There are several categories to complete. This example shows a comprehensive profile where the participant used her first (real) name as her username, her photo, and why she chose to participate on the site. The profile shows how the participant identifies herself professionally. This suggests that she wishes to connect with other colleagues professionally (Fig. 7.15).

7.5.2.7 Activity: Add a New Colleague

As part of site activities, participants can add a colleague so that they can see updates of their posts and activities. In this activity, Lusha added Yemi-J as a colleague on 30/7/2011. This activity allows participants to expand their network of colleagues and remain connected.

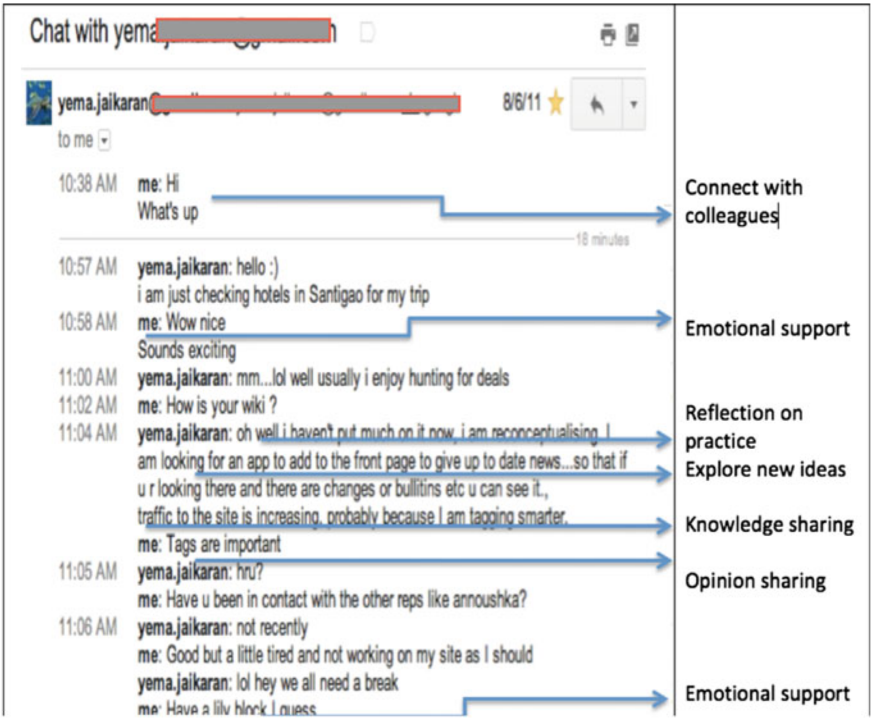


Fig. 7.14 Online chat

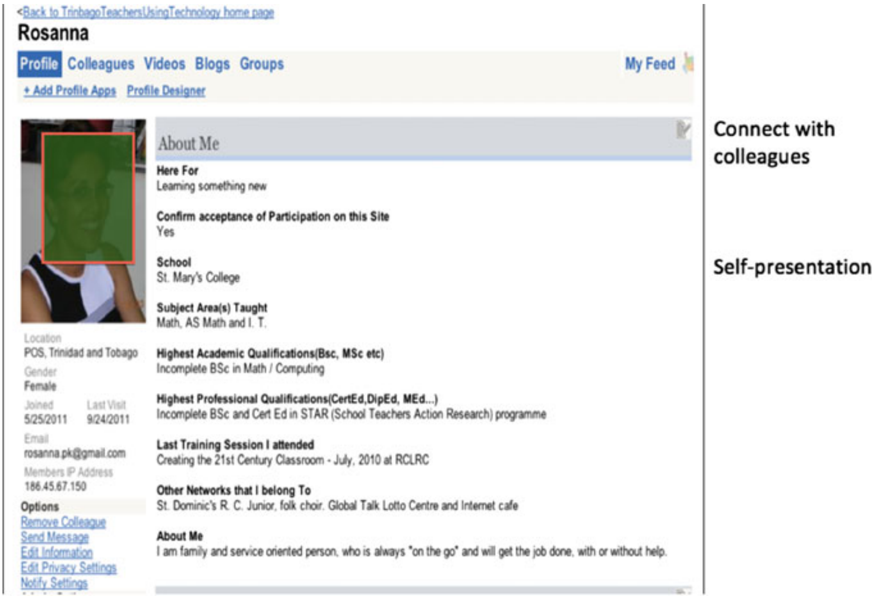


Fig. 7.15 Teacher profile

7.5.2.8 Activity: Collaborate on a Wiki

Wikis are synchronous tools that allow more than one person to collaborate on the same document. As such it allows participants to connect together in a shared activity simultaneously. It can also be edited over time. Wikis have two states, read, and edit. Wikis are in read state by default. Read state means that the wiki page looks just like a normal webpage, but when the user wants to edit the wiki page, they must access the wikis edit state. The following example shows a collaborative effort between Yemi-J and Vimala through a snapshot of the history of the creation of the wiki, which shows respective contributors and the particular item shared. As such, both authors create content and knowledge is shared (Fig. 7.16).

7.5.2.9 Activity: Taking Part in an Opinion Poll

This snapshot below shows the results of one of several online opinion polls created on the site. The site allows for a number of polls to be created, shared, and analyzed. This poll on laptop use had three votes (Fig. 7.17).

7.5.2.10 Activity: Media-Sharing

In the Classroom, participants can upload videos, photos, and lessons. I have chosen a video and a photo to illustrate what types of media participants chose to upload.

In the first example, DH uploaded a video called ‘PowerPoint for training and education-a semi dramatic approach.’ There were 53 views and 1 comment. This shows other colleagues were looking at the activity and seeking some information on it, while the author sought to connect with other colleagues. He shared his knowledge on the video by adding detailed comments and background information “This is a just a simple example of how you can….” He invited colleagues and to comment by sharing their opinions “hopefully the more creative of you out there will appreciate the idea” and to engage in further knowledge sharing “come up with some better examples.” He also reflected on his practice “the sound is a little off.”

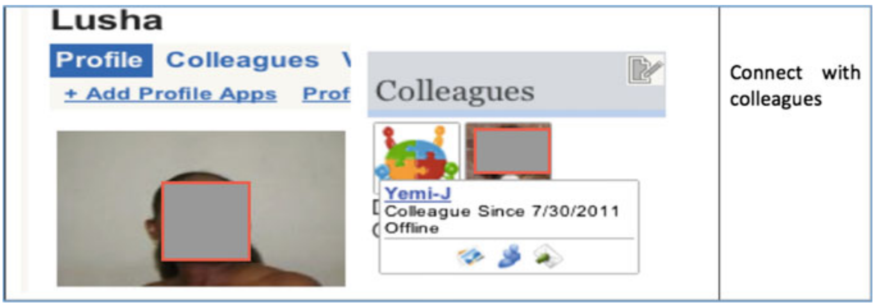


Fig. 7.16 Teacher colleagues

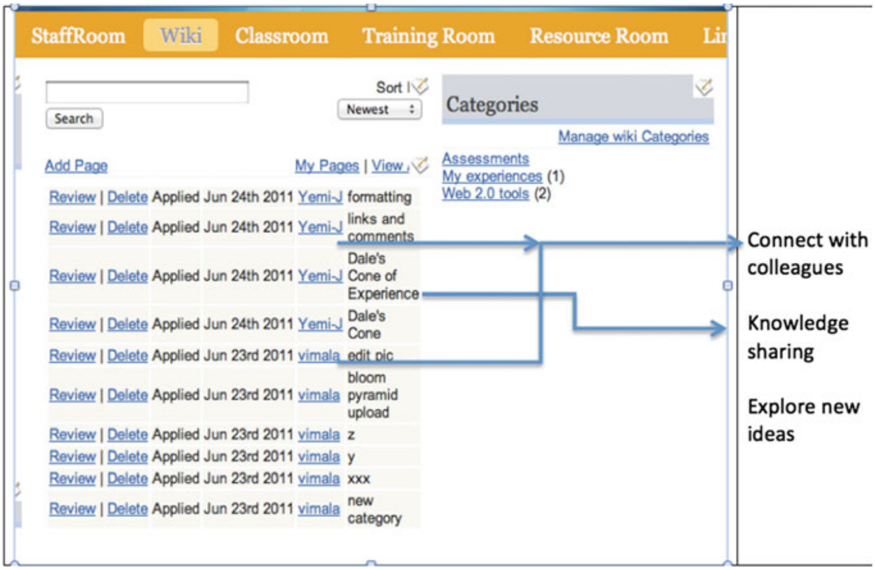


Fig. 7.17 Wiki edits

In the second example, Yemi-J uploaded a photo of her students doing a class activity entitled “Students working on a Geography lesson on the Form1 laptops.” It was photo 3 out of 4 of a collection called ‘Students PBL work.’ It was the only photo that attracted comments, which I have also included below the photo. While Yemi-J did not add comments to the photo initially, this form of digital text conveys messages that can be analyzed. The photo allowed the contributor to share what she was doing in her classroom as she reflected on her practice as well. It can be interpreted as a way of connecting with her colleagues through showing what her students were doing in the classroom (Figs. 7.18 and 7.19).

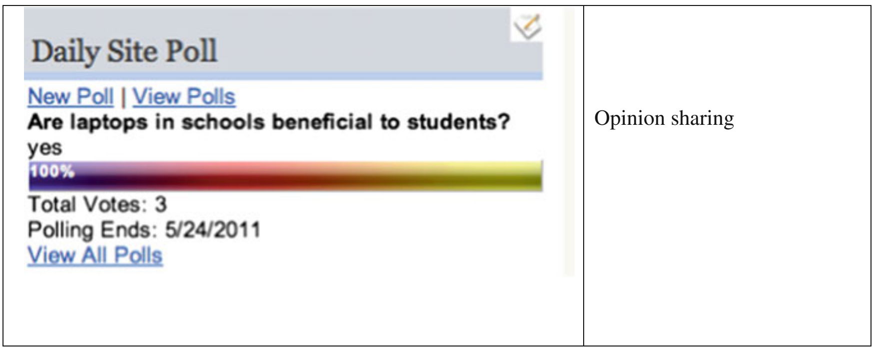


Fig. 7.18 Site polls

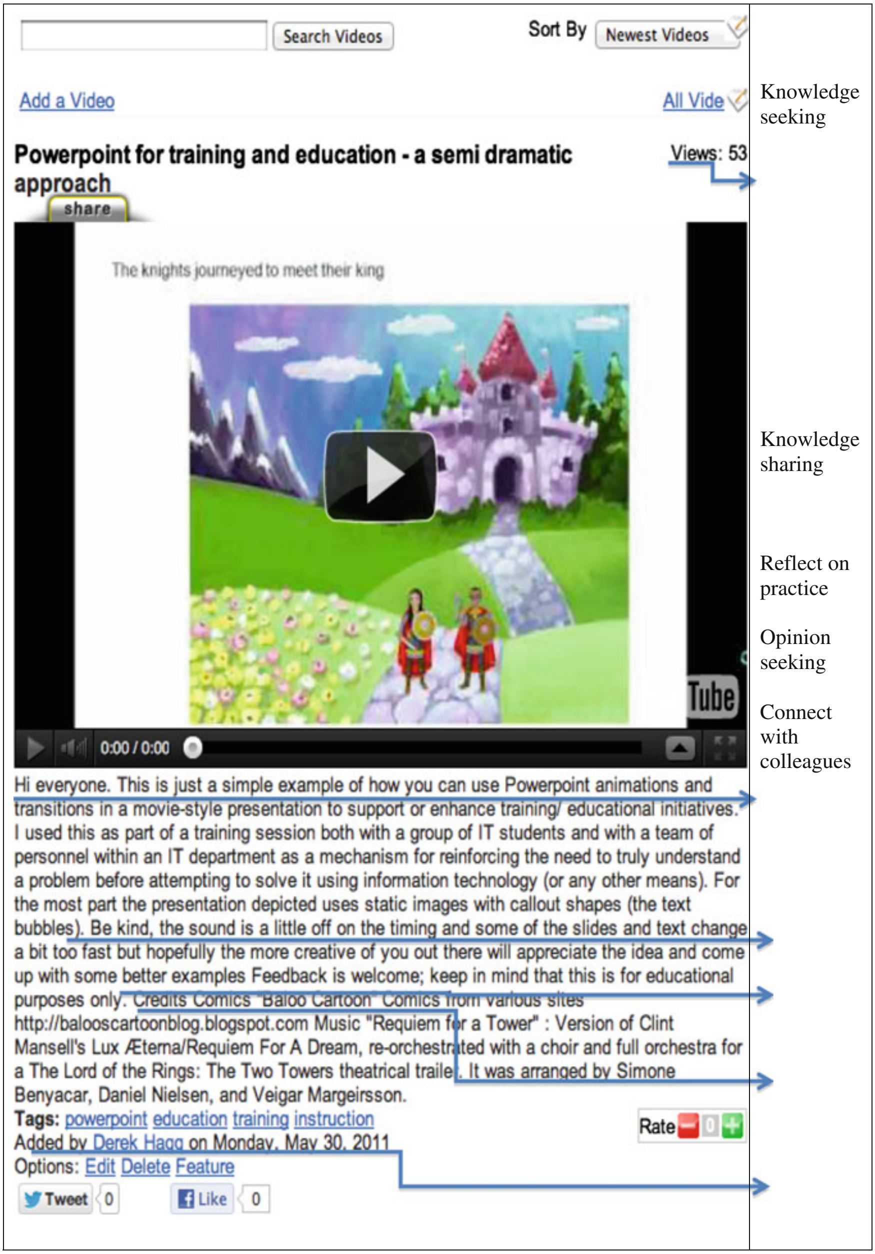


Fig. 7.19 Video upload

7.5.2.11 Activity: Google Doc Collaboration

Google Docs are free online tools that allow documents, spreadsheets and presentations to be worked on collaboratively among a number of users. The following Google presentation, TPACK, was worked on collaboratively with Yemi-J and me. She added content to the slides related to her curriculum area, Geography, while I was creating the presentation. There were a total of seven slides (Fig. 7.20).

Fig. 7.20 Photo upload

7.5.2.12 Summary of Affordances of Participation in Site Activities via Web 2.0 Tools

Table 7.1 summarizes how various Web 2.0 tools afforded teachers a learning experience. Most tools allowed teachers more than one benefit and this combined allowed the online social networking space to be a digital learning space.

7.5.3 Differences in Teachers' Participation on the SNS

Teachers differed in their participation on the site and in so doing. Analysis of participation in different activities was noted through logs of activity in the tool, such as dates of posts, poster name, and a comparison of views to comments. The activities selected are blogs, forums, and videos as these activities had a log of views and comments on the site. Other activities, such as wikis, discussion topics, photos, file downloads did not show a record of such data (Fig. 7.21).

A comparison of participation by reading to writing/adding content is now illustrated.

A review of the number of comments to views in blog postings showed that there was an average of 18 views per post to two comments for the same post. This indicates that only 1 in 9 or 11 % of participants chose to comment as opposed to view. The graph, Fig. 7.22, shows the significantly higher number of views to number to comments in blog posts.

When data from blogs, forums, and video-sharing is compiled, the number of views exceeded the number of comments in all cases (Fig. 7.23). Blog postings had a higher number of postings than forums or videos. The total number of postings in all three activities was 590 compared to 44 comments total, which averaged 7 %. That meant that for every 100 views there were seven postings. Further, the tables show that different participants added content to the site across time. In the Forum activity, one topic thread each was created in three different Curricula areas while one thread was created in Technology. The ICT thread in this Forum was the most popular activity with 168 views and eight replies. The chart below compares ratios of views to comments in blogs, forums, and video-sharing.

The pie chart below (Fig. 7.24) shows that participants preferred viewing to posting comments in blogs, forums, and in video-sharing even though blogs seemed to facilitate a much more comparative balance. The ratios are particularly high in favor of viewing.

These data have indicated that while participants have the option to contribute content to the site, they generally preferred to simply view existing contents.

Table 7.1 Affordances of various Web 2.0 tools

Affordances									
Activity	Knowledge sharing	Knowledge seeking	Opinion sharing	Opinion seeking	Self-presentation	Explore new ideas	Connect with colleagues	Reflect on practice	Seek/show emotional support
File sharing	✓	✓							
Blog posting	✓		✓	✓		✓	✓	✓	✓
Online course		✓	✓				✓		
Forum	✓	✓	✓				✓	✓	✓
Online chat	✓	✓	✓	✓		✓	✓	✓	✓
User profile creation			✓		✓		✓		
Add colleague							✓		
Wiki	✓					✓	✓		
Opinion poll			✓						
Media-sharing	✓	✓	✓	✓		✓	✓	✓	✓
Google docs	✓					✓	✓		

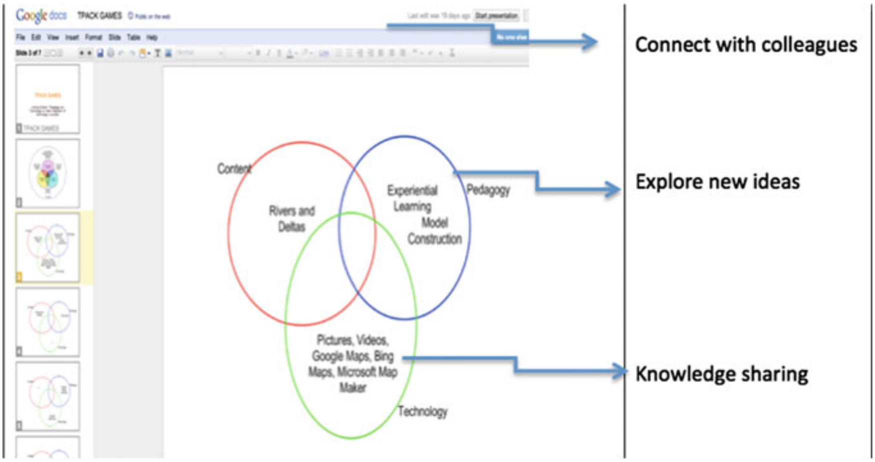


Fig. 7.21 Google docs

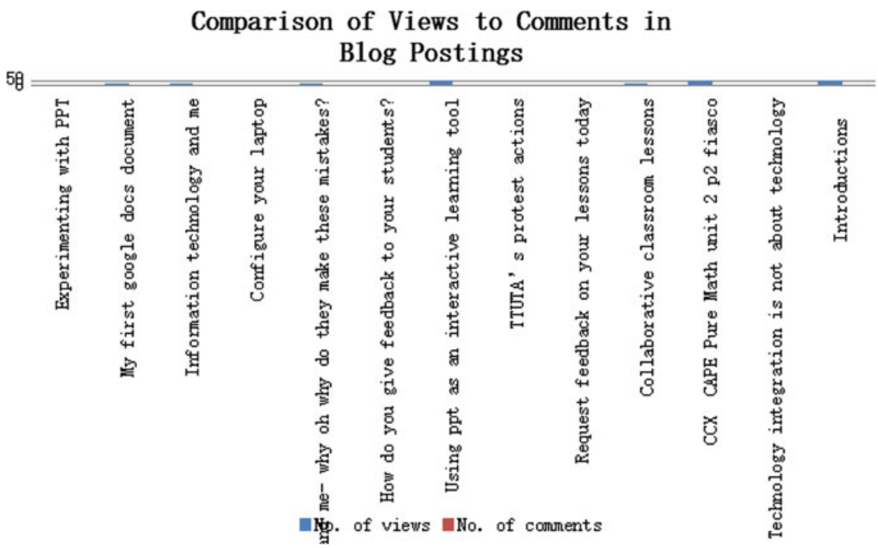


Fig. 7.22 Comparison of blog views to comments

7.5.3.1 Exploring Reasons for Roles Played

In order to understand reasons why participants chose a certain role on the site over another, I explored participation of three teachers in more depth. I treat teachers separately from my colleagues from the Ministry of Education.

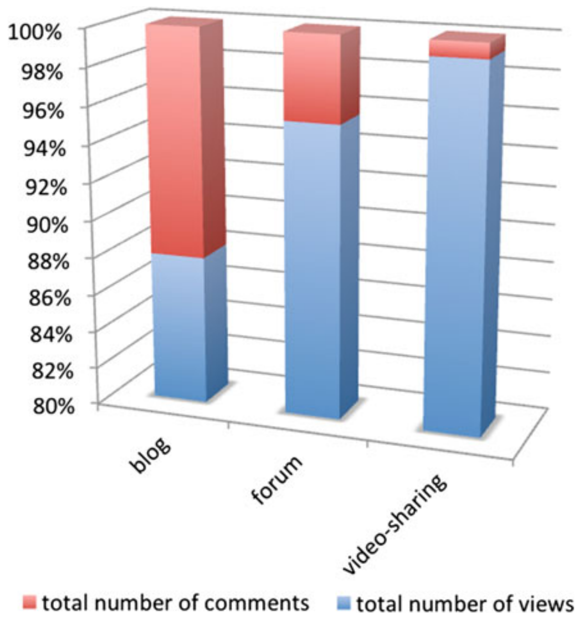


Fig. 7.23 Comparison of views to comments in certain Web 2.0 tools

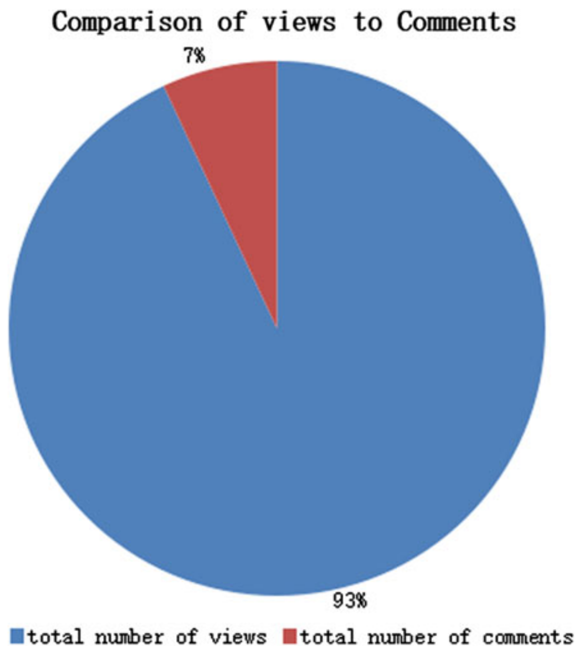


Fig. 7.24 Comparison of views to comments on the site

By Teachers

Based on data gathered from the site and online questionnaires given to three specially chosen teachers, I present data on how three site-registered teachers described their experiences based on participation on the site during May and June. I present these data separately in anecdotal form.

Steve

Steve claimed he entered the site very few times and was registered on 7 June. His last visit was on July 11th and during this time, he set up his user profile and participated in some online polls. He said he spent some time on the site just reading. He accepted the invitation, as he wanted to find colleagues with similar interests. He claimed that Internet access, work priorities, and difficulty in using the Web 2.0 tools on the site were the main barriers to his participation. He felt most comfortable using email and used online polls/surveys for the first time on this site. He claims he was aware of online courses being offered for PD, but found the site fairly difficult to navigate. He felt that the site did not allow him to express his views freely but did allow him to network with colleagues in other schools. He felt that the site exceeded his expectations in showcasing technology-led lessons and fairly well in meeting other colleagues. He felt good to be part of the network and felt that it could evolve into a professional community of teachers.

Angel

Angel was registered on the site from 18 May to 2nd June on 7th June. Her last visit was July 11 and during this time, she set up her user profile and spent time on site reading and participating in opinion polls/surveys and in posting comments on the discussion Forum. She launched the forum topic 'Internet access for Form 1 students' that was the most popular activity on the site (see Sect. 5.4.4). She accepted the invitation, as she wanted to learn something new and felt that the site met these expectations well. She claimed that she was too busy with schoolwork to participate more and she actively used Facebook. She felt most comfortable using email and blogs. She found the site 'interesting.' She claimed that she was aware of online courses being offered for PD and that the site allowed her to express her views freely but did not allow her to network with colleagues in other schools. She felt 'wonderful' to be part of the network and felt that it could evolve into a professional community of teachers. She felt that I listened to her previous comments on ways to improve the site. This was her response "You already did, when you put up what's events are coming up via the most popular social network—facebook."

Yemi-J

Yemi-J spent more than 6 months on the site and was registered from 24 May to 1st November. During this time, she visited frequently and contributed to the site in a number of different ways. Her initial reason for joining the site was to share her expertise with her colleagues. She set up her user profile, and spent time on site reading, participated in opinion polls, discussion forums, media-sharing, and blogs.

She created a wiki, collaborated on a Google doc presentation and engaged in a number of online chats. She found the site 'interesting' and said work priorities prevented her from participating more. She felt comfortable using blogs and emails and participated for the first time in a Forum. She felt that the site was not that easy to navigate. She claimed that she was aware of online courses being offered for PD and that the site allowed her to express her views freely and allowed her to network with colleagues in other schools. She felt that the site met her expectations well in showcasing technology-led lessons. She felt 'great' to be part of the network and felt that it could evolve into a professional community of teachers. Her open comments were "Spread the word so more teachers will use it!"

Some key data from these interviews on these three participants are summarized in Table 7.2.

In examining teachers' views on their roles on the site, I have found a relationship between their participation patterns and the roles played on the site. Steve claimed that he did spend time reading on the site and even take part in opinion polls. Since my site did not register names for polls I was unable to track this, so the only participation I have recorded for him is setting up his user profile. As such I evaluated him to be a consumer of site content and suggest that he played a role as

Table 7.2 Reasons for levels of participation from selected teachers

Participant Name	Reasons for participation given at beginning of study from user profile	Participation activities	Frequency of participation in selected activity	Duration of participation	Reasons for levels of participation during study
Steve	Connect-finding colleagues with similar interests	Just reading user profile online polls	Few times	7/6–11/7 (1 month)	Internet access work priorities difficulty in using Web 2.0 tools on the site
Angel	Learn–learning something new	User profile opinion poll forum	Occasionally	18/5–2/6 (2 weeks)	Too busy with school work and using Facebook
Yemi-J	Share-sharing expertise with colleagues	User profile Online poll Forum Wiki Blog Email Online chat Google docs Media-sharing	Frequently	24/5–1/11 (6 months)	Site is interesting. You are doing a great job. The discussions were related to my interests

of reader on the site. He claimed that a number of barriers prevented him from participating more, such as Internet access, work priorities, and difficulty in using Web 2.0 tools on the site.

While Angel did not spend a long time on the site (2 weeks) she did make a meaningful contribution by her post 'Internet access for Form 1 students' as this post generated the most interest in all activities on the site. She did contribute to the site by adding content and so I call her a content producer or contributor. She claims that that she spent time on Facebook, which may have affected her greater participation on the site. Yemi-J made her presence felt on the site and participated in almost every activity, with success. She emerged as leader on the site by not only reading and contributing content but also by collaborating with me and other colleagues in a number of activities. She acted in a number of roles such as initiator, networker, risk-taker, mentor, and adviser over time. She also claimed that work priorities were an issue for her, but that did not appear to impede her site participation and the multiplicity of roles on the site.

By MOE Officials

Based on data gathered from the site and face-to-face discussions with one Educational Technology official and two Curriculum officers, I present data on how these site-registered officials described their experience with the site. While all eight curriculum officers were invited to the face-to-face session to discuss the site, only two officers turned up. I present these data separately in anecdotal form.

VA

VA is a curriculum officer responsible for Social Studies and she joined the site on 9 July for one day after several reminders. She joined because she wanted to find colleagues with similar interest. When asked about here level of participation on the site she said that she did not remember getting an invite. She said that she was "Too busy at work" and that the site was" "low in my priority list." She also said that, "I will make an attempt to look at it. Sorry for being delinquent."

IDD

IDD is a curriculum officer responsible for foreign languages and she agreed to join the site to share her expertise with colleagues but remained for only one day, 26/5-27/5. When asked for reasons for her low participation levels she said the following:

> I have own email group with my subject area teachers. I agreed to participate as I was the only Foreign Language CO at MOE

She was unavailable to give any further insights about the site.

DH

DH joined the site on 16/6 and stayed until 12/7. He too expressed a desire to find colleagues with similar interests and is also a member of Facebook and LinkedIn. He has made some significant contributions to the site in terms of media-sharing and Forum posts. He exhibited leadership qualities by taking on the roles of Networker and Encourager. He critiqued the site for being too difficult to navigate and advised me on how to improve the look and structure of the site. He said that low response to his posts led to declined interest in participation.

These data provide limited opportunities for analysis of participation among MOE officials. I had anticipated that they would have taken up the role of mentors on the site as curriculum and technology experts. However, this was hardly seen. DH was the only official who made significant contribution to the site and did act in roles higher than contributor, but did not emerge as a leader on the site based on my criteria. Officials generally claimed that time and low interest in the site were the main reasons for their lack of participation and possibly only agreed to register due to repeated requests by me.

Summary of Reasons for Roles Played

In summary, I have found that time/work priorities were a common factor among all six participants. Low interest in the site as well as technology difficulties also contributed to low levels of participation. I also suggest that other ways of social networking, such as Facebook, which were more familiar to participants affected participation on the site. As such many participants remained as content consumers and minimally as content producers. In general, teachers seemed more interested in participating on the site than MOE officials. They felt that the site met their original expectations quite well and expressed positive comments about their participation. They generally felt that the site allowed them to network with other colleagues and to express their views freely. A leader emerged on the site, who acted as a mentor to other colleagues, but this leader was a teacher, not a MOE official. She wanted to share her expertise with her colleagues and she did, in many ways over a significant time period.

7.6 Conclusion

The wide range of Web 2.0 tools allowed teachers to select participation freely, independent of time, and location. Different activities allowed teachers a variety of benefits which include knowledge sharing, knowledge/information seeking, opinion sharing, opinion seeking, experience sharing, seek or give emotional support, self-presentation, exploring new ideas, and reflecting on classroom practice (Hew and Hara 2007; Hur and Brush 2009; Pardo and Nussbaum-Beach 2011). Teachers were able to develop an online professional identity, add content related to their own concerns and contexts and share ideas and knowledge with other colleagues, unknown to them prior to the study. As such, participation in various activities seemed to indicate that teacher learning did occur.

The following are some limitations of this research:

Much of the study depended upon the design of the site and its activities and my ability to select and use Web 2.0 tools that could enhance participation on the site. Many of the tools were new to me and I had to learn how to use them as well as develop suitable content for the site. I also had no experience with social networking sites and had to learn to design and manage the site on a new platform, spruz.com. Site maintenance took a lot of work and as such I had to restrict the length of time of the study to 4 months. This suitability of the website platform itself to the study may be questioned and the facilities of the site as well as its newness may have contributed to restricting access and hence, participation.

Also, there are relatively few models of good practice to draw upon and existing frameworks for examining learning on SNS are inadequate for a nebulous cyberspace. Further, existing theories of online learning have been configured to online courses and online social learning theories are still evolving. Links with participation to learning are at an early stage of research. I have had to glean characteristics of learning from theories of online learning, social learning, and networked learning in order to explore what learning can look like on an SNS. The problems faced by the researcher are compounded by gaps in theory of online teacher learning.

As such, conclusions about teacher learning on an SNS remain problematic in spite of teacher online participation. I have suggested that learning took place through participation in site activities and through interactions in a shared networked environment though learning may have only taken place at knowledge levels. Since learning is described as a change in knowledge, attitudes, and beliefs and/or change in practices (Bakkenes et al. 2010), there is insufficient evidence that ideas expressed by teachers on the site were implemented or that knowledge shared actually altered practice.

Future studies can track the sharing of site artifacts and how teachers use them in practice over time. Allowing collaboration with colleagues from other countries and cultures can enhance the site. The interest expressed by global visitors to the site should not be ignored, both for the site itself and for online course subscription.

Continued use of the site with a focus on expanding networks of teachers can lead to further exploration of teachers' learning through Web 2.0 tools to enhance their practice. There is a need for teachers to embrace these tools in the classroom to expand students' spaces for learning.

The tension between privacy and publicity can be explored further, especially as Trinidad and Tobago has such a small audience. Further, content on the site can potentially benefit both Caribbean and international neighbors. The potential of the web to make public (Lieberman and Mace 2008) the contributions of teachers in Trinidad and Tobago cannot be ignored.

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Chapter 8
Information Communication Technologies in Education for Developing Countries

Zehra Altinay, Betul Yikici, Gulyuz Debes, Yusuf Deviren and Fahriye Altinay

Abstract This chapter encompasses cases of schools in the use of information communication systems and their education systems. In addition, this chapter gives insights on how information technology is used and efficient in different cases and provides details on contextualization of education system in Northern part of Cyprus. In addition, reflections on educational technology in schools and class are discussed in this chapter. Innovative attempts are shared in this chapter in terms of educational technology and school practices. As centralized education system limits the practice of teaching and learning effectiveness, in this chapter, three cases provide reflections on how educational technology is important in digital management and enhancement of the school culture, management.

Keywords Contextualization · Education system · ICT · Management · Leadership

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8.1 Contextualization

In the developing countries, education and economy play a major role. Especially in Northern part of Cyprus where the economy relies on education, investments in education have fundamental importance. Advancing to become an educational island, the use of ICT in learning and teaching environment is important. However, ICT is mostly used in the higher educational system. Although there is a technological infrastructure in K-12 public schools ICT is not widespread. This situation is thought to have connections to the lack of adequate infrastructure and the importance of limited use of technology. This year distance learning applications used in higher education will be put to service by the ministry. Teachers' ICT competence is aimed to improve this year with educational seminars. For personal and professional purposes, teachers in the social structure with its emphasis on education will participate in ICT seminars to improve their skills. Although virtual learning environment applications become widespread in the system, there is no adequate infrastructure in this regard. Although application of new technology into classroom context improves both teaching and learning in terms of quality, the use of ICT is limited in schools and classrooms. In contemporary educational context, ICT become popular solution for disabled learners. Learning environment of those learners can be enriched with the support of technology. Unobstructed information technologies in education become an alternative way for fostering learning and teaching effectively. In regular classes, particular courses such as English, Science, ICT, etc., teachers attempt to use technology. Based on technological infrastructure and educational programs, education system needs to adopt new teaching models in line with technology. The general structure of the education system is listed below and with the use of ICT three study cases have been presented.

8.2 Objectives of National Education

The overall objective of the Cyprus Turkish National Education is to train all members of the Turkish Cypriot Community, within the principles stipulated in the following paragraph;

To develop citizens who protect and improve Ataturk's nationalism, democracy social justice and the law principles and revolution, with the objective of ideas and partnership between citizens which aim to modernize Turkish Nation and national consciousness;

Raise citizens who know the truth about the core struggle of existence of the Turkish Cypriots, are aware of the struggle, connected to the beliefs, who protect and improve its cultural values, love its nation, motherland Turkey, bound to the Turkish nation, community, and family with strong ties, know its duties and responsibilities toward the secular state, who know can convert this awareness and continuous behavior into characteristics that is peaceful but also knows of its rights;

Raise citizens with balanced morality in body, mind, and emotion wise, strong personality and character, scientific thinking power, have an extensive view of the world, who love people and respect human rights, who have responsibilities toward the society in all its aspects, that contributes to the community's economy, who hold the society's interests above theirs, someone who can see the community's welfare and carefully preserve the existence of society and the state, defend its state against all kinds of dangers and resist until the end, bold, constructive, creative, and productive;

Raise citizens to equip them with the necessary skills and knowledge to evaluate their skills and talents, to provide them with work habits, using this way prepare them to life, who have professions that contribute to the development of their society that will make them and their family happy, thus, to increase prosperity and happiness; on the other hand support and accelerate social and cultural development with social cohesion and economic integrity, who want to make its nation and society the partner of constructive and creative contemporary civilization and show continuous effort this way.

8.3 General Structure of the National Education System

Cyprus Turkish National Education System consists of two main parts, namely non-formal and formal education.

8.3.1 Formal Education

8.3.1.1 Pre-school Education

Pre-school education includes the children who are not old enough for primary school. Education is carried out with the state assist for 1 or 2 years depending on the program expanded to cover all pre-school education age population. In accordance with the general objectives and basic principles of Cyprus Turkish National Education goals and tasks of pre-school education are as follows;

1. Development of the children's body, mind, and the senses, to acquire useful skills with good habits.
2. To prepare children to primary school in every way.
3. Creating a suitable habitat for children and families from unfavorable environmental conditions.
4. Provide children to talk fluent and correct Turkish.

Pre-school education institutions can be opened as separate kindergartens or as another educational institution connected to public schools elementary or kindergarten classes. Children who have completed the age of 4 and 5 before the 31st of

December of that year will be assigned to the application linked to a separate nursery kindergarten classes.

8.3.1.2 Primary Education

Primary education includes the education and training of the children who are aged between 6 and 11 years old before the 31st of December of that year. Primary education age begins at the last day of the august of that year the child turns 6. In accordance with the general objectives and basic principles of Cyprus Turkish National Education goals and tasks of primary education are as follows;

1. Teach the kids the truth that lies at the root of our social struggle with Ataturk's principles and revolutions of Ataturk's nationalism.
2. Give children necessary skills like general knowledge, behavior, and habits to become good and useful citizens.
3. To improve children's interests and skills to prepare them for social life and upper education.
4. Improve the aesthetic feelings of the children, to give them the ability to see the good, the truth, and to act together in cooperation, solidarity, friendship, create a superior human emotions such as love.

Primary education institutions consist of 1 or 2 years of kindergarten and 5-year primary school. When the fifth year of the primary school is finished an elementary school diploma is given.

8.3.1.3 Secondary Education

Secondary education includes 6 years of training based on the primary education. In accordance with the general objectives and basic principles of Cyprus Turkish National Education goals and tasks of secondary education are as follows;

1. To provide and maintain in line with the nationalism of Ataturk's social and cultural integration.
2. To provide all the students in the secondary education a common minimum level of culture, find solutions, contribute to the society's economic, social, and cultural development.
3. Students are also required to develop the economy of the community according to their interests and abilities in the context and oversee a variety of programs to prepare for higher education or both profession and higher education or their social life and business.

Three-year secondary schools implementing various programs in accordance with the program are referred to general schools, vocational schools, technical schools, and consist of other schools. Secondary schools can be set up separately as well as connected to high schools. The duration of secondary schools is determined by the program's functionality implemented by the Ministry for not less than 6 years. According to the type of school they graduate from the children are given either secondary school diploma or high school diploma in the case of completion. Directing, especially begins in middle school and gains density. Orientation, continues in high school to avoid error and to provide rerouting based on possible developments.

8.3.1.4 Higher Education

Higher education includes all the training that is based on at least 2 years of education. Students who have successfully completed any of the high school, depending on the conditions of higher education institutions have the right to benefit from these institutions. In accordance with the general objectives and basic principles of Cyprus Turkish National Education goals and tasks of higher education are as follows;

1. To provide and maintain in line with the nationalism of Ataturk's social and cultural integration.
2. To train students in their means of interests and skills for the manpower requirements of the society's and community's higher level and various areas.
3. To give scientific education in areas relevant to social needs.
4. Make publications in the means of written and similar, especially those involving our country's social, economic, and cultural issues to resolve with the general and technical problems of all kinds of scientific methods related to education, science, expand and deepen the study and make research.
5. To provide benefit to other segments of society affected by the problems with society and in particular with the legislative and executive bodies. Educating with a scientific approach to nations development and improvement.
6. Engage in wide education services.

Institutions of higher education institutions, opening, specific objectives, activities, and other matters related to faculty and institutions of higher education are determined in a special law in these institutions. Higher education is paid. However, without adequate financial resources, all kinds of students with learning disability and successful students' costs, scholarships, are covered as free boarding or extent loan by the state.

8.3.1.5 Special Education

Covers all the education up to the age of 18 with physically and mentally disabled children who are in need of special education. Every student who requires special education are entitled to free education or free boarding special education while in their compulsory education age. However, those who want to take special education outside the education age are provided by the state. In accordance with the general objectives and basic principles of Cyprus Turkish National Education goals and tasks of special education are as follows;

1. To provide social and cultural integration determined by the direction of Ataturk's principals and revolutions and Ataturk's nationalism.
2. Provide opportunity to every student in need of special education to utmost their skills and interest.
3. To educate these students to be useful citizens, provide necessary vocational rehabilitation, and private educational institutions; implementing special programs consist of board or other body or group of schools in special classes in separate schools.

8.3.2 Non-formal Education

Includes education activities outside the formal education.

8.3.2.1 School Buildings and Facilities with Education Tools and Equipment

All levels and types of educational institutions buildings and facilities are planned and carried out by the Ministry according to the characteristics of the environment and programs to be implemented. For this purpose, necessary appropriations are budgeted by the ministry each year. It will be benefited from the citizen's assistance as well as the land, equipment, and the construction of the school buildings provided by the state. A fond shall be established for this and other educational purposes.

Educational Tools and Supplies

Consist of educational tools and materials to be used in educational institutions, teachers and students with textbooks that utilize the objectives of Cyprus Turkish National Education.

Duties of the Ministry

Ministry is affiliated with the academic institutions to prepare educational tools and materials, to develop educational technology, to provide in accordance with the program, and methods to select, confirm, to standardize, to renew, to determine the textbook deals and is help benefit anyone with or without payment.

Fulfilling the Duties

Use education tools and equipment of the Ministry;

1. To prepare and make advantage of school facilities
2. Commission will organized and established to prepare the participants to the competition
3. To buy; to choose between the private sector that has provided already or prepared

8.3.2.2 Education System

Nowadays, increased variations, economic improvements resulting from globalization, international relations and population and student mobility are also changing the structure and functioning of schools. In the research conducted in recent years, an argument has risen at schools that students are not raised with skills and knowledge required by global structures and international competition which is causing frustration to the school headmasters. This has led the school headmasters to make an additional effort (Leithwood et al. 2006).

The headmaster is required to be a step ahead due to changing teacher's, student's, guardian's, and social environmental expectations. In comparison with the past, students question the traditional role of those teachers and the administrators more who care about their own abilities, who adopt irregularity and contradiction. Teachers are required to adopt various roles in order to continue with their personal development to meet the guardians' expectations. Back in days, the school headmasters' tasks was clearly and precisely determined and specified. In accordance with the said, the headmaster was tasked to provide discipline and resolve problems about the school (Dipaola and Thomas 2003: 7). Various factors such as departing from the traditional society, technologic improvements, increase in population, and increase in educational demand has caused the educational administrators to add additional skills to their existing ones. In parallel to social, political, and technological changes, the school headmasters' tasks continue changing (Demirtaş and Özer 2014). It has been revealed from various researches that the main task of a school headmaster's duty is to manage the school and to identify the vision and the mission of the school.

Technological innovations and developments in the education system affect the teaching-learning process in this context. Technologies used in everyday training are leaving their place to new technologies. Internet-connected computers, electronic whiteboards take their place in the classroom and educational environment is carried on to network environment (Eren and Kurt 2011). It has been emphasized by various authors that the school headmasters are required to be a good change leader, good educator, and trainer who adopts rapid technological changes in addition and in parallel to being a good technological competitor. Being a technology leader, the schools administrators are required to take responsibility in apply effectively the information and communication technologies on school management and in class and gaining qualifications to fulfill this responsibility, and self-development has become a necessity (Hacıfazlıoğlu et al. 2011).

School headmasters are expected to ensure that existing educational technologies are effectively used at schools (Eren and Kurt 2011). It has been revealed in studies that teacher competency and leadership exhibited by school administrators is effective on student success, a school administrator with high qualifications is said to administer activities effectively, as well as carry the teacher's and student's performances to the next level.

Subjects of learning, acquired knowledge, education and educational standards have come into question in light of increasing importance of knowledge. Various studies state that school headmasters need to contribute increasing the school capacity, increasing the teaching and learning areas, or to get the students focus on the best. Studies show that the roles and acts of school administrators vary in accordance with needs and purposes of organizations. The main factors affecting the roles and acts of school administrators are the purposes of the organization that they work for, the expectations of the organization, and their current conditions. Every school has its unique environment, organizational atmosphere.

The aim of education systems is to provide education and training. Education and training mean learning. People who will provide variation are teachers and administrators. Today, the success of school is assessed by students' qualities. For this reason, the expectation of society increases about the quality of expectation for training. The researches show that behaviors of the headmaster affect the quality of the education (Balyer 2013).

The most strategic way of education institution is teachers and administrators. Teachers who do not have sufficient knowledge must have in-service training courses.

TRNC (Northern Part of Cyprus) Education System

Cyprus was divided into two in 1974 as North and South via the green line. Turkish Cypriots and TRNC citizens live here. Turkish Cypriots have suffered for many years from political, social, and economic embargoes.

As opposed to the European countries, educational system in TRNC has been centralized and is operated with traditional methods. This affects the education policy and development. Political forces interfere with the educational system. The Ministry of Education states the criteria to inspect the education policy (Mertkan 2011, 2014). In some of the developing countries (China, Thailand, Singapore, Nigeria, Malta, and Pakistan), education system and executive directors restrict the school principals' behaviors. Government is responsible for all education system. The ministry of education is responsible for syllabus, materials, teaching methods, exams, resources in school, workers at school, and teachers. Oplatka (2004: 431) ministry of education gives all decision because of central examination. Schools are connected to ministry of education in terms of budget and staff. School principals and teachers work in orders of ministry. There is no pressure for teachers and school principals to improve themselves. School principals are in contact with ministry. They must obtain the approval of the ministry. The task of principal is to make catalysis. They have less working hours than in other countries. They do not have updated information. They use traditional methods (correspondence) (Mertkan 2011). In addition to these, in TRNC, there are students in range of 11 and 18 and Student enrollment is determined by the ministry of education according to their regions.

The curriculum of the course is very extensive as a knowledge due to, the shortness of the time in the TRNC, the curriculum cannot be completed on time. According to the World Bank (2006) report, the education period is 155 working days; and on the other hand, this is 186 working days in OECD countries, also the course hours less than the OECD countries. The working hours of teachers are less than 60 %. The OECD countries have 701 h while Cyprus has 415 h. That is why students are taking private lessons except the school hours to complete their education properly (Mertkan 2014; Yıkıcı 2014).

Everything in relation to schools including stuff and budget is linked to the central organization. School headmasters are in constant communication and seek the Ministry's approval for school decisions. The school headmaster acts as a catalyzer. The working hours of teachers and headmasters are short. The working hours of the teacher are the lecture hours in his/her timetable. This is a big problem. Teachers and school headmaster's knowledge are no up to date (Mertkan 2014; Yıkıcı 2014). Failure in updating the existing knowledge decreases the teaching quality of the teacher. They do not want to make use of the educational technologies. As utilizing educational technologies require an advance preparation period, they prefer not to use and utilize the traditional methods such as blackboard, pencil. Administrators receive any paperwork sent by the Ministry late. They do not use computers often. They prefer to use traditional communication methods. There is a computer nearly at every house in Cyprus. The Ministry has constructed a PC lab to every school linked to the Secondary Education Department. Although most teachers own their own personal computer, at most times they refuse to use the computers at school while teaching. Teachers in TRNC are inspected by very few inspectors instructed by the Ministry of Education. These inspectors only have the chance to inspect the newly appointed teachers once or twice a year. Teachers whose candidate period comes to an end do not get inspected. Some subject teachers do not have the relevant inspectors and they are inspected by the subject inspectors. As the ministry's support and guidance to teachers is insufficient, headmaster's in-house training of teachers is mandatory.

Teachers' union has a big effect on education. As the union does not cooperate with the Ministry, this adversely affects the education policy (Dağlı 2013). The teacher union's responsibility is to protect and improve the teachers' rights and benefits rather than provide education (Dağlı 2013). Teachers unions are extremely protecting their members' rights (Mertkan 2014). Teachers unions are effective on education, however a restriction on the Ministry's intentions. In TRNC teachers can ask to be transferred to a different school after the end of each academic year. There are no specific requirements for workplace change. Hence, this is causing negativities in education. The transfer process takes place by the cooperation of Ministry of Education and Teachers Unions. Workplace change has been observed at the end of each academic year especially from rural areas into central. Any teacher who starts working at a rural area immediately applies to be transferred to a central area. Teachers prefer to work in central areas due to long distances between their home and their work place. Usually, there are permanent teachers at central schools and this is also causing negativity in education as well. Senior teachers do not wish to cooperate with young teachers. Besides, teachers teaching at rural areas are allowed to replace in accordance with the relevant legislation the vacant position which becomes available at central schools due to retirement or sickness of another teacher. A loss in education occurs when the appointment of the new contracted teacher is delayed who is to replace the vacating teacher. The teacher who replaces the transferred or appointed teacher acts under the impression that s/he is also working temporarily. Some of the appointed teachers work on par-time schedule in two or three schools at the same time (Source: Students and teachers ranking 2014). Those teachers do not feel attached to any school nor improve their belonging feelings (Yıkıcı 2014). Those teachers who constantly change schools are negativity to school headmaster who cannot concentrate on their improvement plans. Another visible problem in TRNC education is the attendance of teachers and using leave. Teachers are allowed 40 days for sickness leave and 5 days for excuse leave. Some teachers use their leave unreasonably and unfairly and as the teachers do not attend to the lectures, there is no compensation for those free hours which is a loss to the education (Yıkıcı 2014).

In the TRNC the service training of the teachers is carried out by the ministry, so the teachers do not have to participate in this service training program. Until the last few years, very low number of teachers was participating in these studies. In addition to this, there is no necessity to participate this service training. The fact that, the teachers were not attending to this service training program until a few years ago Yıkıcı (2014). But, in recent years this training is considered by the people who want to get promoted. Due to non-implementation of rewards and punishments, teachers do not interest in this study.

In the assignment of head manager of the criteria of being teacher is considered as a basis same like in many other countries all over the world. In the TRNC, it is considered that the educational administrators had to have their teaching experience for a certain time; so this is a prerequisite for being administrator in the TRNC. The school managers have the same knowledge and teaching methods as much as teacher's have (educational knowledge, professional knowledge, and general knowledge.). Beside this there are same requirements of being administrator such as professional knowledge and skills which they had to need. Ministry of education sees that the school management could be carried out by the teachers as a second duty, even though the management of the school requires a professional job qualification. There is no necessity to upbringing the people who will be duty on this area. In this area, it is seen different implementations in the different education systems. For example; in the country of US and Singapore, it is expected that when the people are appointed as a head master, they had to be graduated from the department of the Education managements (Yan and Ehric 2009: 2–3). It is believed that in the South Cyprus, the headmasters would be from the quality and experienced teachers; in order to that, for the candidates there are some compulsory education programs or master's degree for head masters.

The people who are appointed as an administrator and teacher, starts their duty without taking in-service training in the TRNC. Some of those appointed as school administrators are not attended to these training activities and implementations. Head masters and teachers have no idea about the schools and the socioeconomic structure of the regions, so they start to work without knowledge and perform their duties with prejudice. In recent years, Ministry of National Education is providing in-service training related to their duties for newly assigned teachers and administrators.

In recent years, the first assignment places of the head masters are away from the central schools. The head masters stay in a short period of time in these schools, then they are changing their correct positions and the next school year with the request they transfer to central schools. Those headmasters during the mission follow the rules and directives of the Ministry; in short, they carry out their mission by traditional understanding of the headmaster and around the rule of bureaucratic by the directives of the ministry.

Turkish Republic of Northern Cyprus Secondary School Information—Communication Technologies Application

There is no data available that highlights the activities within schools within the Turkish Republic of Northern Cyprus educational system, due to the absence of an objective-oriented structure (Mertkan 2014). The central organization decisions are not determined by scientific research. They make their own decisions and share it among their stakeholders.

There is no data available related to the use of technology and related teaching strategies within Turkish Republic of Northern Cyprus education. By identifying the strategies used to improve the activities for training and teaching, to increase the effectiveness of the school by the school principals in Turkish Republic of Northern Cyprus, a research was carried out by Yıkıcı (2014) in order to determine the extent of technology used in the school by the school administrators and to what extent the teachers supported and directed toward the use of technology. Technological innovation and improvements in the education system has affected the duration in the context of teaching—learning. Internet-connected computer, estimation, and electronic boards have taken their place in the classroom environment and have moved the learning environment to the network environment (Eren and Kurt 2011). Individuals all around the world are able to communicate with each other with special thanks to the Internet. School administrators, as the leaders of technology, are required to take responsibility for the effective use of information and communication technology in the management of the school and classrooms.

Innovation and development in technology has led to big changes in society. Current information changes all the time and the understanding of a lifelong learning are spreading. At present, gaining knowledge should not be restricted only for schools. Student profile has changed a lot. Teachers remain face to face with game playing students who are using their smart phones for information processing by downloading videos via the internet. Students spend majority of their time on their phone visiting social networking sites Attention given to the teachers by the students in the classroom during lesson time has decreased. Teachers need to improve their information technology skills while teaching.

The organization of the educational system in Turkish Republic of Northern Cyprus has a central management structure. Central government has the highest level of authority in education. In schools, what is taught, how it is taught, why it is taught, the educational technology to be used in education, whom the training and teaching will be performed by, how to motivate is determined by the Ministry of National Education. The school management policies do not acknowledge the schools characteristics and requirements recommendations determined by the Central Office.

All the expenditures for the school are decided by the central government and it also decides the amount spent on certain types of resources. Turkish Republic of Northern Cyprus divided a share of 12.11 % for the 2014 year and 12.81 % for 2015 year for education. Large part of the budget which has a limited amount and must be used very well goes to staff costs and current expenditure.

Public schools in TRNC are not autonomous and they have no budget; therefore, they try to find sponsors or resources to meet the expenses (Mertkan 2011). The Ministry of Education provides educational materials, computers, desks, chairs, etc., to schools. Computers have been used in education, TRNC since 1980s. In all secondary schools, there are information and communication technologies (ICT) rooms, where students get education. Within the scope of the grant scheme “schools initiative for innovation and change,” European Union has provided financial support in the amount of 3 million Euros to 67 schools for 82 projects submitted between 2008 and 2014. A large number of secondary schools have benefited from this program and produced projects related to educational technology and contributed to their schools computer rooms, language rooms, technology rooms, and visual rooms.

Ministry of Education, with the contribution of the Republic of Turkey, within the scope of Fatih Project, installed smart boards to 6th, 7th, 8th, and 9th classes in 2013, but did not provide internet access. Computer teachers in these schools had in-service training on how to use these smart boards, and gave seminars to teachers in the school where they work. However, participation in these seminars was not compulsory, therefore, some teachers did not participate. It is observed that some teachers are reluctant (shy-insecure) to use the new technology.

It is observed that some of the teachers in profession, thinking they have completed their education, do not attend the in-service training, organized by the Ministry. They use the traditional teaching methods in classes (Yıkıcı 2014).

Case Study 1

Erenkoy high school is a state school situated in Yeni Erenkoy, in Karpas region, in TRNC. At first, the school was active as a secondary school. In 1980, it was turned into a high school where middle school and high school students all receive education. In the census carried out in 2011, the population of Yeni Erenkoy sub-district was identified as 7976. Some of the people in the area settled here before the war in 1974, and some consist of the families who came and settled here in 1976 from various places (Adana, Mersin, Kars, Trabzon, Samsun, etc.). The primary means of livelihood are: agriculture, livestock farming, and fishing. Tourism has also begun to develop within recent years. There are also people who work in government offices.

The people in the area are not well educated. There are also some people who are illiterate. Some of the people in the area are people with low income and some live on social welfare. Although the family structure in the area is nuclear family structure, there are also broken families in recent years.

For the people in the area, school is a strategic institution. Students who have completed their education find opportunities to continue higher education, and take on important tasks both in private and public sectors. The school principal is among the first graduates.

Five administrators including the school principal, 50 teachers, and 10 part time teachers work in the school. The number of students in the school is 575. (Students aged between 11 and 18 receive education in the school.) There are 23 classrooms (10 secondary, 13 high school) in the school. In addition to preparing the students for higher education, the school has the vision to improve the students allover. For this reason, besides teaching, attaches great importance to cultural activities, such as sports and art. Starting in the second semester of 2013–2014 academic year, and ongoing, it carries out the project "multicultural education" with LTL, in the framework of the European Union education initiative.

The school is built up on 25,000 square meter field. School is built on a very large area and has three main buildings. With the thought of "Safe school" the parent–teacher association (PTA) mounted 24 cameras in the school. The main building consists of an administrative department (a room for the school principle and a secretary room, staff room, a copier room, and a vice-principal room). Two educational technologies rooms, a language room, library, music room, physical education room, guidance room, and seven classrooms where 11th and 12th grade students receive education. In front of the building there is an area, as large as a football pitch and on the side of the field there are roofed tribunes which were made with the contributions of the PTA. In the main building, the school is seeking fund for a seminar room equipped with educational technology. The middle building consists of a laboratory and workshops. In the building; two technology design classes, an art room, and a science laboratory (which is redesigned this year) are used actively. The third building consists of 16 classrooms where students receive education. In the building there is an information communication technologies room. There is a schoolyard between this building and the middle building. There have been physical rearrangements for disabled students. School has a cafeteria, which has a capacity for 200 people. It is situated on the right of the tribunes. The basketball field of the school is also used as a place where students are gathered. School has a large green area. The backside of school has Mountain View and the front side has sea view.

The school's vision includes not only preparing students for higher education but also developing them from all aspects. For this, the school pays attention to activities such as sports, arts and cultural events in addition to education. The school is also working as the pilot school as part of the "multicultural education" projects offered by Lefkoşa Turkish Lycee which is funded by the European Union within the EU "Schools' Initiatives for Innovation and Change" grant program. In the "multicultural education project" which started in the second semester of the 2013–2014 academic year and is still ongoing; both schools are collaborating on philosophy, environment, and photography and dance clubs.

The school cafeteria, which was built with the contribution of the parent–teacher association (PTA), is hired by the educational foundation. The school's budget is composed of the rent money, which is given to the school administration. This is a low amount of money and it is spent on the purchase of the ink of copiers, internet, payment of telephone charges, cleaning materials, repairing of broken educational materials, etc. Because of a very limited budget, it is spent to meet the essential needs of the school. The parent–teacher association (PTA) tries to meet the other needs of the school under the guidance of the school administration.

Despite these circumstances, the expenses of the school's educational technology equipment are covered by the Ministry, parent–teacher association, and the universities. The information technology room is organized by the Ministry. 6th, 7th, 8th, and 9th grade students receive education in this room. Two information technology rooms have been established by the Ministry. High school students take advantage of these rooms and they are given seminars and lessons through fixed projections in these rooms. Academic members invited from universities use these rooms to give seminars to teachers and students. In one of these rooms, there is also a portable projection.

Within the scope of the Fatih Project, the Ministry has established smart boards in classes for all secondary school students. 6th, 7th, and 8th grade students benefit from these smart boards. However, there is no internet connectivity yet.

School computers used by the school administration are equipped by the Ministry and the printers are equipped by the parent–teacher association. Parent–teacher association provides great support in this regard. Although the families in the area are people with low income, they support all the activities (lottery printing, tea parties, giving advertisement for school annual, etc.) organized by the parent–teacher association, to provide financial support for the school. Since 2010, parent–teacher association has established a fully equipped guidance room with two computers and printers for the school and bought computers for the school principal and vice principles. These computers have been donated to school by education volunteers through the parent–teacher association. The computer and the printer in school principal's room have been donated by an educational charity. A private university donated a computer to school's language room. The room has internet connectivity. Students watch films via the projection.

Parent–teacher association established the school library and equipped it with two computers and a printer. The Ministry established the projection system of the room and a parent donated a television for the room. All the books in the school library are registered on the computers. The borrowing and returning books system is done on computers with barcode system. There are also two computers for students to use. Students are given presentations with a fixed projection set up in the library. Our country's important writers, poets, and researchers are invited to school and students are given presentations by these people. Students watch documentaries on TV in this room. Internet access is provided under control.

The e-school activities in the school first started in 2007; the registration of Turkish and TRNC-Turkish students was done and their grades were entered into the system. The experts came from Turkey under the sponsorship of the Turkish Embassy informed the administrators on how to use e-school. The current director of the school also attended. The director, who observed that this program eases administrative duties and saves time, explained the benefits of the program to the executive board of PTA and his colleagues and pioneered bringing the smart school program with similar applications to his school.

For educational and administrative affairs in our school, smart school program is used. With contributions from parent–teacher association, school administration first set up the internet network in all administrative rooms, guidance room, and the seminar room that is going to be established, and later bought this program. The internet is purchased via wireless network. Smart school program has been used at school since 2010–2011 academic year.

It is one of the first five schools using this program for administrative duties. This program allows to input all information about the students (student's registration to school, file information and photo); school's timetable; information about the subject teachers; course grades of students; reports and diploma information; students', teachers', and personnel attendance and school's inventory over the smart school. It is possible to get almost 180 report types from the program.

The biggest problem which the school has been facing in regard to running educational activities is the exchange of teachers. Each academic year starts with absent of teachers. It takes 4–6 weeks for branch teachers to start working and as a result serious losses occur in education. Teachers who attend in-service courses, organized by the minister, volunteer leave school at the end of the academic year. Their reason to leave school is that the school is very far away from where they are normally living. In order to prevent educational losses due to this situation, the headmistress provide orientation days and information about student and family profile, school's structure, available educational technologies, and school objectives to new coming teachers,

School's vision and mission are remained and written versions are given to them. Expectations from them are also explained. Their subject groups also coach them. This should be done as the number of nominee teacher's form 1/6 of total teachers at school. CT teachers are responsible for administrative affairs and as they are frequently changing, a need for administrators occurs to develop them on work. Headmistress has learnt from ICT teachers how to do administrative works, apply for universities online and she has explained it to other administrator teachers and the guidance counselor. One of the vice principals has been proficient on university applications. Educational and teaching works are not failing in case the guidance counselor becomes assigned late.

The person who created the Smart school program came to school to show teachers and administrators how to use the program. Especially, the ICT teacher helped other teacher on the program. Before this program there were teachers and administrators who did not know how to use computers. After buying this program, these teachers went took an ICT course from the Minister of Education and got help from the teachers who know how to use computers very well. At the moment, every teacher in the school can use computers. Teachers can work more quickly thank to this program. Necessary set ups were done to record students' marks on the system and it is planned to apply this system this term. As the students' guardians have low education levels it is now not possible for them to follow their children's progress through this system. Smart school has also helped to answer students' and their guardians' demands in a short period of time. It will also help administrators to work quickly as they have limited time. The program is planned to be opened to parents as well in future. Thus, parents will be able to follow attendance status and course grades over the Internet. There is no program of the Minister in regard to how to use classrooms equipped with computers. Geography teachers teaching in the high school department are the ones who used these rooms first. When it was realized in seminars, which were led by guest lecturers, that the visual technology increases motivation and reinforce learning processes, other teachers (history, physics, and chemistry) also started to use these rooms. However, the extent of this use is not still as wished for the teaching. Most of the teachers avoid using visual technologies as they believe they spend more time on getting material prepared.

ICT teachers had an in-service training on how to use smart boards in the secondary school department and then they gave a seminar to all teachers and downloaded the program on teachers' laptops. However, at the end of the year, some teachers, including an ICT teacher, left the school as their duty school has changed.

Although teacher exchanges at school lead loses in education, new teachers have been doing their bests for students' education. These teachers also use educational technologies more. This situation has been reflected on students in a positive way as their motivation has increased in a great way. The new teachers also inform other teachers on how to use these technologies in classes. At the moment foreign language, geography, and science, teachers are using these technologies. The headmistress is trying to encourage other teacher to use educational technologies in classes.

The information and technology-based developments in the twenty-first century have caused some changes in the societal structures as well. The TRNC National Education System, which started a process on restructuring in 2005, has embraced the "learner-centered education" principle. The targets are set based on learners' needs. Teachers and administrators are ought to be able to used computer technologies as basic skills in the new, restructured education system.

Fast changes in technology lead changes in learning spaces. Learning space is not only limited in school. Electronic learning is also available through the developments in ICT, multimedia and communication technologies.

Social network is an important information sharing platform due to the wide use of the Internet. Internet is especially used in almost all societies as Web 2.0 (Facebook, Twitter, Blogs, etc.) social media tools. In today's world, use of social network became a necessity for individuals and communities. Internet has brought e-mail, e-education, social media, news feed, e-marketing, virtual friendship, etc., into our lives. Thus, it is crucial to channel social network into education systems and use it for educational purposes.

According to Gülbahar et al. (2010), social network, with its features, provide innovative, interactive and cooperative teaching, and learning opportunities for teachers and learners. It also increases learners' interaction among each other as well as with the teachers and the course content.

There are various studies about the effects of social networks on its users and the consequences for teachers and learners of using them for educational purposes. In one of these studies, Karakuş and Varol (2012) found that learners use Internet mostly for social network and spent at least 1 hour every day in front of the computer. Similarly, Koç and Karabatak (2011) showed that social networks are widely used by learners and this situation is almost like a habit.

Social media like Facebook does not only allow learner–learner interaction over a web-based communication platform but also allows teachers to communicate with learners over issues such as homework activities and resource sharing. It also allows learners to communicate with other learners for asking questions about the exams or homework and doing homework (Ekici and Kıyıcı 2012). Lepi (2012) stated that social networks have the power to improve teachers' and learners' communication skills. Some researchers argue that social networking sites support learners' learning process by enriching the process with text, video and audio materials; as well as supporting teachers teaching and assessment process.

Majority of the school teachers are able to communicate with the students over Facebook. Guidance teachers use Facebook to inform students who will move to higher education regarding the various announcement and other issues. Subject teachers created groups and are informing the students on homework, exam questions, and activities.

Students at Erenkoy Lycee are between 12 and 18 age groups. 12–14-year old are in the secondary school section while 15–18 year olds are in high school. There are 23 classes at school. In average there are 25–30 students in each class. And each two students share the same desk. However, students still show less interest on lessons, have absent days and spend most of their times on social media. They know how to use smartphones and computers very well even at school. This situation is observed almost at all schools on the island (Yıkıcı 2014).

Student profile has change in TRNC's education system. Students pay less attention in lessons and have not got a prospective goal, do not come to school regularly and spend most of their time on social media as they know how to use the technology very well. This is also seen in students of other school throughout the country (Yıkıcı 2014).

In the secondary school section, there are smart boards whereas in the high school section there are whiteboards in classes. However, some lessons of high school students are held in the two ICT rooms built by the Minister of Education. In these rooms each student has a desk. Geography, physics, and chemistry teachers do their lessons visually in these rooms. On some days, History teachers show videos in these rooms. On the other hand, via the fixed projector in the library, students watch presentations of guest authors and poets during Turkish Literature classes and involve in the lesson more effectively. Besides, in the Resource Center students watch films and presentations through fixed projectors. Form 6, 7, 8, 9s take applied ICT lessons in ICT rooms.

Classrooms which have smart boards are not connected to the internet available in the educational technology rooms. Teachers who are using smart boards are using their own Internet facilities for connection. The school is trying to find funding for Internet connection for the rooms with educational technologies.

There is Internet connection in the administration building. Internet is also available in the student council room, management section, resource center, and library. Teachers who use ICT rooms do their preparations in advance and give visual presentations to students. It is observed that in some classes, where teachers use visual resources, there are less problems with student behavior. Use of educational technologies provides more motivation and permanent learning. A teacher should constantly develop himself in order to update his knowledge.

There are also some circumstances when it is hard to use educational technologies. Crowded classes, students with different learning capacities, and bad student behavior are examples to these circumstances. Only two ICT rooms are not enough for high school students. As teachers need time to start the lesson with technological equipments, normal lesson duration (40 min) is not enough for them. Apart from this, teachers come to these classes from other classes and they consider this as a time loss and they avoid using these rooms. Sometimes more than one teacher wants to use the same room at the same time and as a result the rooms cannot be used effectively. The teachers who want to use these programs have the suitable hours involved in their lesson programmers. However, the level of using educational technologies is not as wished.

Fast growing information and technology has been increasing human needs too. As the frequency of introducing new technologies is increasing fast, the technologies in production and services are changing in short periods of time. Societies need people who constantly improve themselves and open to lifelong learning. Changes in educational technologies make teachers improve themselves as their students know how to use these technologies and pay low attention to classical methods. Students can reach unlimited information on the internet. Student's attention is also less on lessons because the curriculum is too busy.

Reflection of Educational Technologies on Classes

Use of educational technologies has not reached the extent that is aimed yet. Frequent exchange of teachers (due to location of the school) especially the ones who took in-service courses on educational technologies makes it hard to achieve the goals. As a school vision has been developed within 5 years, it is aimed to prepare students for further education and improve different skills of them. Headmistress always encourages teachers to improve themselves and use educational technologies in class. Headmistress also transfers needs of teachers to the Minister of Education and invite private university lecturers on different topics to the school through the minister. These lecturers give seminars to teachers which have been very useful especially for permanent teachers. An increase is observed in the number of teachers attending in-service programs on educational technologies. Teachers' motivation for using educational technologies was increased especially by the seminars on new educational technologies, information sessions on web-based education by the experts who came to the school. On the other hand, new teachers can use these technologies very effectively in classes. They also help other teachers on these technologies; however, they mostly leave school at the end of the year.

School council's financial support, which was earned from the rent of the cafeteria, on 2010 budget made it possible to buy the Smart school program. Thank to this program teachers' points of view on educational technologies have changed. It is observed that they save time and money by preparing lessons and entering marks using educational technologies. Their tendency to attend in-service courses on how to apply this skill in class has also increased. Administrators who could not use computers attended courses or had help of teachers who could use computers. Only a small number of teachers do not have computers. They can do their lesion preparations on school's computers which were bought by the school council. As there is internet connection in the administration building, they can do research and download materials via internet. Teachers' ability to use computers has recently increased. Before a couple of years most of the teachers, except ICT and Geography teachers, were not using educational technologies to develop a more effective teaching and learning processes. They were not feeling ready to use these technologies. They were telling that lesson preparations for these technologies were tiring and time consuming,

School teachers highlight that they do not receive sufficient training regarding the use of technology and are not able to follow the rapidly developing technological tools. Same incident is observed on teachers who use educational technologies. According to the studies of Oakes and Martin (2002) and Haydn and Barton (2007), it is emphasized that teachers are not using educational technologies as a mean of improving learning during the term time and they do not feel ready to use these technologies.

Although it is not still at desired level, some branch teachers have started to use educational technologies. Despite this, some teachers still believe that the classical methods of teaching are the most effective ones. A whiteboard and board markers are enough for them to teach. They believe that teachers should be active and students should be passive in class. Busy curriculums, limited time for teaching all the topics obstruct teachers to use educational technology rooms. In the questionnaire which was held in 2015, under 38 teachers, was questioning the extent to which teachers use computers and internet to meet various teaching objectives. 18 teachers with 0–9 working years, 16 teachers with 10–20 working years and 4 teachers with 21+ working years attended the questionnaire and 24 said they had ICT lessons at the university while 14 said they did not had such lesson at the university. 13 of them attended in-service courses on computers. Most of the teachers are found to use the internet to communicate on social networks (Facebook, twitter etc.), ($f = 34$), some others use it to do research (31), to prepare lesson notes (26) to find additional materials for teaching (26), to read newspapers (25), to do shopping, listen to music, watch films (22), to send and receive mails (21), and play games (12).

It is mentioned that teachers spend 2–3 h a day (20), a few hours a week ($f = 13$), and 5 h a day ($f = 5$) on computers. 50 % of teachers who are working between 0 and 9 years spend 2–3 h, 27.77 % spend 5 h, 22.22 % spend a few times a week on computers whereas 50 % of teachers working between 10–20 years use computers 2–3 h a day, and 50 % 2–3 h a week. Teachers who have been working 21+ years said they were using computer 2–3 h a day.

All of the teachers can use internet. However, they are not always reflecting this on classes. It is interesting that these teachers spend 2–3 h a day on computers and internet, but they do not reflect this on classes.

There is not a government policy on how to integrate new educational technologies in classes. As it is not regularly controlled what teachers are doing in class, some use classical teaching methods. Some crowded classes, sitting arrangements (two students sharing a desk), active teachers, and passive students make it hard to bring education to the aimed level. Yıkıcı (2014) found out that headmasters has been doing works on technological equipment's and usage of these equipment's in their schools; however, it is up to teachers whether to use these technologies or not. Some participants mentioned that the headmasters encourage them to use smart boards but they are not using them. Headmasters also said that they have financial problems and handicaps in developing education and teaching in their schools (Yıkıcı 2014).

Case Study 2

Polatpasa High School is one of the cases in this study. There are two computer laboratories at this school. Each of these has 20 student computers, 1 teacher computer and 1 data projector. One of these laboratories has internet connection and this laboratory is used by the teacher and students if a lesson needs the use of the internet. Otherwise the other laboratory is used by students and teacher. Also there is a foreign language laboratory which is used by the English lesson teachers. It contains 20 student computers and a teacher computer with head speakers and English teachers use this laboratory for their listening and speaking lessons.

There are 13 smart boards at 6, 7, and 8 classrooms. Teachers can use these smart boards if they think that it is necessary or useful for their topic. Also there is a normal room that has a computer, a data projector, and a smart board. So classes who do not have smart board can use this room if teachers decide that it is useful for their lesson topic. There is a chart for this room and each teacher writes their name on a list when they will use this room. There is a Wi-Fi connection at our school which is for teachers. There's a school software that is used for preparing grade reports, holding student data, and preparing all other reports related to students and school work. First of all our goal is to teach students how to use a computer and then to improve their abilities to use the internet in searching for useful information. Also, ICT courses cover informing students about the digital literacy and threats of using internet.

School administrators always try to follow the improving changes and try to find financial aid either from the ministry or from the big companies or from charities. Sometimes they organize activities in order to supply expenditures. They usually announce the teachers the seminars or meetings which will be useful for them. But in fact it is very expensive for us to renew both the computers and the programmers.

Students are mostly the secondary school students who are between the age of 11 and 15. At these ages it is compulsory for our students but after 15 years of age it is optional.

In order to improve our teachers' ICT competence in our country, first of all we need enough computers for our teachers to use whenever they want. Then the computers must be in good conditions and must be able to connect to the internet. Also the teachers can get print out whenever they might need it. Beside these during the lesson each student should have a separate computer and use it alone by himself or herself.

Case Study 3

Canbulat Secondary School is one of the parts of this project case study. Nowadays, technology is one of the most important aspects of our lives. Everything depends on technology such as health, education, entertainment, etc. Therefore, it is important to improve teachers' ICT competence to be able to follow modern trends in education and be able to use technology in classrooms for quality in learning and teaching. The school administrator provides cd players for listening lessons, smart boards, internet and projectors, etc. Ministry and school administrator provide workshops and training to be able to use technology in class. The effectiveness of these attempts needs teachers' willingness and competence.

The rapidly developing Internet and computer technologies provide opportunities or teachers working in schools to efficiently pursue teaching-learning services. A teacher can use the computer setting to prepare forms, graphics, and audio and animated presentation using all the materials, they can reach from all around the world which this school has infrastructure. In addition to these, computer technologies influence the education sector in terms of: accessing and sharing information; distance education; professional guidance; suggestions for the problems of students and parents, online announcements via video conferences, communication via e-mail, distance support systems, and receiving supervision. However, this school has no virtual learning environment.

Internet makes it easier to provide the opportunity of reaching the course material any time and whenever needed through the Web. Conducted researches pointed out that teaching profession with computer and Internet technologies has significant impact on qualified profession that meets the needs of the twenty-first century. There are various studies on teachers' computer use competencies, benefitting from computer technologies in educational services and ethics of providing such services. These studies show that teachers benefit from computer technologies if they know how to use technology in teaching and how to increase learning atmosphere.

The use of the Internet and computer technologies in the teaching–learning field. In addition to this, it is highlighted that it is easier to reach the social structure around the student, parent, and the school more efficiently using the Internet and computer technologies in a strategic way.

It is observed that the use of computer-based technologies, which attracts attention from many different disciplines due to the efficient innovations it provides in opposite to the traditional methods, is a necessity in the modern service understanding of the teaching–learning sector.

In order to understand how close or how far the teachers, who provide services under the influence of the technological improvements, are to the technology-based modern service understanding; it was found that the following two points are crucial: (a) teachers' computer competencies; (b) knowing for which teaching-learning services they benefit from the computer technologies in schools.

It is a reality that you are in a different classroom setting than the classical classroom when you are teaching in a classroom using computers. Thus, you may need to practice different techniques for classroom supervision. In that case, teacher should be the person guiding the information rather than the one transferring it. Although teachers have abilities that could be developed through trainings; they suffer from infrastructure and digital literacy competencies.

8.4 Innovative Attempts of ICT Competence and Communication

Project-based actions with significant evidences for practical implications are very crucial for developing ICT competence and technology acceptance within the education system. Significantly, awareness of ICT competence and digital literacy through trainings for all target groups are very necessary in developing countries. Although this is innovative attempt to diffuse technology competence for enhancing learning and teaching process and digitalizing management process in school environment, there are small innovative steps achieved within the education system.

Furthermore, listed achievements below can be concrete example as evidences or practical model to diffuse those implications to the whole system.

Digital Management and Technology Acceptance

With a large scale of research study, Akcil et al. (2014) investigated readiness of the education system for digital management within school environment. The technology acceptance and the awareness of the headmasters and teachers within the schools were investigated to examine the situation analysis of the ICT applications within the schools. Upon the results, headmasters as leaders have awareness of ICT competence, however trainings are necessary to diffuse the update knowledge and experience in digital management and leadership. Furthermore, trainings were delivered to Ministry of Education personnel to increase the awareness of the ICT competence, digital management and leadership from top to down management.

Digital Citizenship and Leadership

The action research is one of the significant evaluative tools which propose change and development within its nature. Based on action research learning cycle, Akcil et al. (2014) investigated awareness of headmasters, teachers, and students upon digital citizenship and increased the ICT competence through trainings of those participants. This research also shows how school culture can be developed through considering digitalization and participative management for change and development as a model of practice. In addition, Akcil et al. (2014) investigated practical implications of digital leadership within school culture. The research study shows that headmasters of the schools in all levels; primary, secondary, vocational and high schools need further trainings to digitalize education system and implement digitalization to the whole system

ICT Competence in Special Education

Unobstructed information technologies for disabled learners and special education have potential impact on enhancing needs of the learners within the education system. Altinay and Altinay (2015) reported the evaluation of ICT competence and standards in the schools which encapsulate special education. The report underlines that technological infrastructure and applications of those infrastructures require training. Furthermore, research shows how ICT can be innovative for learning of disabled learners and learners who have special needs.

8.5 Conclusion

This study discusses how to develop teachers' ability to use the contact information in public schools. Educational technology equipment of the school carried out by private universities, parent–teacher association and training volunteers beside the ministry support. The use of educational technology is not mandatory; it depends on the teachers' request. Despite educational technology in classroom in secondary schools, the number of teachers that use it is not at the desired level. The educational technology rooms are inadequate in schools. More than 50 % teachers specify that they take two or three hours a day on computer and internet use but very small number of these teachers prefer to use computers in education. The majority of teachers do not feel ready to use this technology. The ministry and school considering teachers' need in-service training activities. The service training issues is focused on basic skills required for training in the twenty-first century and the importance of using websites in education. Educational technology in education is significant for school, administrative jobs, guidance jobs, and teacher's seminars. This is a motivating act. Involving profession with the support of technology, teachers, and administrators can improve their digital literacy skills. It has been observed that teachers help each other for the new trends which show their enthusiasm. The education ministry should make mandatory in-service training activities for digital citizenship, digital literacy.

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Chapter 9
An Italian Pilot Experience in Game Making for Learning

Jeffrey Earp, Francesca Maria Dagnino and Ilaria Caponetto

Abstract School systems worldwide are coming under increasingly pressure to prepare young people to become active, capable and resourceful members of the rapidly-changing knowledge society (Jerald in Defining a 21st century education, Center for Public Education, 2009). While digital technologies can undoubtedly play a key role in *facilitating* this process, their use in formal education does not embody the shift per se. Meeting such demands necessitates broader, more deep-seated change, including the integration of active, student-centred learning approaches that engage learners in a holistic manner: cognitively, affectively and socially (Ananiadou and Claro in 21st century skills and competences for new millenniumlearners in OECD countries, OECD Publishing 2009). A cornerstone of this change is addressing and nurturing so-called twenty-first century skills, such as critical thinking, problem solving, collaboration, learning-to-learn and creativity. This chapter reports an Italian pilot experience that investigated the potential of an innovative educational strategy—digital game making for learning—for activating transversal twenty-first century skills in primary schools. These activities were part of a pan-European project called Making Games in Collaboration for Learning (MAGICAL) that took place from 2011 to 2014. Led by the Institute for Education Technology (ITD-CNR), MAGICAL investigated the viability and educational added value of game making in a range of educational settings, covering both classroom practice and teacher education and training.

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9.1 Case Overview

This case study draws on a pilot experience investigating learners' digital game making as an educational strategy for adoption in schools. It was one of a series of classroom pilots run within an EC project called MAGICAL—Making Games in Collaboration for Learning.[1] The main research aim of MAGICAL and of the reported pilot was to investigate the viability and educational added value of digital game making, especially for supporting transversal twenty-first century skills such as collaboration, creativity, problem solving and ICT literacy.

The experience was conducted by three researchers from the Italian Research Council's Institute for Education Technology (ITD-CNR).[2] It took place towards the end of the 2013–14 school year at a primary school located in the city of Genoa in northwest Italy. Three third-grade classes and two fifth grades took part, with an overall participant population of 102 students and eight teachers. For this pilot, a digital game-making platform called Magos Lite[3] was employed. This was developed within MAGICAL for adoption in the project's field experiments and also for use by the education community at large.

In planning and implementing the experience, the research team adopted a design-based research approach (Cobb et al. 2003), and drew on specifications defined within MAGICAL for performing field activities and for gathering related research data. The specifications included a reference activity scenario comprising an initial phase of teacher introduction and preparation, a sequence of three ninety-minute classroom sessions for each class involved, and subsequent debriefing for both students and teachers. Data were gathered through the entire sequence of pilot activities using the project's proscribed research protocol and tools.

This chapter begins by examining the rationale behind digital game making as an approach to learning and also the strategy that was adopted for implementing and deploying this approach in the field. Subsequently, the tools and methods adopted in MAGICAL pilot activities are described, and a description is given of the particular context and population involved. This is followed by an account of the activities that were carried out in the case study. Finally, an overview of results and outcomes is given, together with some general considerations about the lessons learnt, the open issues and the prospects the authors see for digital game making as a means for educational innovation.

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[1] http://www.tinyurl.com/magicaldoor.

[2] http://www.itd.cnr.it/.

[3] http://magos.pori.tut.fi/.

9.2 Background

9.2.1 Overview of ICT in Italy's Schools

The pattern of ICT use in Italian schools is varied, with isolated pockets of consolidated integration, even excellence, set against an education landscape that is largely resistant to innovation generally and Technology Enhanced Learning (TEL) in particular. A number of underlying structural conditions make it especially difficult for TEL practices to take root and spread in Italy's school system. To begin with, the country has one of the lowest levels of education funding by GDP in the OECD (although on a per-student basis spending is average), as well as the oldest, most stagnant teacher pool (OECD 2014). At the same time, successive national governments have sought to introduce their own particular raft of education reforms and initiatives, including measures to address the ICT shortfall and kick-start the uptake of TEL. This has led to volatile educational policy-making and a tendency towards short-term measures that have relatively little knock-on effect or sustained impact in the longer term.

Compared to other developed countries, access to digital technology in Italy's schools is low (European Union 2013). In 2011–2012, computer-to-student ratios in primary schools was six per 100 (EU average 14.5) and 80 % of students attended schools with low or inexistent internet connectivity. The ratio in lower secondary schools is little better: 8.3 per 100, putting Italy near the bottom of EU rankings (average 21.1). Only 6 % of Italy's students attend schools with advanced digital equipment against an EU average of 37 %.

Computers in schools are generally confined to separate computer labs with often outdated equipment and low levels of technical support. Recent promotion of interactive whiteboards has resulted in numerous schools introducing an IWB in one or more classrooms, although indications are that, like computer labs, these are used on a fairly sporadic basis, and usually by a small core of the teaching staff. The use of networked tablets and other mobile technologies is confined to isolated experimentation.

Over the years, major efforts to boost ICT use in schools nationally have tended to focus on the provision of technological infrastructure, with other aspects confined largely to piecemeal, experimental undertakings. A key exception was the ForTIC programme launched in 2000 and overseen by the special government body responsible for ICT in schools, INDIRE[4] (Schietroma 2011). ForTIC centred on professional development, engaging a total of 180,000 teachers, or 20 % of the entire teaching population. It culminated in delivery to these participants of 12 h of formal training (six face-to-face plus six online), which, in addition to being limited in scope, also varied widely in quality across the country. Although schools gained in terms of technological infrastructure through ForTIC, its ultimate impact on actual teaching practices was very limited (Bottino 2003).

[4]http://www.indire.it/.

The most recent large-scale ministerial programme, the National Plan for Digital Schools, was introduced in 2009 (Bottino 2014). This programme comprised a set of separate actions, the chief among was dedicated to interactive whiteboards and included funds for their procurement and deployment in schools. Another action, called *Cl@sse 2.0*, was designed to promote the integration of ICT-based learning environments in daily school activities and involved 416 individual class-level projects proposed and led by participating teachers. Later, in 2011, an experimental action called *Scuol@ 2.0* was launched targeting whole school level. This investigated the organisational and management implications of ICT-based educational innovation through experimental field studies conducted in 14 testbed schools. Another branch of the plan was dedicated to supporting wider access to commercial digital content for educational purposes.

The targeted development of practitioner attitudes and competencies that underpin the uptake of TEL and sustain innovative practices have tended to take a back seat in terms of policy and implementation. In part, this reflects the lack of solidly established, systematic Initial Teacher Education (ITE) and Continuous Professional Development (CPD) in Italy. These have only existed in the past decade or so; formerly, teacher preparation consisted in gaining a degree in the relevant subject area. Present ITE syllabuses do address the acquisition of digital competences, as foreseen by the 2006 Recommendations of the EU Parliament and Council, but this remains a fairly limited segment of teachers' professional preparation. Over the past decade, some online teacher training in TEL has been provided via INDIRE, and this is now directed exclusively towards newly-appointed teachers.

In recent years, restrictions on the type of material that teachers in Italy could adopt for classroom use have been lifted, allowing adoption of digital content as well. Indeed, all school textbooks must now be available in both print and digital formats, a measure originally introduced to meet accessibility regulations set out in social inclusion legislation. In addition, under certain cost conditions, schools can also use digital content of other kinds, including material developed in-house by teachers themselves, provided this is then submitted to the Education Ministry for registration and sharing within the school network.

As a disciplinary subject in its own right, computer science is only taught in technical-oriented high schools. However, the 2015 Education Act (passing through parliament at the time of writing) includes, among other ICT-related measures, a policy initiative to promote coding and computational thinking in primary schools. The aim is, by 2017, to involve 25 % of all primary schools in an optional Hour-of-Code-style programme, with 9 % being involved at a more advanced level.

In the European context, the involvement of Italian schools in EC initiatives promoting ICT-based innovation is reasonably strong overall. The Commission's main funding programmes for education-oriented projects, such as the former Lifelong Learning Programme and the current Erasmus+ programme, attract solid involvement from Italy's education sector, as do projects run by EUN like e-Twinning. However, while these initiatives often generate very satisfactory outcomes for the organisations and actors directly involved, they do not have a significant knock-on effect leading to upscaling of innovative practices through Italy's school network.

9.2.2 Assumptions and Objectives

There is now general acceptance of the need to bring about a radical shift in education so that school experience helps young people acquire the means to become active, capable and resourceful members of the fast-changing knowledge society (Jerald 2009). The harnessing of digital technologies in formal education can undoubtedly act as a *facilitator* of that shift but it does not embody the shift itself. The sort of radical change that is increasingly expected and demanded is more deep-seated. It requires active learning approaches that address and engage learners in a holistic manner—cognitively, affectively and socially—and that generate student-centred learning (Ananiadou and Claro 2009).

Active learning approaches emphasize the enhancement of learner engagement and, crucially, the development of skills that contribute towards greater learner autonomy, resourcefulness and self-regulation (Newman et al. 2014; Anderson et al. 2007; Bell and Kozlowski 2008). These qualities play a vital role in developing the problem-solving skills now required to cope with the emergence of new—often unforeseen—challenges in the scenario of rolling change we associate with twenty-first century life (Edens 2000).

Until fairly recently, the flag of what are now commonly dubbed twenty-first century skills—critical thinking, problem solving, learning-to-learn, collaboration, creativity etc.—was waved largely by progressive educationalists and the academic *intelligentsia*. Now it is also being picked up vigorously by key players in business and industry, many of whom see these skills as core requirements (Shapiro et al. 2011, p. 32). Educational policy makers are not deaf to these calls, even within largely innovation-resistant national systems like Italy's. A clear example is the policy whitepaper for Italy's 2015 Education Act, which, as well as addressing pressing macro-management issues, recognizes digital literacy as a priority and promotes the formation of creative, entrepreneurial "digital maker" students from the earliest age (MIUR 2014—pp. 95–97).

In Italy, as elsewhere in Europe, the technological boundary conditions for implementing such actions are largely in place. On the whole, schools are reasonably well endowed with ICT infrastructure and primary schooling in particular is generally characterised by a certain degree of curricular, methodological and organizational flexibility. However, teachers often lack the confidence, know-how, and support they need to adopt the innovative practices that digital technology use can facilitate.

These concerns were, and are, firmly in the minds of the education researchers who participated in MAGICAL, a European project co-funded under the Lifelong Learning (now Erasmus+) Programme (Bottino et al. 2012). These researchers joined forces to investigate the viability and added value of digital game making as a means for supporting deep-seated educational innovation. They consider this approach to be a fabric in which different theoretical and methodological threads (e.g. constructionism, social constructivism and collaborative learning, Technology Enhanced Learning, Game Based Learning) are tightly interwoven (Bermingham et al. 2013). As a teaching/learning approach, digital game making is seen as a way of positioning Game Based Learning (GBL) within an active learning framework. This can support learners' generative processing (Mayer 2005) by setting a dual challenge: to select and organize information forming the core content of the game and, at the same time, to determine how the parameters, behaviours and rules driving playful interaction with that content will be fashioned towards a game experience (Kafai 2006; Games and Squire 2008; Brennan and Resnick 2012).

The central research aim of MAGICAL, and of the reported pilot, was to investigate the viability and educational added value of digital game making, especially for supporting transversal twenty-first century skills. For this purpose, MAGICAL implemented a series of pilots in (mostly primary) school classrooms located in different European countries, including the experience reported here, which was carried out in northwest Italy.

In the first instance, these pilots offered the chance to test (a) the methodological approach that MAGICAL had devised for implementing game making as a classroom innovation and (b) the tools and resources it adopted or developed for that purpose. Interest here focused on identifying and monitoring emergent factors effecting the overall feasibility of the approach and, more generally, of game making as a digitally-based, active learning-by-doing approach to primary education (Ackermann 2004; Fat 2010).

Focusing more closely on the learning process, the main objective was to understand whether—as hypothesized—game making actually leveraged the targeted transversal (or soft) skills, namely creativity, problem-solving, collaboration and ICT literacy. These form part of the wider twenty-first century skill set considered an integral part of an active and productive life in the digital society (Trilling and Fadel 2009), a set that also includes communication, social and intercultural awareness, digital literacy, critical thinking, learning-to-learn, self-direction, planning, flexibility, risk taking, productivity in a globalized world, conflict management, resourcefulness and entrepreneurship (Voogt and Pareja Roblin 2012).

With the present growth in the popularity of GBL, the range of digital tools and platforms available is rapidly increasing, and these include many easy-to-use game authoring tools suitable for educational use of different kinds.[5] Some of these, like Kodu,[6] GameMaker[7] and Scratch,[8] are based on visual programming and are

[5]MAGICAL online community library of digital game authoring platforms—http://amc.pori.tut.fi/game-building-tools/.

[6]www.kodugamelab.com/.

[7]https://www.yoyogames.com/studio.

[8]https://scratch.mit.edu.

increasingly being adopted in the growing push to encourage young people to learn coding and acquire computational thinking skills. At the same time, we are witnessing a boom—both inside and outside education—of user-generated content generation in gaming contexts, mainly on open-ended, “sandbox” platforms like Minecraft (Ekaputra et al. 2013) but also via player modding of commercial entertainment games aimed at the youth market (Mehm et al. 2012).

However, even with these advancing trends and the ever-increasing advocacy of GBL adoption at practitioner, policy-making and research levels, there remains something of a shortfall in our understanding of digital game making for learning. It is this gap that the MAGICAL field experiences—including the pilot reported here—sought to address. Targeted issues included the precise impact that game making can have on learning, how best to approach and manage classroom deployment, integration within school curricula, and assessment of learning outcomes.

As well as producing research-based evidence, MAGICAL generated and tested assets intended to help practitioners run game making activities in the wild. Chief among these is Magos Lite, the main—but not sole—digital game authoring platform adopted in the field activities (see below). Others include a digital tool educators can use to design and plan out game making classroom activities, a kit for training practitioners in game making, as well as guides to implementation. These are described in the Outcomes section.

9.2.3 *Initiative Description*

This case study is drawn from the pool of 37 classroom experiences that MAGICAL conducted in 2013–14 in the four partner countries—Belgium, Finland, Italy, UK—as well as in Greece. These pilots involved around 600 students and teachers in about 150 h of classroom activities carried out for the most part in mainstream primary schools; some pilots were also performed in centres dedicated to Special Education Needs (SEN) as part of the project brief to investigate how digital game making might fit into an inclusive approach to learning.

The overarching intention in these pilots was to give teachers and their young learners the means and opportunity to engage in digital game making activities in the classroom as part of a full iterative cycle of team design and production, peer play-testing, peer review, feedback assessment, versioning and publication.

9.2.4 *The Digital Game Making Platform*

While some different editors were adopted in MAGICAL experiences, the bulk of the pilots—including all of those run in Italy—were performed with a single-user browser-based platform called Magos Lite: see Fig. 9.1.

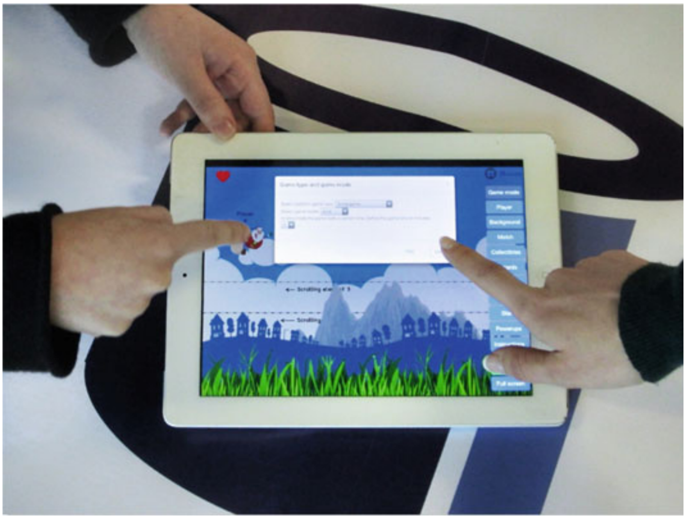

Fig. 9.1 Digital game making using the Magos Lite editor

This tool was developed by the MAGICAL consortium's technological partner in Finland for use in project pilot activities and, ultimately, for supporting wider game making uptake in the wild. Learners as young as seven or eight can use Magos Lite to produce and share simple side-scrolling educationally-oriented games. To do so, they can work on a desktop computer or tablet, either individually or—ideally—in small face-to-face teams. Importantly for use in the reported case study, the platform is available in Italian and Finnish as well as in English.

Having participants experience the full iterative cycle of digital game making foreseen in the MAGICAL pilots imposed some key boundary conditions. In the first instance, the adopted platform had to have a very low entry threshold and shallow learning curve. This was necessary to ensure that:

- students as young as eight could manage to produce a complete game with a reasonable degree of autonomy;
- teachers without previous digital GBL experience could use the editor confidently in the classroom without lengthy training and preparation;
- managing operational aspects of editing functions would not totally dominate participants' attention;
- the full classroom cycle of game play, game making, play-testing, peer review, feedback assessment and game revision could be completed in a narrow, five-hour window of available class time.

Meeting these requirements obviously had an impact on the kind of game design experience that could be enacted in the pilots and, more specifically, on the characteristics of the editor that learners would use. Magos Lite offers a single default mode of game interaction: an arcade-style, virtual side-scrolling format in which the

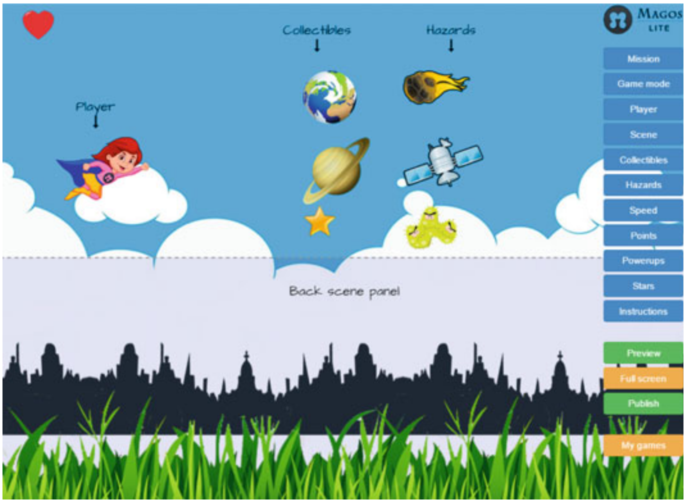

Fig. 9.2 Magos Lite game editor

player catches or dodges incoming collectibles/hazards. The overarching aim is to accrue maximum points in a set time, or over a given virtual distance, or while retaining game life.

The game editor interface presents game design as a semi-guided, step-by-step decision-making process. Authors work through a simple authoring template (see Fig. 9.2), selecting key game elements to include (player avatar, backgrounds, collectibles, hazards, etc.) and setting some basic game parameters.

Parameters include the game's overall goal type as well as game behaviours such as avatar control/movement, speed/interval of incoming collectibles/hazards, scoring regime (points earned/deducted for successes/failures), reward assignment, etc.: see Fig. 9.3.

Authors also add a "learning mission" to their game by providing some textual learning content that will ultimately appear as collectibles/hazards in the game, along with the chosen graphic collectibles/hazards. This content can either be a number set for one of the two maths-oriented game formats available, or a set of correct/incorrect text items for any subject: see Fig. 9.4.

Authors package their games for sharing with peers by including a title, a description, instructions, and a thumbnail ID image.

While certainly posing limits, this semi-guided template approach facilitates the deployment of game making activities in the primary school classroom and makes Magos Lite an ideal entry-level platform for inexperienced game makers at middle school level as well. The presence of the exercise-oriented "mission" function (Fig. 9.4), while not a cornerstone of MAGICAL investigations, has a number of advantages. It helps draw learners' attention to the ultimate goal, playability and cognitive load of the game they are producing, and encourages them to consider the end-user perspective, something which is at the heart of design thinking (Games

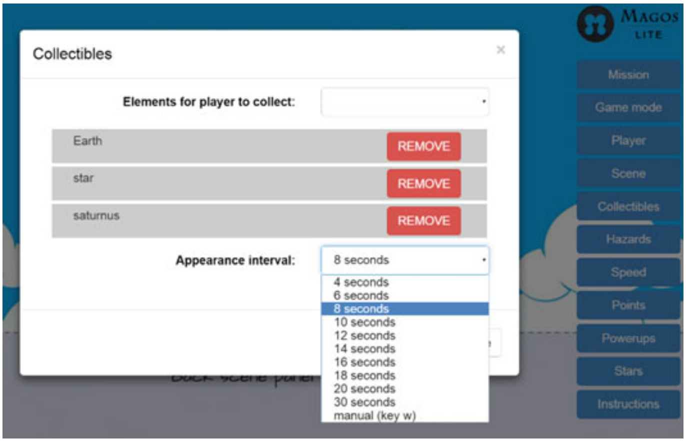

Fig. 9.3 Setting behavior of collectibles in the Magos Lite editor

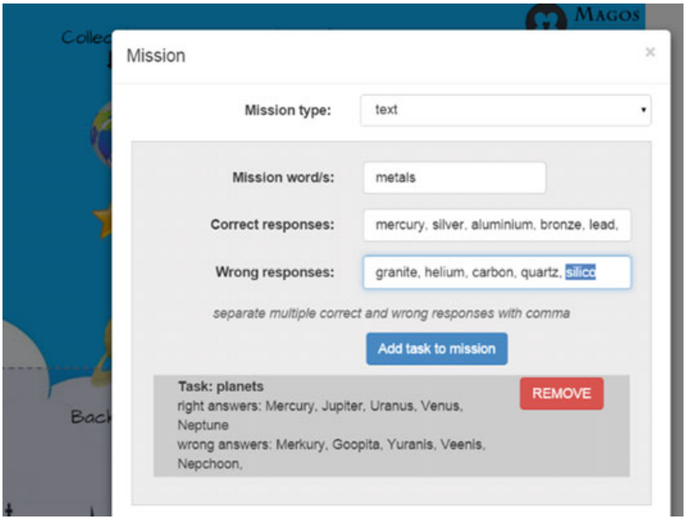

Fig. 9.4 Creating the game's "learning mission" in Magos Lite

and Squire 2008). From the teacher's viewpoint, the mission function renders game making activities easier to link up with the curriculum framework, which facilitates uptake and also helps when proposing game making as an educational activity to school authorities and parents. In addition, it can give the teacher extra scope for cross-class involvement, e.g. by having fifth graders produce games with learning content designed for younger fourth or third graders.

From the operational viewpoint, Magos Lite is a cross-platform, browser-based application that is cost/advertising free and covered by open-source licensing.

These technical characteristics make it particularly well suited for school use. Indeed, in some European countries, the installation of additional programs or plugins on school computers is prohibited outright, making a number of game editors totally off-limits.

The above-listed characteristics differentiate Magos Lite from many other game making platforms designed (or at least suitable) as core components of digitally-enhanced learning environments. A number of education-oriented editors like Scratch and Kodu give young learners the opportunity to grapple with the fundamentals of programming logic through learning and mastery of a visual programming language. Other tools such as Sploder (to name an example aimed at the recreational gaming community) feature relatively high-level visual editors that provide a palette of combinable game operators and objects, a number of which embed pre-set behaviours to facilitate game creation and render the game ultimately more lively and interactive (Dagnino et al. 2014). As part of learning environments, editors like these offer significant educational affordances, provided adequate time/effort investment can be made in terms of technical preparation, teacher training and preparation, and student time-on-task inside and outside the classroom. Where there are limitations on such resources, the "light" approach exemplified by Magos Lite could offer a entry-level alternative with some distinct practical advantages for deployment.

9.2.5 Learning and Innovation

In addition to the digital platform employed for game making purposes, the other (tightly interconnected) factor underpinning MAGICAL piloting is the specific methodological approach followed for implementing digital game making activities in the classroom. As mentioned, research interest centred on the potential of digital game making for activating twenty-first century skills like collaboration, creativity, problem-solving and ICT literacy. These are seen as pillars for innovative, student-centred learning processes considered suitable for modern learning that responds to current societal conditions and requirements.

Assessing such transversal skills is a complex endeavour at the best of times, let alone when it concerns very young learners in 'real' educational settings. This makes benchmarking and quantifying gains through standard techniques like pre-post testing problematic. The MAGICAL approach, therefore, was basically qualitative, relying on structured researcher monitoring and analysis of participant perceptions to determine the *activation* of these skills. The nature of learner interaction with the digital game making platform certainly constituted a core locus of that investigation. However, attention was also directed towards the overall methodological approach adopted and how its deployment impacted on the enacted teaching and learning processes.

This strategy is in line with the tenets of design-based research, which underpinned the overall research effort in MAGICAL (Earp et al. 2014; Barab and Squire

2004; Cobb et al. 2003). This approach recognizes that “the enacted intervention is a dependent, not an independent, variable” (Hoadley 2004, p. 204) and that in a sense “… the intervention (itself) is the outcome” (Design-Based Research Collective 2003, p. 5). Indeed, in educational innovations piloted in real settings, the ‘playing field’ is complex, not wholly controllable and anything but level. This is partly because to investigate the innovation in question the researchers need to make it ‘work’, i.e. (help) engineer a successful operational instance in a setting shaped, at least to some degree, for that specific purpose. So classroom pilots tend to embody or even express a given research agenda, rather than act as the ‘objective’ testing grounds that many assume them to be (Field and Hole 2003).

In addition, the innovative dimension of the general implementation methodology and the teaching-learning strategies that were enacted lay in situating learning-through-game-making as a social endeavour: team-based game production forms part of a cycle that also includes peer play-testing, peer review, feedback assessment and game versioning. The intention is to give young pupils to chance to experience learning by doing as part of a *collective* effort that entails both design thinking and taking on joint responsibilities.

9.2.6 Intervention Plan

All the field pilots conducted in the MAGICAL project were based on a reference scenario serving as a guide for deploying classroom activities and on a protocol for gathering related research data. As summarised in Fig. 9.5, this scenario comprised an initial step of teacher introduction and preparation, a sequence of three ninety-minute classroom sessions for each class involved, and subsequent debriefing for both students and teachers. Research data were gathered at all stages.

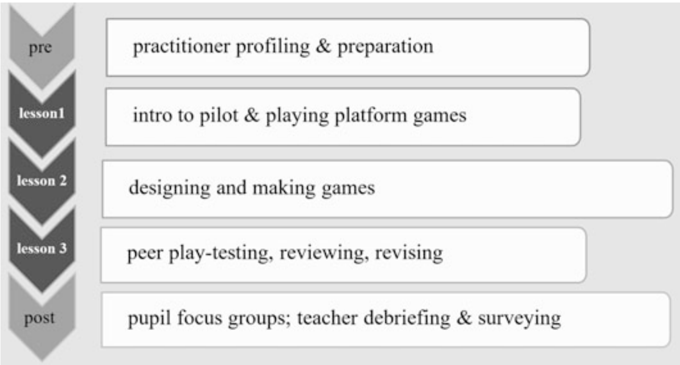

Fig. 9.5 Reference scenario for MAGICAL school pilots

9.2.6.1 Preliminary Session (for Teachers)

Activities—Presentation of the project and overview of GBL and game making. Introduction to, and practice with, game platform and editor. Joint negotiation and consolidation of pilot activity sequence. Questionnaire administered.

Rationale and expected outcomes—teachers acquire:

1. basic understanding of the theory underpinning GBL and game making
2. an appreciation of the pilot rationale and co-ownership of its objectives
3. familiarity with the platform and its potential affordances for learning
4. a clear sense of their role within the pilot and co-ownership of its implementation
5. readiness to prepare and run the class activities.

Data is also gathered on teachers' attitudes to and experience with gaming and GBL. These serve to establish entry-point teacher profiles.

9.2.6.2 Class Session 1

Activities—Introduction to the pilot experience and to game making. Walk-through of the platform and the different game types available on it. Intensive game playing in groups with teacher supervision and support where needed. Class walk-through of the game editor with explanation of the authoring process. Game making task set for Session 2. Questionnaire administered to gain learner profiles and benchmark their attitudes to the intervention.

Rationale and procedure—Learners' view of the design cycle necessarily commences with a concrete experience from the user/player perspective. The aim is that they become aware of the principles governing game play on the platform so that, when they are walked through the authoring process, they have (a) an initial understanding of what effects the editing functions actually produce and (b) an initial impression of how those functions fit together in the generation of a new game. The game/s played in this session can be drawn from examples previously created by the teacher/s during the preliminary phase and/or by learners in other classes. In either case, a constructively critical view of the game/s played is positive and is encouraged (*Anything not quite right here? What would make it better?*).

Expected Outcomes

1. group consolidation
2. familiarisation with game formats and mechanics
3. awareness of authoring process, dynamics, tools and imminent game making task

Learner profile data gathered, including attitudes to and experience with gaming for benchmarking.

9.2.6.3 Class Session 2

Learners work in teams on the collaborative design and creation of games according to the established task/indications. Teacher monitors and provides any critical support needed but allows learner autonomy and encourages intra/inter team support. Teams are encouraged to playtest, review and revise their game/s iteratively. Researchers perform focused monitoring.

Rationale and procedure—This is the main arena for emergence of twenty-first century skills. Special attention is focused on the way individual team members contribute and interact, and how the group works together to produce a playable game. Teacher provides critical support and also acts as facilitator and orchestrator, allowing space for pupil autonomy and encouraging them to seek practical help from teammates and other classmates. This activity can be continued/completed out of class, provided teammates make suitable agreements to do so during the session and communicate the intention to the teacher.

Expected outcomes

1. practical mastery of game editor, its functions and use
2. experience in and appreciation of game authoring as a process
3. grasp and critical appreciation of the aspects that make a game more or less playable
4. understanding what it means to design for others
5. activation of twenty-first century skills
6. awareness of the collaborative process and responsibility for its management.

9.2.6.4 Class Session 3

Groups playtest one or more games produced by other teams and peer-review these. Groups then assess feedback received from the other team/s and decide whether/how to modify their game accordingly. In a mediated plenary discussion, class shares and reflects on personal experiences/performance, the process and the outcomes. Questionnaire administered to gain qualitative data on learners' perceived experience of the intervention.

Rationale and procedure—teacher pairs off teams for peer assessment. During playtesting, groups complete a simple game assessment sheet prompting both positive and negative comments. Groups exchange sheets, discuss feedback received and decide on any modification to implement in their game (also by borrowing ideas gained from playtesting). In the plenary debriefing, the teacher prompts students to recount and compare different aspects of their individual experience, helping them to identify benefits and challenges, and reflect on their experience as a whole.

Expected outcomes

1. experience of a collaborative peer review process and awareness of the joint responsibilities this entails in a learning community
2. appreciation of designing for others within an iterative game authoring cycle
3. finer grasp and critical appreciation of the aspects that make a game more or less playable
4. activation of twenty-first century skills
5. emergent signs of metacognition regarding the learning process undertaken
6. student feedback data.

9.2.6.5 Post Class Debriefing Session

Detailed feedback on learner experience gathered via a six-member focus group. These include a desirability-testing activity to generate spontaneous learner statements and opinions. Semi-structured interviews on the pilot experience and its outcome also held with the teacher/s.

Rationale and procedure—Gaining reliable learner experience data from very young pupils is complex, in part due to the Hawthorne effect (Cook 1962), their innate tendency to appease authority figures. Accordingly, a desirability-testing activity[9] was run that is based on the Microsoft Reaction Card Method (Benedek and Miner 2002). This is designed to generate a body of (relatively) unconditioned statements about aspects of the intervention that the subjects choose of their own volition.

Expected outcomes—Participant feedback data for the qualitative evaluation of the pilot experience and for analysis of outcomes related to the core research questions. These data supplemented the feedback from the entire learner population, teacher interviews, and the structured monitoring that the researchers carried out during class activities.

9.2.6.6 Intervention Implementation

In the reported pilot case, the activity plan described above was deployed towards the end of the 2013–14 school year at a comprehensive (kindergarten, primary, lower-secondary) school located in a densely populated residential area not far from the centre of a city in north-western Italy. The school is attended by 625 pupils and has a staff of fifty (teaching and non-teaching). The demographic is largely white-collar and middle-class, and students of Italian origin form the majority of the

[9]See D6.2—Analysis of pupils' performance and attitudes—http://tinyurl.com/MAGICALdel6-2.

school population; about two or three students per class have immigrant backgrounds. Most of the students who attend the school continue beyond the minimum leaving age and successfully complete upper secondary school. In Italy, students with SEN generally follow mainstream education and can be assigned special support teachers for a limited number of class hours; this school places a limit of three such students per class.

The experience involved five classes—three third grades and two fifth grades—with a participant population totalling 102 students and eight teachers. They were supported and monitored by the three ITD-CNR researchers, who attended classroom sessions in pairs. The population breakdown is shown in Table 9.1.

Results from the learner profiling questionnaire administered in Class Session 1 revealed that the majority of the learners, especially males, consider themselves to be frequent digital game players. Their baseline acceptance of GBL in the school context could thus be assumed to be solid. Most were enthusiastic about the opportunity to engage in game making, whether or not they were self-declared digital game players. Indeed, the majority of the learners expressed confidence in their (predicted) capacity to manage a game editor autonomously, particularly the fifth-graders.

The pilot population included learners affected (to a non-critical degree) by: learning disabilities such as dyslexia, dyscalculia and dysgraphia; Attention Deficit Hyperactivity Disorder; mild cognitive impairments; short-term memory deficit; Autism Spectrum Disorder and low vision. While the feasibility of game making for SEN was a specific focus of other MAGICAL pilots, the researchers were nonetheless interested in observing the implications for inclusion in this case as well.

The teachers taking part were all females with a mean age in the 40–49 bracket. They described themselves as, on average, occasional digital game players who had had minimal classroom experience of digital GBL, most of them none at all. They declared that they were generally enthusiastic about the idea of GBL and saw the opportunity to implement GBL in their teaching in a positive and confident light.

Table 9.1 Population participating in the reported pilot

Class	Pupils				Teaching staff (M/F)
	Age	Sex	SEN pupils	Total pupils	
3A	8–9	5 F + 14 M	3	19	3 F in turns
3B	8–9	7 F + 11 M	2	18	2 F
3C	8–9	7 F + 11 M	2	19	1 F
5A	10–11	10 F + 13 M	3	23	1 F
5B	10–11	13 F + 11 M	2	24	1 F
Σ = 5	μ = 9.3	Σ = 42 F + 60 M	Σ = 12 (11.8 %)	Σ = 102 μ = 20.4	Σ = 8 F

However, if given the chance to use games for their own learning, most were unsure whether they would opt for digital over non-digital games.

The preliminary session was held as a single half-day workshop that was open to all school staff. This effectively functioned in the first instance as a recruiting drive to engage interested teachers (and their classes), and also to prepare them for the subsequent intervention. The workshop was attended by about a dozen teachers, some of whom had organizational commitments that prevented them from taking further part in the pilot activities despite their expressed interest.

Negotiation and consolidation of the reference scenario with the participating teachers led to the scheduling of three ninety-minute class sessions at weekly intervals. Four of the classes opted to follow this calendar, while for organisational reasons a fifth (3rd grade) class had to run two two-hour sessions, also scheduled a week apart. For all the learners, the first session (introduction and gameplay) began in the school's multimedia room, which is equipped with a projector and white-board. The remaining class activities were held in the computer lab equipped with 13 networked Windows PCs. The third graders had never used the lab before then, so this experience was a complete novelty.

ITD-CNR researchers attended classroom sessions in pairs. They liaised with the teachers on the implementation and orchestration of pilot activities, provided technical support where requested and gathered research data in accordance with the protocol[10] jointly defined by MAGICAL partners. This comprises a set of procedures to follow, together with the research tools (questionnaires, structured monitoring sheets, etc.) to adopt and specific guidelines for their use in the appropriate point of the scenario sequence. The rationale for the researchers' involvement in the planning and deployment of classroom activities lies in the principles of design-based research, as explained in the Initiative Description section.

For the post-class debriefing session with learners, four focus groups were held, two for each grade level. Each comprised six learners, who were explicitly chosen by the teachers and researchers. The rationale for selecting participants rather than randomly assigning them was twofold: to avoid the presence of teammates from the same game-making group and thus prevent peer pressure unduly influencing the free expression of opinions; and to engineer a reasonable degree of representativeness of the relatively small class groups, which had a mean population of just 20.4 learners. Three of the focus groups were held in special rooms at the school dedicated to ancillary activities, while a fourth took place in a vacant classroom rearranged for the purpose (see Fig. 9.6). One researcher acted as focus group moderator while a second observed and took notes (Fig. 9.7).

[10]Described in *Deliverable 5.2: Report on School Experiments*—http://tinyurl.com/MAGICALdel5-2.

Fig. 9.6 Digital game making in a MAGICAL pilot class

Fig. 9.7 Desirability testing during a MAGICAL learner focus group session

9.3 Outcomes

This section gives an overview of outcomes resulting from the pilot. Those generated from MAGICAL field experiences as a whole are presented in the Final Project Report,[11] while detailed analysis of the qualitative research method and data are reported in Deliverable 6.2—Analysis of pupils' performance and attitudes.[12]

Perceptions of the experience were collected from the entire student population and from the student focus groups, while semi-structured interviews were conducted with the teachers. These participant data supplemented the researchers' structured monitoring carried out during class activities.

Overall, the experience was favourably received by the student population. To the feedback survey question "What did you like about the experience?", the students provided 79 responses. These were parsed to identify 'keywords' strings (single or multiword lemmas) flagging student attitude. A set of 120 flag occurrences were collected and, for categorisation purposes, informally clustered into eight overriding themes: game play, game making, the Magos Lite platform, group work and collaboration, opportunity for a new experience, learning, using the computer, avoiding routine classwork (one negative response was also returned). The percentage distribution of the 120 keyword flags across the eight categories is shown in Fig. 9.8.

When combined, the themes of game making (40 %) and collaborating/group activity (22.5 %) accounted for almost two thirds of the keyword occurrences (62.5 %), indicating solid appreciation for the core aspects of the experience. Interestingly, learning (8.3 %) was singled out almost as much as gameplay (10 %) and more than either computer use (7.5 %), new experience (5.8 %), the platform (3.3 %) or avoiding regular class work (1.7 %). Overall, these findings indicate that learners responded in an unprompted manner to the main research focus areas, and this overshadowed the underlying novelty factor of the experience.

The question "What suggestions do you have for improving the experience?" generated 69 responses containing 69 keyword flags clustered into five categories, as shown in Fig. 9.9. The number of responses in the "nothing to add" category (53.6 %) may have been inflated by the Hawthorne effect (Cook 1962), i.e. (young) participants' intrinsic urge to appease the research team. In addition to this, four specific themes emerged: enhancing the platform (23.2 %), typically by adding other game types; altering how the activities were orchestrated (10.1 %), typically the group formation strategy; enhancing the technology used (7.3 %), typically by employing tablets; and having more class time for the activities (5.8 %).

A number of specific student responses provided insights into the impact of the pilot as a learning experience at both cognitive and affective levels, for example:

[11] http://tinyurl.com/MAGICAL-final-report.

[12] http://tinyurl.com/MAGICALdel6-2.

Fig. 9.8 Themes in student responses to the survey question: "What did you like about the experience?"

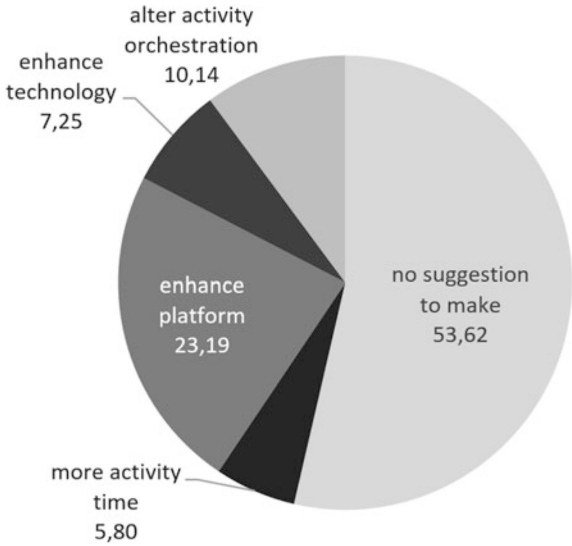

Fig. 9.9 Themes in student responses to the survey question: "What suggestions do you have for improving the experience?"

- "I learnt how games are made … a whole new experience";
- "(The good thing was) working together because I wouldn't have managed on my own otherwise";
- "I enjoyed following my classmates' suggestions for modifying my game because it made me feel like a real game inventor";
- "I've added Game Designer to the jobs I'd like to do when I grow up".

Fig. 9.10 Word cloud generated from focus group desirability testing corpus (757 words)

To gain clearer understanding of student response, the researchers also ran learner focus groups. As mentioned, these included a controlled desirability testing activity, which generated a corpus of 133 spontaneous comments containing 757 words.[13] This is illustrated in the word cloud shown in Fig. 9.10.

Parsing of the corpus revealed that 78 % of comments were positively connoted, 21 % negatively connoted and 1 % neutral. Echoing the feedback results reported above, opinions gravitated around two main themes, group activity/collaboration and digital game making, respectively comprising 26 and 25 % of comments. For game making, 97 % of the attitudes expressed were positive. By contrast, group activity/collaboration generated a 65 % positive—32 % negative split, with 3 % neutral. This breakdown represents a significant divergence from the general student population feedback, in which 20 % of third graders but only 2 % of fifth graders expressed any ambivalence about collaboration.

Closer analysis of the focus groups' negative comments on collaboration reveals that that these actually regard the challenge involved in group work (expressed using adjectives like *hard* and *complicated*) rather than personal aversion or refusal. Two things are worth considering here. Firstly, intensively collaborative approaches that include peer review and co-assessment can represent unfamiliar territory to younger learners. Secondly, group-based co-production activities can indeed boost intrinsic motivation and engagement by generating a sense of ownership over process, artefact and learning (Kafai 2006). At the same time, however, they also 'turn up the heat' at the affective and social levels. To ensure this energy fuels—rather than scalds—effective learning and transversal skill development, proactive teacher scaffolding is required, both in the form of in situ guidance and through fostering of learner reflection in the debriefing stage.

With regard to learning impact, the teacher interviews highlighted perception of a number of positive aspects, particularly strong learner motivation/engagement, and constructive collaboration. On the latter point, some mentioned that students who were not expected to work well together, including SEN learners, managed to collaborate successfully. Other perceived benefits mentioned were activation of

[13] http://tinyurl.com/MAGICALdel6-2.

critical/logic thinking and problem solving, learner self-regulation and autonomy, and opportunities for linking with curriculum contents. In keeping with the learners' view, teachers also felt it would be beneficial to enhance the Magos Lite platform with more game types and game elements, partly to grant learners wider expressive scope but also to facilitate curriculum integration.

Researcher monitoring of sample learner teams in class and of the focus group afterwards also highlighted learner motivation/engagement and collaborative attitudes/behaviour as areas of positive learning impact. A factor (possibly a dependent variable) that appeared to affect the former was learners' perceived degree of autonomy, especially in the faculty to devise and implement their own core game idea. This seemed to influence the sense of ownership over process and product, which underpins motivation and engagement. Clearly, it also raises the issue of how best to combine the pursuit of transversal skill development with curriculum-related goals, a critical tension discussed in MAGICAL deliverable D6.4 Open Issues.[14]

Collaboration was view favourably, however some difficulties were also noticed in intra-team interactions, notably where one member of a game authoring team tended to domineer the other/s. This phenomenon, commonly encountered in children's computer-based group activities, once again stresses the need for care in team forming and class orchestration, and particularly in activity monitoring and support.

The researchers' monitoring also supported participants' view about the potential advantages of a wider and richer set of game types. The Magos Lite platform provided a good starting point for young learners, offering a suitably low technical threshold. Enrichment of the available game making types and functions would help to raise the usability ceiling and thus, in the authors' view, lend further learning support and twenty-first century skill development, especially by allowing greater scope for activating creativity and fostering ICT literacy.

In terms of the deployment strategy, the researcher monitoring confirmed the feasibility and value of situating game making as a social endeavour, provided suitable support is on hand. Although still very young, most learners demonstrated the mutual commitment and responsibility called for to successfully complete the iterative cycle of collaborative game design/production and testing, inter-group playtesting and peer review, co-assessment of feedback and subsequent game versioning. Furthermore, when adequately scaffolded in the debriefing stage, many proved capable of reflecting on their progress through this activity cycle and appreciating its value.

As to the implementation strategy, the teachers' main response was that more class time would be beneficial (students wanted more time specifically for game making). They also concurred with the students about learner-driven team formation being preferable. Interestingly, one teacher indicated that the development of

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[14] http://tinyurl.com/MAGICALdel6-4.

learners' collaborative attitudes and skills ought to be regarded as the prime objective of game making interventions and thus deployed at the beginning of the school year.

While the feasibility of game making for SEN was a specific focus of other MAGICAL pilots, the researchers here were nonetheless interested in observing the implications for inclusion. With due attention and adjustment, many SEN students managed to participate actively and profitably in the activities. However, the more demanding aspects, such as understanding how game design settings affected game playability, performing peer review, etc.—were too close to or beyond their limits. Intra- and inter-team collaboration benefitted inclusion for some, while for others (e.g. with ASD) special measures were clearly called for.

9.3.1 Benefits for Pilot Participant Groups

Teachers gained insight and practical experience in GBL, and in digital game making in particular, as ways of enhancing learning and of innovating and enriching their practice. They experienced enactment of a technology-based, learner-centred constructionist approach within a highly-supported context with low personal stakes. School students tried their hands at making their own digital games and, in doing so, experienced a fun, learning-by-doing process at school. They also gained a sense of how transversal skills form part of, and contribute to, their learning.

All participants benefited from the added class-group awareness and cohesion derived from a meaningful and constructive collaboration process featuring peer assessment. The school, principal, teachers and students all received official recognition of their contributions.

9.3.2 Benefits for Stakeholders

Researchers and policy makers: research-based analysis and evidence of the viability and educational added value of game making, especially for twenty-first century skills. Includes analysis of empirical evidence and open issues.

Practitioners in teacher education and K-12 sectors: ready availability of tools and resources for implementing game making in practice:

- Magos Lite,[15] the digital game authoring platform used in the reported pilot;
- Pedagogical Planner,[16] an online tool for designing and planning out educational interventions that has been enhanced with game making features;

[15]http://magos.pori.tut.fi/.

[16]http://www.magical.itd.cnr.it/.

- an online community library of digital game authoring platforms[17] showcasing over sixty different tools from around the world that are suitable for use with learners.
- a resource kit for introducing game making to student teachers and trainers[18] and for preparing them to adopt this approach in their practice;
- guides to implementation, including synthesis of best practices.[19]

Research Publications: Caponetto, I (2015). Sight Impaired Students Facing a Game Making Environment: A "MAGICAL" Challenge. In L. Gómez Chova, A. López Martínez, I. Candel Torres (eds.). Proceedings of the the 9th International Technology, Education and Development Conference (INTED, 2015), IATED.

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Dagnino, F., Earp, J., & Ott, M. (2012). Investigating the "Magical" effects of game building on the development of 21st Century Skills. ICERI2012 Proceedings, 5778–5785.

[17]http://amc.pori.tut.fi/game-building-tools/.

[18]http://tinyurl.com/MAGICALdel6-1.

[19]http://www.itd.cnr.it/download/MagicalDeliverables/.

9.4 Conclusions

The conclusions drawn from the full set of pilot experiences performed in the MAGICAL project are reported in the Final Project Report.[20] In this section, we summarise those that are of particular relevance to the case study reported in this chapter.

Overall, the experience appeared to have particular benefits for enhancing learner motivation and engagement, and for triggering collaborative attitudes and behaviour. These can be seen in relation to game making per se, but also in terms of the strategy adopted in the pilot for implementing digital game making in primary school. A crucial factor here is the adopted game making tool. On the strength of the experience gained in MAGICAL pilots, the authors believe the Magos Lite platform is ideally suited for learners in the eight to ten age bracket, or around third to fourth grades. As mentioned earlier, a key requirement for the pilot was that the game editor should be simple enough for participants—both teachers and students—to grasp and master fairly quickly. Meeting this requirement clearly places some limits on the potential expressiveness of the adopted tool, with the associated risk that older learners may quickly exhaust the perceived game making possibilities and experience a drop in interest levels (Kiili et al. 2014). This highlights a key MAGICAL recommendation for practitioners, namely that they devote particular care when selecting a game making tool to use in the classroom, one that balances ease-of-use with a sufficient degree of challenge and expressive potential for the learners who are to use it (low threshold, high ceiling) (Dagnino et al. 2014).

Another implementation lesson learnt in the pilot is the need to ensure that the technological infrastructure is properly prepared and managed, and functions as expected. Technical problems can demotivate learners very quickly and make it extremely difficult for the teacher to manage the flow of classroom activities while simultaneously seeking to monitor and scaffold student progress. This is true of any technology-enhanced learning environment but it is particularly crucial when, as was the case here, an iterative cycle of learner design-production is attempted that also includes peer review. Smooth runtime functioning depends not just on technical stability but also on adequate preparation and on the teacher having a sufficient level of familiarity and confidence with platform functioning and features.

From the viewpoint of the ultimate end users—the learners—critical factors include their perceived sense of autonomy in developing a game idea, their individual comfort within their game making team, and having the opportunity to try out, playtest and review the games produced by peers. Opportunities to continue game making outside the organized classroom appear to offer significant added value and a blended deployment approach is certainly worthy of further investigation. Learners with SEN can benefit from the approach, provided sufficient face-to-face guidance is on hand.

[20] http://tinyurl.com/MAGICAL-final-report.

Turning to implementation and classroom praxis, a key recommendation emerging from the pilot is the need for careful consideration of the classroom activity sequence and how the steps are to unfold in class. This does not mean strict adherence to an orchestral ‘score’ at any cost; deployment of digital game making calls for flexibility and nimble (often creative) teacher response on-the-fly to unforeseen contingencies. It entails carefully thinking out the progression and timing of activities, and recognizing where potential ‘fault lines’ and critical checkpoints may lie along the way.

On the question of orchestration, it is important for teachers to resist the temptation to squeeze learners’ initial familiarization with the digital platform or reduce their post game-making debriefing. The experience gained in this case study underlines how important the former is for a smooth and (crucially) effective game making phase. Similarly, many learning gains that can be derived from game making emerge from—and are consolidated in—the debriefing stage, when learner reflection is activated and positive experiences are consolidated.

From a more pedagogical viewpoint, a key lesson learnt was the need to strike an appropriate balance between (a) learners’ freedom to explore, experiment and pursue their own game making agenda and (b) ‘steering’ them towards achievement of pre-set learning outcomes, especially subject-oriented ones. These two aspects are neither absolute nor mutually exclusive but, to gain the most out of digital game making, teachers need to have an appreciation of both perspectives and how they relate to the ultimate objectives of the intervention.

This touches on the issue raised at the beginning of this chapter regarding the position that twenty-first century skills assume in the minds of practitioners, schools and policy makers, and how this is translated at curriculum level. Arguing the case for accommodation of twenty-first century skills and their development via approaches like digital game making requires advocacy at all levels, beginning with teacher education and professional development. Davies et al. (2012) suggest that evidence of global impact on pupil attainment and attitudes need to be adequately presented to schools and policy makers in order to smooth the way and help address obstacles to uptake. The ongoing efforts presented in this chapter are attempts to move in those directions.

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Chapter 10
Frog Virtual Learning Environment for Malaysian Schools: Exploring Teachers' Experience

Mei Lick Cheok and Su Luan Wong

Abstract This paper is a case study exploring 12 school teachers' experiences in using FROG VLE in their teaching and learning. FROG VLE is a learning management system which the Malaysian government has adopted for all its 10,000 government aided schools nationwide. This ambitious programme which connects all the schools within a single online platform though has caused the country a substantial amount of money, has not been reciprocated with the same amount of enthusiasm by its teachers. A report published by its Auditor-General (2013) revealed poor usage in schools. This study interviewed 12 teachers in order to understand the workings in schools that had caused the poor usage of the VLE. All teachers, despite coming from different states and schools, seemed to resonate in terms of the challenges and limitations faced. No one denies the benefits and strength of the e-learning approach for the betterment of the education system. This paper elaborates and highlights these teachers' concerns and frustrations, and recommendations for better implementation reform are included.

10.1 Case Overview

In October 2011, the Malaysian Ministry of Education launched a comprehensive review of the education system in order to develop a new National Education Blueprint (MEB) (Ministry of Education 2012). The blueprint is a detailed plan of action that maps out the education landscape for the next 13 years (2013–2025).

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One of the many initiatives identified under the first wave of the MEB includes process that Malaysian school teachers and students are undergoing at present. It then explores the teachers' experience using the VLE. It also raises a few challenging areas that the MOE will still need to look into to ensure sustainability and scalability of the programme.

10.2 Background

Malaysia is situated in Southeast Asia. It is a multi-ethnic, multi-religious society encompassing a majority of Muslim population in most of its states. Ethnic Malays make up about 60 % of the population, while Chinese constitutes about 26 %, while Indians and the indigenous people make up the rest. It consists of two regions separated by some 640 miles of South China Sea with a federation of 13 states and three federal territories. The capital city of Malaysia is Kuala Lumpur with Islam as the state religion and Malay language as the official language.

For a developing country like Malaysia, attaining competitiveness is not only about liberalisation of the economy, but entails how far Information and Communication Technology (ICT) is being used in the country. Since ICT benefits all activities, a wider diffusion has been planned to ensure Malaysia accelerates its ICT integration into the national educational system. The integration of ICT in Malaysian education can be traced back to the 1980s. Significant funds have been allocated to boost the uptake of ICT integration. The 10th Malaysian Plan (2011–2015) focused on expanding the existing communication network across the country, reducing digital divide, while enhancing the infrastructure and ICT facilities, and expanding professional development and training opportunities for teachers (The Economic Planning Unit 2010). The adoption of new technologies is transforming the entire educational landscape.

In October 2011, the MOE launched a comprehensive review of the education system in order to develop a new Malaysian Education Blueprint (MEB) (Ministry of Education 2012). The blueprint is a detailed plan of action that maps out the education landscape for the next 13 years (2013–2025). One of the many initiatives identified under the first wave of the MEB includes the setting up of the 1BestariNet project. It is a project led by the Ministry of Education (MOE) to provide access to a cloud-based virtual learning platform known as the FROG VLE and a high-speed connectivity by June 2014 to all its 10,000 public schools. It will cost Malaysian taxpayers RM 1.5 billion and its implementation is expected to run for 13 years.

Across all the 10,000 schools, ICT will enhance teaching and learning with students having access to a wider range of content that is more engaging and interactive. They will be able to learn some lessons at their own pace and no restrictions to what they choose to study and focus on. On the other hand, teachers and administrators will have access to both national and international learning resources and communities to help them improve their practices. ICT will be a ubiquitous part of schooling with no urban-rural divide. Students and teachers will be equipped to use and benefit from this technology.

This case study looks at the workings of the 1BestariNet programme, Malaysia's most gigantic project of connecting all its 10,000 schools to a single virtual learning platform. It will describe in detail the range of related activities that Malaysia's education is undergoing. The project is now continuing into its second phase starting next year. As a result of this project, most of the schools are now equipped with an integrated system which allows teaching, learning, collaboration, and administrative functions to take place through the internet-based virtual learning environment.

10.3 Initiative Description

In the Malaysian context, one of the key aims of the MOE in today's ICT enabled classrooms is to make students more active in the learning environment. In 2011, the MOE had launched a comprehensive review of the education system in Malaysia. The review found that despite the massive expenditure on the Smart Schools initiative, 80 % of the teachers were found to use ICT less than an hour per week (as cited in Ministry of Education 2012). A report by UNESCO stated that even if ICT was used, it was limited to word processing applications (as cited in Ministry of Education 2012). The Smart School programme was an effort by the government to integrate ICT into classroom learning, administration, and students' daily lives. It started in 1999 and completed in 2010. The review process preceded the formation of the MEB. Of the eleven policy shifts identified in the Malaysian Education Blueprint (MEB), one was to leverage on ICT in order to improve learning quality across Malaysia. Across all 10,000 schools in Malaysia, there will be internet access and learning platform provided via the 1BestariNet project. The MOE has adopted a cloud-based virtual learning platform known as the Frog VLE—a United Kingdom's designed application created to ease lesson plan development, facilitate administrative tasks, and allow students to access learning resources. This learning platform is to be fully embedded into their school's working practices and tailored to the needs of the respective schools.

The 1BestariNet project will provide access to a single learning platform and high-speed 4G internet connectivity to all 10,000 schools nationwide. The project was launched in March 2012 and the implementation is being carried out in stages and all schools will be connected to the Frog VLE. 1BestariNet is the key component in Shift 7 of the Education Blueprint, which is an initiative by the Ministry of Education to transform education in the country by leveraging on the internet and technology to improve teaching and learning, and bridge digital divide between the rural and urban schools. Malaysia aims to provide 4G broadband internet access and make a VLE available to all teachers, students, and parents in Malaysia.

10.4 Implementation Plan

Through the Frog VLE, teachers are able to digitise their teaching content and explore new ways of bringing the best resources and teaching methods to be shared across the 10,000 schools. Teachers can easily share some of their best practices with other teachers, or even learn and get ideas with their own lesson planning. Vast resources made available through the single platform will lighten teachers' work and make them more efficient at planning and delivering their teaching and learning sessions. Teachers can be in touched with their students and their students' parents through the Frog VLE without being constrained to the schooling hours. Parents on the other hand, can find out more about their children's performance in schools quite easily from the comfort of their home and anytime they want.

YTL Communications Sdn Bhd is the company that was selected by the MOE to provide internet connectivity to all the schools through its high-speed wireless 4G mobile network. The Frog learning platform will be delivered through FrogAsia Sdn Bhd (FrogAsia), a joint venture between Frog and the YTL Group of Malaysia. This project is set to radically transform the way teaching and learning is delivered in the country. This platform will be used in all 10,000 state schools in both Peninsular Malaysia and East Malaysia, serving a total of 6 million users from YTL Communications' purpose built data centre in Sentul, Kuala Lumpur. The Frog learning platform is an inclusive solution that will meet the needs of all schools, regardless of their abilities or geographical and socioeconomic barriers. All schools, whether urban or rural, will have access to the same, high quality resources and content, giving equal delivery of education to all Malaysian children. The new learning platform solution will support collaboration between high and low performing schools, sharing best teaching methods and resources—helping all schools to raise the standards in the way teaching is delivered to students.

According to the Education Blueprint 2013–2025, ICT in education will be addressed in three stages. With reference to Fig. 10.1, the first stage; 2013–2015 will see the 1BestariNet programme launched for the purpose of setting up the foundations for ICT in schools. YTL Company is appointed as the company that needs to equip all schools with sufficient network bandwidth. A huge amount of licensing fee was paid to FrogAsia for the usage of their learning platform. The learning platform requires teachers to upload their own lessons with the accompanying task sheets or link. It works as almost the same way as any other free virtual learning platform like Moodle, for example. Initial trainings were carried out by the FrogAsia trainers which were then passed on to the state education department to appoint their own set of trainers amongst those personnel trained earlier by FrogAsia. Every school will have at least a teacher trained at the central level. The teacher is then expected to train their colleagues in the respective schools. The second stage will be carried out from 2016 to 2020 where teachers are expected then to be more skillful at managing their e-learning. As all the teething problems have been ironed out, the focus now will be on sharing best practices. Finally, 2021–2025 will have e-learning fully embedded in all Malaysian classrooms.

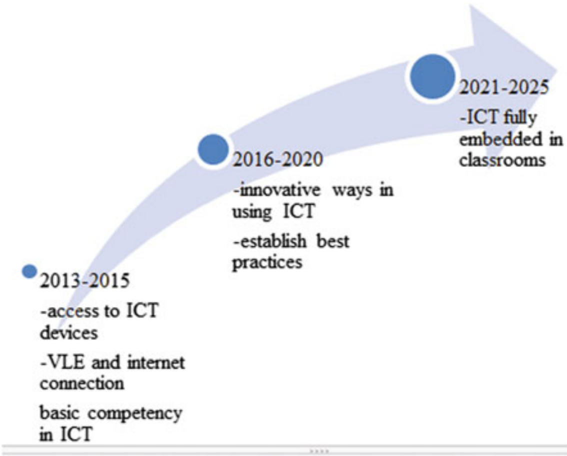

Fig. 10.1 Implementation plan time frame

The implicit assumption that the MOE had was with all the teachers trained, YTL Company will by then have the internet services ready and running smoothly for the teachers to run their e-learning lessons. The state education department of every state will also play their part by encouraging teachers to use the system. The latest circular (dated 15 June 2015) in one of the states where we collected data for this study, had requested schools' administrators to make sure that teachers integrate Frog VLE in their teaching and learning. The circular advised school heads to encourage their teachers to build and use their websites and set tasks through the VLE. Teachers with the most usage will be awarded during staff meetings in an effort to motivate others to follow suit. They are also reminded to encourage parents to supervise their children's progress through the VLE. Schools' administrators then need to send a report of teachers' usage to the state department.

10.5 Implementation Process

The data collected for this case study were qualitative in nature. Twelve school teachers were interviewed to elicit information about their experience in using the Frog VLE for teaching–learning. The teachers selected were from the states of Selangor ($N = 9$), Melaka ($N = 1$), Kedah ($N = 1$) and Sabah ($N = 1$). The interview sessions were meant to understand first-hand accounts of teachers trying to implement the VLE in Malaysian schools. Ten of them are from urban schools while the other two are from rural schools. Only three are from the secondary schools while the other nine are from the primary schools. Two teachers were interviewed face-to-face while the rest were interviewed online through Facebook messenger. These data were analysed using the qualitative method to discover patterns and emerging concepts that form the basis for making conclusions.

According to the interviewees, trainings were carried out differently depending on the initiatives of their schools' principals and the ICT teacher. Some of the teachers interviewed reported that they had undergone on-going in-house trainings since last year while most reported a one-off, one or a two-day in-house training sessions. Schools differed in terms of extra efforts taken to build up their teachers' ICT competencies. Some schools seemed to have 1 or 2 days training sessions on how to operate the VLE, and are left to continue exploring on their own. Some of the more proactive schools took it upon themselves to prepare simplified modules for their teachers and from the interview, it was gathered that the MOE has also developed their own module which will be provided to all teachers soon.

The teachers interviewed mentioned that their younger colleagues are more comfortable with the VLE as compared to the more senior ones. However, these younger teachers despite the confidence in their ICT usage, are still not using it in their teaching and learning due to other constraints namely the slow internet connection, insufficient computers and LCD. One of the teachers interviewed mentioned that facilities are still the main challenge faced in the school. Her school has only one LCD and this makes it difficult for the teachers to use. Chromebooks are only provided to some selected schools, in which case these schools have successfully showcased excellent practices. This in a way shows that if given enough facilities, teachers can make the VLE a success. The researchers feel that lacking in pedagogical, technological knowledge may also be a hindering factor.

Some principals made it compulsory for their teachers to upload a minimum of four task sheets in each month in order not to raise a red flag when the district officers monitor the schools' VLE usage. The number of hours logged-into the VLE is also being assessed. As such, according to two of the teachers, they will resort to logging in but continue with their other work. One of the teachers mentioned that as she is teaching in a school with low-income group parents, many of her students neither own a computer at home nor assess to the internet. Teachers, therefore, had to print out the task sheets for their students.

10.6 Outcome

Although the aforesaid information paints a woeful picture of how the VLE is currently being used in schools, most teachers recognised that the Frog VLE has generated interest among the students. Apart from that, easy access to a wealth of materials and resources were some of the main benefits identified. These teaching and learning resources can help to improve learning outcomes and nurture self-directed learning among the students. Flexibility in learning regardless of place and time, increases motivation among the students and in the process it also increases their ICT usage and awareness of ICT's potential as an alternative way to learning. This updated approach of learning, in the long run provides greater opportunities when these students enter the job market. Students will be more equipped with the much needed twenty-first century work skills.

The Frog VLE is student-centered with its reduced need for teacher talk. Despite this, surprisingly a few teachers felt that their interaction with their students have increased through the VLE. Perhaps the ability to connect any where and any time, for students who have access, made it easier to connect to their teachers. Teachers also claimed that the system provides “hands-on” information for the students. With technology, students can view, listen, reflect and just do about anything in order to comprehend any new items that they wished to learn.

Many of the teachers appreciated Frog VLE in helping them make their teaching job easier than the traditional approach. Besides that, the system also helped them to organise their teaching and learning materials. This saves their time when updating or locating for specific materials. They are also pleased that with the system, they need not print or distribute handouts and this reduces cost substantially.

Even though teachers realised the benefits and strengths of ICT, the poor uptake of it reflects a number of constraints that needed immediate attention. Lack of time is one of the key concerns towards the e-learning implementation. They claimed the workload in school prevented them from exploring and mastering the system further. For this reason, the teachers’ workload needs to be reassessed.

A few teachers expressed a critical need for more training and exposure to the system. Despite having trained and spent a substantial amount of money, ICT skills remain an issue with the teachers. Not having technical support was also stressed as a challenge in utilising the system, and teachers felt the management should be working on this aspect to ease the innovation’s adoption process.

Besides having limited ICT skills, lacking in English proficiency is also a barrier in understanding the Frog VLE. Some felt the language used was difficult for them to understand including the students. The inability to understand the language used by the system has caused confusion as claimed by some teachers.

Another identified barrier was having too many students in a class (30–45). This made it difficult for them to implement e-learning in the classroom. It is a challenge to let students take more responsibility for their own learning as they were not always on task. Whatever the technology being used, teachers with strong classroom management skills and ability to create a positive classroom culture are needed. Students tend to get distracted and visit other than the suggested websites, thus this lack of control was considered a struggle in running e-learning in the classrooms. Some felt teachers’ initial guidance is heavily needed by the students due to students lacking in skills and exposure in using the system.

Nearly all teachers complained of poor internet connection and facilities as the greatest barrier towards e-learning implementation. Slow internet connection and that only certain areas in the school have access to the internet made it difficult for the teachers. They also claimed that they do not have enough working computers to make e-learning possible during their lessons. As such, due to the constraints expressed, plus high maintenance incurred by e-learning, some teachers insist preference over the traditional face-to-face approach.

The findings of our case study support the conclusion reached by the Auditor-General’s (A-G) report (National Audit Department 2013) that the RM 663 million spent on the 1BestariNet project is suffering from lack of usage. The report also revealed that usage of the Frog VLE by teachers, students and parents was between 0.01 percent and 4.69 %. Daily utilisation of the VLE by teachers was found to be between 0.01 % and 0.03 %. The aforementioned report suggests that the VLE is underused or unused by most of the teachers.

The poor report by the Auditor's General (2013) had caused an uproar among the Malaysian public, who has demanded better implementation and monitoring process of the 1BestariNet.

Due to the recent pressure also, the MOE and the state education departments have come up with multiple measures of monitoring the VLE's usage plus exerting soft pressure on the teachers. In one of the states, the education department has initiated a unit specially to monitor teachers' usage. For a start, instead of measuring the success of the VLE in terms of whether students were thinking critically and creatively, whether they were collaborating and communicating with others, the MOE has resorted to an easier measure of getting teachers to show them the hours of usage.

10.7 Conclusion

In light of the aforementioned findings, it is troubling that teachers whom we interviewed are experiencing more challenges than benefits while using the Frog VLE. On the other hand, it is commendable for the MOE to embark on such an ambitious programme to transform the teaching–learning environments in Malaysia. Undeniably, true transformation always comes with creative destruction, risks and uncertainties (Hanna 2013). These challenges are, therefore, expected but what is clear now is that more effort and support are needed at the implementation level in schools before integrating e-learning in our education system.

Our findings suggest that the teachers welcomed and are aware of the benefits ICT bring into their students' learning, but what is preventing them from fully embracing the FROG VLE is the heavy workload, unstable and slow internet connection, lack of computers, LCD and competence in handling the technology. In addition, in order to fully realise and optimise ICT in teaching, training for teachers must be a continuous one rather than a one-off basis.

Strategic partnership and openness is one of the missing links in this ICT implementation. Knowledgeable and proactive school leaders must step up their leadership skills into making this innovation work. They need to be empowered to take control in the implementation process. They should also be taught to assess teachers' ICT readiness and needs assessment instead of following the one pathway set by the MOE for the whole 10,000 schools. Teachers should be allowed to decide the pace the Frog VLE is to be implemented in their classrooms. With the challenges present and minimal support available, teachers must not be left groping in the dark; to make sense of what teaching should be or look like in the virtual learning environment.

To conclude, a systemic change which involves not just a new innovation in the pedagogical aspect but also the realignment of the curriculum and assessment will create a more sustainable and durable outcome. Teachers' ICT competencies can then be gradually developed with more usage (Lau and Sim 2008).

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Chapter 11
Building a Smart Classroom—A Case Study of Spreading Inquiry-Based Nature Science Courses for Elementary School in Taiwan

Hsien-Sheng Hsiao, Jyun-Chen Chen and Tzu-Chien Liu

Abstract The main target in this research was to assist elementary schools building a smart classroom. To let students learn in the smart classroom, four points were underlined as follows: (1) developing the inquiry-based nature science learning materials, quiz, and model; (2) designing digital learning system and tools; (3) doing teacher and student training; and (4) planning the learning environment. There are 18 schools, 22 teachers, and 1355 fourth-grade students in Taipei City and New Taipei City joined this project. The research guides the concept of standard operating procedure, which means everything has its standard operating procedure to ensure the operation effective and quality; it is also a benefit for large-scale promotion. The result showed that students' science learning performance has enhanced prominently. The inquiry-based nature science courses help student understand the main points of science question and finally construct the completed scientific concept and knowledge.

Keywords Smart classroom · Inquiry-based learning

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11.1 Case Overview

In the research project, "Building a smart classroom—a case study of spreading inquiry-based nature science courses for elementary school in Taiwan," we built a smart classroom for 1355 fourth graders to teaching and learning in a digital environment. To achieve the purpose, four points were underlined as follows: (1) developing the inquiry-based nature science learning materials, quiz, and model; (2) designing digital learning system and tools; (3) doing teacher and student training; and (4) planning the learning environment. We integrated all learning resources and trained people to go into the virtual learning environment and improve students' learning performance. The research guides the concept of standard operating procedure, which means everything has its standard operating procedure to ensure the effective and quality; this is also a benefit for large-scale promotion.

11.1.1 Social-economic

In the time of global competition, every country has fully dedicated into e-learning and developing innovations becomes the important method of increasing competitions. We hope we can bring the e-learning blossom and advocating ever-lasting learning sprits in e-learning field. The total value of e-learning in Taiwan took around NT 57.3 billion in 2013. Comparing this to 2012, it has been build up 23 % rate. From the view of subfield, digital materials take around NT 11 billion; the rate is 19 %. Platform takes around 3.3 billion; the rate is 6 %. Learning service takes around NT 21.3 billion; the rate is 37 %. Hardware learning takes around NT217 billion; the rate is 37 %. These show out the government and the supplier of e-learning both upgraded the equipment of Internet environment, the technology of information, and mobile devices popularization.

11.1.2 Government Policy for ICT in Education

In the process of promoting e-learning in Taiwan, normally we will promote and provide counseling in digital material, platforms, service of learning, and hardware learning. We had promoted Taiwan e-Learning and Digital Archives Program from 2003 to 2011 to build the digital learning field and establish the environment which is easy to build up e-learning. Moreover, we also promoted National Science and Technology Program for e-learning, mainly based on collection of material, developing e-learning materials to advocate applied in variety usages, and increasing the value of e-learning field through integrating the software and hardware materials. Besides, we advocated e-Learning Industry Cross-Domain

Advancement Plan to increase the value of field and integrating emerging technology and provide the service for users. And proved by domestic and foreign e-learning platforms, integrate the idea of inputting project, building business mode and exploiting international market. By promoting the revolution of teaching and learning, we built up a fine learning chain. We evaluated we can reach to multiplication of value of e-learning and the goal of multiplication from internet.

11.1.3 Purpose (The Reason to Implement the Initiative)

In the study, a smart classroom was constructed. Smart classrooms, which are general classrooms supported by mobile technology, provide students with many chances to use digital technology to access digital resources that contain information in digital form for learning subject content (Chan 2010; John and Wheeler 2008). Smart classrooms help to create an ideal constructivist learning environment, in which learners are enabled to progressively develop a deep understanding of domain knowledge through the convenient access to appropriate and the sufficient resources and extensive sharing of useful information (Kong 2011; Richardson 2003).

11.1.4 Expected Outcome

To let students learn in the smart classroom, we prepared and integrated all learning resources to construct a smart classroom learning environment.

Learning resource: The project was conducted in an elementary school nature science course, and the eight programs with 24 unit learning materials and quiz were developed by inquiry-based learning strategy.

1. Learning system: The learning system was developed by web technology, and students could connect to the internet by wireless AP and server and learn on any terminal with internet and web browser. Students used pad to receive learning materials, to execute scientific inquiry activities, to upload answer, and to get feedback from teacher. Teachers used pad to send learning materials and feedback to students. The most important is that teachers used pad to manage and monitor students' learning situation and he could arbitrary walk around in the class.
2. Learning model: In this study, a prediction–observation–explanation (POE) inquiry-based learning model was developed by integrating the POE strategy of inquiry-based learning model and the feedback-corrective process. In the steps of POE, students must predict the outcome of an event or situation and provide justification for the prediction, which provides opportunities for them to clarify and justify their own preconceptions. In the feedback-corrective step,

students learn to gradually get rid of scientific misconception, and deeply understand scientific concept. In the learning process, students receive a science question and must understand the question. Students have three complete POE inquiry learning activities, and students must discuss the answer and reason in each stage. Students share and listen the observed phenomenon and integrate a team answer to the instructor. Instructor immediately gives a feedback. Finally, students get correct and complete explanation for the science question in helping them overcome their science misconception. In the entire process, when students discussed without solving question, instructors must provide some clues and guide students keeping scientific inquiry activities and discussion.

11.1.5 Baseline Study (Teacher Background, Student Background, Facilities Background)

There 18 schools, 22 teachers, 51 classes, 1355 fourth-grade students in Taipei City and New Taipei City joined this project. The teacher background, student background, and facilities background will be explained as follows.

1. Teacher background
   These 22 participants all are the science teachers of elementary schools, each one of them has at least 3 years of teaching experience. However, only three teachers have experience of digital teaching among them, and the remaining teachers are all applying traditional teaching mode. The information ability of them is normal; they can surf internet and use office softwares but they are not capable with software designing, hardware assembly, and establishment of building internet environment.
2. Student background
   There are 1355 fourth-grade students among those 51 classes. They started computer lessons from grade 3. All of them have over 1 year of using computer's experience. And around 300 students of 15 classes have learning experience in e-learning classroom; hence, they are capable with searching information and fill out the questions by pad.
3. Facilities background
   There is only one school among 15 schools has finished building up the digital classroom, and there are enough pads and WIFI for them to use. As for the remaining schools, they only equip with traditional computer classroom, either WIFI or pads which the quantity cannot provide a whole class to use. These schools do not have learning platforms, or some of them have learning platforms but are lacking of learning materials and test questions, let alone a full e-learning mode because they do not have chances to use digital teaching stuff.

11.2 Background

11.2.1 Features and Innovation

Science is an important foundation course in compulsory education in Taiwan (Ministry of Education 2008). By reference the Ministry of Education's Grade 1–9 Curriculum Guidelines of Taiwan, in Science and Technology Areas, it pointed that "By learning science, we know that how to do the inquiry activities" (Ministry of Education 2008). Learning science advanced students' inquiry ability and promoted the comprehension of inquiry and those trained students could be observing, thinking, generalizing, and creating like a scientist. Finally, learning science improved the scientific and technological literacy of citizens (Abd-El-Khalick et al. 2004; Ministry of Education 2008).

Hong et al. (2014) indicated that by understanding the cause of a problem in science, students can comprehend a scientific concept through the cognitive process, and students understanding of scientific concepts can be facilitated by developing prediction–observation–explanation (POE) content. Learning science should be through inquiry and handmade (Ministry of Education 2008). Many studies pointed that inquiry learning model is effective to assist science learning (Abd-El-Khalick et al. 2004; Hung 2010; Lederman and Lederman 2004; Lin and Hsu 2007; National Research Council (NRC) 2000). Inquiry learning model could help students resolving science questions, guide students becoming aware of the problem-solving points, and lead students thinking critically (Holt and Kysilka 2006; Lu et al. 2008; Raes et al. 2012; Zion et al. 2005). Among the inquiry learning models, the POE strategy could be carried out on a conventional computer or on an intelligent mobile device, such as pad, and it is complied by three steps "prediction, observation, and explanation" to help students have a scientific thinking, participate in scientific problem-solving process, begin scientific dialog, provide the basis for further scientific exploration, and improve the science learning performance (Hong et al. 2014; Hsu et al. 2011; Kearney et al. 2001; Wu and Tsai 2005; Zacharia 2005). This study revealed that the students learned with POE model significantly outperformed their counterparts in the science concepts.

The smart classroom is a new medium of instruction for both teachers and students, where e-books replace textbooks and pencils, and e-boards replace blackboards and chalks (Chan 2010). In the smart classroom, with safeguarded and comprehensive portfolios for each student, teachers can better protect and maintain student's confidence (Cheng et al. 2009). In this study, for teachers, teachers can show the learning materials on the electrical white boards, or monitoring the status of leaning situation from pads timely, and move back and forth of the classrooms and help on students' questions. This can definitely solve the problem of traditional teaching mode that teachers are locked at a fixed area, who cannot able to find out the students' problem timely. For students, the learning platform and inquiry-based learning materials can fit students' learning ability. Every student can follow the learning speed by themselves, and also can control the learning status by formative evaluation. Students can learn to control the learning status by themselves.

11.2.2 Overall Objectives and Milestones

The overall objective is to make students learn in digital classrooms and enhance the performance of science learning. The descriptions of milestones are as follows:

1. Developing the inquiry-based nature science learning materials, quizzes, and models. So we can conduct an experiment to prove the availability of the whole learning mode.
2. Designing digital learning system and tools. The developed inquiry-based nature science courses and learning mode can apply on the learning platform in the future promoting.
3. Doing teacher and student training. This can make both of them similar to the learning mode, learning platform, and operation on pads, and provide standard operation procedure for teachers and students.
4. Planning the learning environment. This can help to build up the digital classroom environment including purchasing pads, setting software environment, building up WIFI, and making the standard operating procedure of equipment in digital classrooms.

11.2.3 Funding

This research is partially supported by the “Aim for the Top University Project” of National Taiwan Normal University (NTNU) and the Ministry of Education and Ministry of Science and Technology, Taiwan, R.O.C. under Grant no. NSC 101-2511-S-003-056-MY3.

11.2.3.1 Initiative Description

What is the implementation plan and content? Developing the inquiry-based nature science learning materials, quizzes, and models. The eight programs with 24 unit inquiry-based nature science learning materials were developed by a prediction–observation–explanation (POE) inquiry-based learning strategy. This is conducted by a university professor who is qualified with nature science for developing the learning materials. The university professors, elementary school science teachers, and nature science researchers will conduct the developing learning materials all together. When every learning material is finished, it will be investigated by three science teachers. After twice investigations, and twice edits, they invite some fourth-grade students to use and ensure the materials are all good.

The developing process of testing questions is as follows. We have a meeting and training for elementary science teachers, and for those who are capable with science knowledge and professionals of testing questions. We focus on the direction of proposition and particularity that the computer must play a role of matching the characteristics of multimedia. The tests of designing multimedia must inspire the ability of student's science thinking. The question type is based on choice question. After the proposition, we had the elementary science teachers and subject specialist to investigate and edit. They need to ensure the questions are all fit to the age of students. In the meanwhile, we also invite the specialists to evaluate the proposition validity. If the testing questions have a good validity, it will become the official testing questions. If not, we will edit it again.

1. Designing digital learning system and tools.
   The learning system was developed by web technology, and students could learn on any terminal with internet and web browser. In order to handle the complicated data calculation and provide the source of materials in time, the learning platform is established in a small private cloud. We applied VMware virtualization technology to implement the dynamic resource allocation to adjust the loading of system in case of overloading which leads to crash on the system. The learning system was designed by Joomla management system, PHP backend, and MySQL database. All people used the learning system in a digital classroom and connected to the internet by wireless AP and server. Students used pad to receive learning materials, to execute scientific inquiry activities, to upload answer, and to get feedback from teacher. The system function plan including account login area, teacher's preparation area, learning area, testing area, learning portfolios area, the description is as follows:

   - Account login area: every teacher and student have their own accounts and passwords, where they need to log into use the learning platform.
   - Teacher's preparation area: this area is only for teachers to use, where they can arrange the lessons, manage the testing, monitor the learning status of students, and provide the feedback for students' learning.
   - Learning area: we conduct inquiry-based nature science course in this area.
   - Testing area: students have test in this area.
   - Learning portfolios area: we record the answer condition during learning stage of students, the feedback from teachers, and the testing result (Fig. 11.1).

2. Doing teacher and student training.
   We convene a training workshop for teachers, which can help them familiar with the inquiry-based nature science learning materials, testing, and learning system. Teachers must use these resources and match to what the research team has planned for smart classroom.

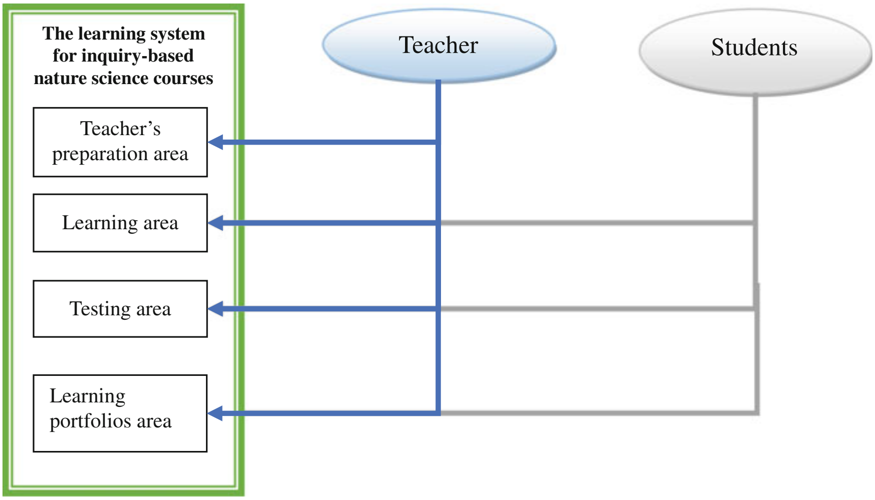

Fig. 11.1 The learning system for inquiry-based nature science courses

- The inquiry-based nature science course: We trained teachers to understand how to use the materials and test very well. We make teachers to pretend as students to use inquiry-based nature science learning materials.
- Learning system: We trained teachers to familiar with the system, and make sure they can able to monitor the learning status of students and provide the suitable feedback.
- We provide some Q&A to teachers and can make teachers to handle unexpected events.
- Student's training: The program will be conducted by a well-trained teacher to advise students how to use pad, including logging in accounts, using materials and tests, etc.

3. Planning the learning environment.
   The inquiry-based nature science course will be conducted in digital classroom environment.

   - Equipment: computer, electrical board (or projector), pads, and WIFI.
   - The behavior of teachers using equipment:

     – Using computer and pad to log into the learning platform.
     – Using electrical board (or projector) to show materials.
     – Using the monitor function with the learning system to know the learning status and to feedback to students.
     – Using the WIFI to connect all devices.

- The behavior of students using equipment:
  - Using pads to log in, to learn, to test, and to know portfolios.
  - The students can listen to teacher's lecture through electrical board.
  - The students can do collaborative learning with team member by WIFI; they can discuss face to face at classroom, or discuss on the internet when leaving the classroom.

What is the effect can teaching and learning achieve with the help of technology? When we applied technology with teaching in the smart classroom, this can help teachers integrate the digital learning materials, quizzes, learning system, and learning mode to build up a full teaching process. Hence, the teachers can integrate the variety of teaching source and tools systematically, and follow the standard operating procedure for every lesson. By the timely management on the internet, teachers can monitor learning progress, learning condition, testing process, test result, and all the learning portfolios of every student. Teachers can rapidly find the learning difficulty of students easily, interact with students at classroom, and provide initiations for learning.

When we applied technology with learning in the smart classroom, it can lead students to do science thinking and provide the students enough learning source. We added learning burden and increase the learning materials along with students' learning growing progress. In addition, the learning speeds of each student are different; by the assist of learning system, it can provide different learning materials to different users in order to reach the goal of adaptive learning. The learning condition of students can upload to the system timely, and then teachers or tea members can find the learning difficulty in time and fix the problem together. Finally, students learn in a feedback-corrective process to gradually get rid of scientific misconception, and deeply understand scientific concept.

1. How to implement effectively?
   The research guides the concept of standard operating procedure, which means everything has its standard operating procedure to ensure the operation effective and quality; it is also benefit for large-scale promotion.
   - The progress of developing learning materials: We applied POE inquiry-based learning strategy to design the instruction of learning progress, and the materials designers can fill into the contents following the instruction. After we finished the materials, we have three subject specialists to do the reviews and editions twice. Finally, we invite students to try out; if there are no other questions, we decide the edition.
   - The progress of developing testing question: We have a meeting and training for professional specialists, and we focus on the direction of proposition and particularity that the computer must play a role of matching the characteristics of multimedia. After the proposition, we have three science subject specialists to do the investigate and edition twice. In the meanwhile, we also

invited the specialists to evaluate the validity and invited over 200 students to try out. If the result is good, it became the official testing questions.

- The progress of developing learning system: We applied the plan–do–check–action (PDCA) step. During the developing process, we continuously confirm, design the system, tests, and evaluation with the developers of materials and testing. When we finished the learning system, we invited students to try out and collect the feedbacks as modifying evidence.
- The progress of building smart classroom: According to the usage scenarios in the smart classroom, we will plan a list of hardware, software, internet, teaching, and learning behavior needed. We also ruled a management using progress of equipment. We provide some Q&A for teachers to handle unexpected events.
- The progress of training teachers: We do training for teachers, including how to use learning materials, quizzes, learning platform, and learning equipment. And students will be instructed by well-trained teachers to learn with inquiry-based nature science course.

2. Who are the participators? (Including collaborators)
   In order to finish all items for this project, we formed six teams which are project management team, material development team, test development team, system development team, project promoting team, and experimental schools.

   - Project management team: Program manager and planning staff.
   - Material development team: Subject specialists, materials developer, and design specialists.
   - Test development team: Subject specialists, test and evaluation experts, education statistics experts, and computerized test experts.
   - System development team: Programmers, hardware engineers, database managers, and computer art designer.
   - Project promoting team: marketing personnel, education and training personnel, and support stuff.
   - Experimental schools: Administrative staff, information management personnel, subject teachers, and students.

3. How long does it last?
   The project is operated from 2012/12/01 to 2015/07/31; we divided it into three stages.

   - First stage 2012/12/01 to 2013/07/31: developing the learning materials, quizzes, platform, and do the small experiment.
   - Second stage 2013/08/01 to 2014/07/31: continuously developing learning materials, quizzes, platform, and the large-scale experiment.
   - Third stage 2014/08/01 to 2015/07/31: we copied modes and do large-scale promotion.

11.3 Implementation Plan

11.3.1 Implementation Process: Focus on Innovative Teaching Strategies

In this study, a POE inquiry-based learning strategy was developed by combining a feedback-corrective learning process into the prediction–observation–explanation inquiry learning model. Students learned with five stages to deeply understand a scientific concept, and in the five stages, total students had three complete POE inquiry learning activities to think critically again and again. In each complete POE inquiry learning activity, instructor provided feedback to help student's correction in scientific concept. The POE inquiry-based science course was web-designed which could be run on an intelligent mobile device, such as pad or a conventional computer. Students learned in a smart classroom. The learning model process of the inquiry-based nature science learning materials is as follows:

Stage 1: Give a science question. Students must understand the question, have a scientific thinking, and predict the answer and the cause–effect relationships.
Stage 2: Guide thinking directions. The thinking directions help student analysis the science question. Students could start the inquiry activities from the directions and search for relevant information on internet. When students find out the answer and the cause–effect relationships, students must reply the science question by a multiple choice and typing the reason. Instructor immediately gives a feedback to help student's correction.
Stage 3: Provide learning tools. Students must find out the answer and the cause–effect relationships from the learning materials, and then reply the science question by a multiple choice and typing the reason again.
Stage 4: Provide similar examples. Students must find out the similarities and explore the cause–effect relationships to reach the correct answer. Then, students must reply and explain the science question third time. Instructor still feed back them.
Stage 5: Answer and explain. In this stage, we integrate the previous learning resources, including thinking directions, learning tools, and similar examples to explain in detail. Students receive the correct answer and cause–effect relationships, and construct the scientific concept and knowledge.

11.3.2 Process Management

The project was divided into three stages.

The first stage is doing small teaching experiment; there are six classes of fourth graders and 123 students joined. The experiment was conducted on the "Moon" program with three unit inquiry-based nature science learning materials. The experimental process for the learning activities was conducted in 5 weeks. In week 1, each student had a pretest for 40 min. In week 2–4, each week they had 40-min test for a lesson. The topics of these three lessons were "Why does the moon glow?" "Position changes of the moon," and "Phase changes of the moon." In week 5, each student had a posttest for 40 min and students must fill out a learning satisfaction questionnaire in 20 min. Pretest and posttest were the same questions with different orders. The learning satisfaction questionnaire consisted of six aspects (total 18 questions) on a 5-point Likert scale.

The second stage is large-scale experiment: there are 23 classes of fourth graders and 566 students joined. The experiment was conducted on the four programs with 12 unit inquiry-based nature science learning materials. The time of experiment for the first semester of fourth graders is as follows: the total time is 20 weeks from September 2013 to January 2014. The lessons which are developed by the project need to match up with the official lessons of schools. It needs to conduct four circles; there are 5 weeks for each cycle, and the total class is 15. The students must learn one program with three unit inquiry-based nature science learning materials. Teachers must use nine lessons to complete the official lessons and use another five lessons to complete one program of nature science course. The operating mode is same as the first stage.

The third is large-promotion: there are 24 classes of fourth graders and 666 students joined. The experiment was conducted on the other four programs with 12 unit inquiry-based nature science learning materials. The time of experiment on the second semester of fourth graders is as follows: the total time is 20 weeks from February 2015 to June 2015. The operating mode of those 20 weeks is same as the second stage.

11.3.3 Change Management

It must be under discussion and then execute if there is any unexpected event beyond the original plan in project execution. We have a convention once a month that every team needs to report the status of their own. In addition, every team needs to have 2–3 meetings to discuss any changes and requests.

11.4 Implementation Process

11.4.1 Deliverables and Achievements (Description)

Students in learning science process were usually with various cognitive domains including high-level intellectual activities (such as application, analysis, and synthesis) and low-level intellectual activities (such as memory and comprehension). To understand a complex scientific concept, we need a full range of capabilities.

Students need an appropriate learning model to help the high- and low-level intellectual activities at the same time.

In this study, we developed by integrating the feedback-corrective learning process and prediction–observation–explanation strategy of inquiry-based learning model. The feedback-corrective process could help students gradually get rid of scientific misconception, and deeply understand scientific concept (Lin and Chen 2011). When students have a memory or comprehension mistake, instructor could immediately give a feedback to help student's correction. In the feedback-corrective process, students were in low-level intellectual activities and improving scientific memory and comprehension. The POE inquiry-based model could promote students' conceptual changes by actively and encourage knowledge application as well as construction (Bednar et al. 1992). When students in the POE inquiry process, students must have application, analysis, and synthesis scientific knowledge to observe and explain scientific phenomena. The high-level intellectual activities improve student's application, analysis, and synthesis ability.

The positive effects were intensified in the continuous POE inquiry learning activities and feedback-corrective process for students in learning science course. Students have a deeply understanding again and again for scientific concept and knowledge in each POE inquiry activity. Students could gradually improve the learning performance in science course.

11.4.2 Benefits for the Stakeholders

For students:

- Improving science learning performance will strengthen the ability of science thinking.
- Adaptive learning can help the students who have different learning abilities.
- It can really fit technology into learning life by long-term and full technology learning.
- It has full digital learning portfolios which can help on tracking and improve learning condition.

For teachers:

- Enhancing the teaching efficiency can help teaching results and class management.
- Monitoring the learning condition timely and providing the suitable instructions for students.
- Long-term and full technology for teaching can enhance the information ability from teachers.
- The mode which used in smart classroom can be copied rapidly to different occasions.

For working stuff who attended the project:

- Familiar with how to build the smart classroom.
- Familiar with how to develop the digital materials.
- Familiar with the progress of developing computerize test.
- Familiar with the developing of learning system.

They can create the business value of smart classroom by large-scale promotion and application. They can get academic result by working on an essay.

11.4.3 Outcomes

Summary of Benefits:

The project assists 18 elementary schools to build up a full teaching and learning mode of smart classroom, which make 1355 students learned at smart classroom. A quasi-experiment design with nonequivalent pretest–posttest control group design was conducted. The learning performance test was both used in pretest and posttest to evaluate students' learning outcome, and such an approach for developing achievement tests has been used by several previous studies (Hsiao et al. 2012a, b, 2013; Sung and Hwang 2013; Wu et al. 2012; Yang and Wu 2011). The collected data from the pretest and posttest was examined by descriptive statistics and paired-sample t test. These approaches were used to analyze the variation of pretest and posttest for each group.

For example in the first stage, the posttest scores (Mean = 13.49, Std. = 4.38) were better than the pretest scores (Mean = 10.43, Std. = 3.65). The results from the paired-sample t test showed that a significant difference ($t = 10.56$, $p < 0.001$) was found between the posttest and the pretest scores. The results show that students with the POE inquiry-based nature science courses improve their learning performance. The possible reason was that teacher provides frequent and specific feedback regularly correcting mistakes and students make along their learning path (Ozden 2008) and the POE-based strategy helps students to achieve better conceptual understanding for the concept of condensation (Coştu et al. 2012). It could be inferred by the feedback-corrective learning process and POE inquiry-based learning model. While students learn in the continuous POE inquiry learning activities, they have a deeply understanding again and again for scientific concept and knowledge in each POE inquiry activity. Students could gradually get rid of scientific misconception and improving the learning performance in science course.

In these three stages' experiments, students' science learning performance has enhanced prominently. The inquiry-based nature science courses help student understand the main points of science question, thinking directions, using tools, combining theory and examples, and finally constructing the completed scientific concept and knowledge. Students learn the problem-solving method in the continuous POE inquiry learning activities and mastered the scientific concept in the feedback-corrective process. As facilitators, instructors appropriately provide scaffolds, teacher's initiation, and feedback to assist student learning in inquiry activities. If teachers provide a support structure, students could internalize the technique.

Boundary and Limitation of the Initiative:

In Taiwan, there are various versions of learning materials for elementary school. This project is only focused on developing one material. Those schools which use other versions cannot attend the project. If the school does not have enough internet, the internet may disconnect when teaching. However, some teacher does not know how to improve the internet. Some teachers are object to teaching by digital equipment, they think to manage the equipment; the internet and learning system is a troublesome event. They are not willing to accept it.

Lessons Learned:

Teacher is the key person to promote e-learning. They must accept e-learning first, and then teaching by digital equipment. Hence, in the progress of building up learning materials, tests, system, and smart classroom, we designed standard operating procedure to ensure the quality. At the time of promotion, we also developed standard operating procedure of using mode which can make teachers get the correct information rapidly and accept digital teaching mode.

Future Direction/Plan:

It has a good effective at fourth-grade student stage when using inquiry-based nature science courses at smart classroom. We will promote horizontally to make more students use this learning mode. Also, we can promote vertically to develop other's grades' inquiry-based nature science courses.

11.5 Conclusion

Website, published reports, interior materials, and individuals providing information.

The learning system which is developed by the project is located at http://140.122.91.188/; the server is now placed at Department of Technology Application and Human Resource Development in National Taiwan Normal University. The research was partially supported by the "Aim for the Top University Project" of National Taiwan Normal University (NTNU) and the Ministry of Education and Ministry of Science and Technology. The reports were unpublished and will publish on 2017. The output of this project was 24 unit learning materials and tests, one learning system, one promotion manual, and three research reports. And we collected 1355 students' learning data with the inquiry-based nature science courses. We will analyze the data and write papers to propose future research.

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Chapter 12
How to Improve K12 Teachers' ICT Competence in Finland: The Joensuu Region Case

Mari Petrelius, Mikko-Jussi Laakso, Ilkka Jormanainen and Erkki Sutinen

Abstract Unlike the usual, administration-led approach to plan and offer ICT training for K12 teachers, an action-driven approach emerges from the school activities at the grassroots level. A Finnish instance of the action-driven K12 teachers' ICT competence training was designed and implemented in the country's eastern region around the municipality of Joensuu in 2015. It was based on two innovations: (1) trying-out new ICT-based learning methods or tools as in-class tutoring by peer training, and (2) sharing the results at a regional continuing education festival. The innovations tacked four common challenges in the ICT training: level of abstraction, training transfer, financial, and professional identity challenges; all of them having a human and a technical dimension. A parallel case in the country's south western region helps to reflect upon the approach.

Keywords Finnish education · ICT competences · K12 · Teacher education · Contextualization · Computing education

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12.1 Background

12.1.1 Global Trends

There are remarkable national and international efforts to renew curricula to meet the requirements set by two interdependent trends: the so-called twenty-first century *human* skills demanded in a knowledge economy and the rapid development of *digital* technology. For example, Australia has introduced a 'Digital Technologies' curriculum, which addresses computational thinking and the use of digital systems and data, as well as cultural impacts of technology. The specific learning objectives of the Digital Technologies curriculum are heavily geared toward algorithmic problem solving skills (Falkner et al. 2014).

As another example, England's new national curriculum includes areas, such as "computing" and "design and technology". England's new curriculum will expose programming to pupils already during the first grades with the learning objectives to design, create, and debug simple programs. The new computing curriculum in England is divided into three stages, where the highest Stage 3 (grades 7–9 in the UK school system) includes rather specific computer science skills, such as sorting and searching algorithms, modularity, and decomposition (Brown et al. 2014).

A key question of the technology and computing education research (CER) community is the pedagogy that should be adopted when teaching ICT skills for all students (Falkner et al. 2014). As another evidence of the recent emphasis on the interaction between the human and the digital in education, one of the rising pedagogical issues is *contextualization* of teaching computing. The computing educators are more and more demanded to bring real-life context into their teaching (Rick et al. 2012). There is an ongoing debate whether additional, context-dependent knowledge distracts students when learning abstract computing concepts and context-independent skills. From another point of view, often the students are struggling and losing their motivation when they are not able to see how the decontextualized content would benefit them. Then, the context can provide relevance for teaching and learning (Guzdial 2010). Beside contextualization, the renewed curricula emphasize interdisciplinary pedagogical approaches and projects; another indication of the emerging importance of the encounter between the human and the technology.

The European Commission estimates a shortfall of up to 825,000 ICT professionals in Europe by 2020 (http://ec.europa.eu/digital-agenda/en/grand-coalition-digital-jobs-0). Of all job vacancies in ICT, computer programmers are the most in demand, outnumbering the demand for other ICT professionals. This far, there has been limited response from the European education systems. Estonia and England have already introduced computer programming for all ages across the school curriculum, and for example, in Denmark programming is taught at some school levels. Others countries, such as Wales and Finland, are about to introduce these new ICT skills in their curricula in the near future. In other countries, while computing is not part of the compulsory curriculum, there are private and public initiatives and individual teachers who are trying to introduce programming into the classroom. It seems inevitable that all EU member countries must move in this direction if they are to meet the skills demands of the European economy.

It is clear that recent developments in school curricula and especially in ICT and computing education (CE) set new expectations for the learning environments and teachers' professional competencies. The main problem the school system is facing is the desperate shortage of teachers capable of delivering programming and coding as part of the curriculum. In particular, most primary school teachers feel hopelessly ill-equipped to do so and while there are an increasing number of extracurricular activities, such as technology and programming clubs for children, there are not enough ideas, resources, and training available for the teachers of younger pupils. This phenomenon is global—new school curricula all over the world propose that computing skills, including programming, should be taught at all school levels.

12.1.2 ICT Teaching in Finland

The basic right to education is recorded in the Finnish Constitution. It secures equal opportunities for every K12 student in Finland to get their education free including free textbooks and lunch during the elementary schooling. Finnish education policy is famous for quality, efficiency, and equity so every public school in the country is uniform in the quality. There are only margin of private schools in Finland and they all implement the same curriculum as do the public schools. Every Finnish school has its *school curriculum* that follows the National core curriculum. The National core curriculum is determined by the Finnish National Board of Education.

In Finland, the school curriculum does neither define the teaching methods, tools nor the textbooks. Teachers make their private decisions of the tools they use in order to implement the curriculum. In practice the teaching is arranged in the frames of those ICT tools that the school provides to the teacher and the class. The level of school ICT facilities and equipment has a great variation between the schools. The level depends mainly on the principals' decision of how to allocate the public funding among ICT resources and other school functions. In spite of the variation between the schools, Finnish schools in general have a good rate of ICT equipment.

Most of the K12 students also bring their own smartphones to the school with them, starting already from the first grade. Our estimate is that in the context of this paper, the Joensuu region in Eastern Finland, more than 80 % of 7 years old first grade students have got themselves a smartphone. In the group of 10 years old fourth grade students the number already exceeds 95 %. In practice, almost all the school children in Finland own a smartphone. Purchasing a smartphone to a child starting their school is a habit as common as purchasing a backpack or a pencil case. This is due to a Finnish habit of children spending their afternoons alone at home. There are no more landline phones at homes, so children need to have their own mobiles. However, schools do not make use of this widely available resource of mobile devices efficiently for learning. This seems to be mostly due to the lack of teachers' ICT competence.

As indicated above, in 2016 also the Finnish education system is about to go through a major reform of the National core curricula following the reform of the school curricula in both the primary (in Finland: grades 1–6) and secondary (grades 7–12) education. This reform is about to bring more ICT skills required in the teaching of all subject areas. In the core of the new national curriculum for basic education (grades 1–12) stand also seven dimensions of broad-based competence, including ICT competence. Within the dimension of ICT competence, the new curriculum obligates that children should learn several ICT skills, including the basics of software programming, already from the early age of 5–6 years (i.e., at Kindergarten before grade 1). This is a strong message from the Finnish policy makers—the Government, the Ministry of Education and Culture, and the National Board of Education—to strengthen the role of ICT in education both as a learning tool and as a learning outcome.

All Finnish teachers have a Master's level university degree and they have a wide pedagogical training. A teacher's university degree may contain studies of ICT uses in education, depending on their university and time of graduation. Teachers are trusted professionals, who enjoy recognized professional freedom and opportunities to influence their own work, methods, and development of their schools. Working teachers are obligated to take part in continuing education and training for 3 days per year. This is usually arranged by the school or education providers within the municipality. Teachers have also a possibility to suggest any training to be counted in these 3 days. In Finland teachers have been given a lot of responsibility for their own professional development.

Due to the large autonomy that Finnish teachers have in their work and professional development, the teachers' ICT competences has a lot of variation. Most talented ICT users seem to be the ones that have a true interest in the topic. Finnish teachers are not evaluated in their work through any external or formal measures. In practice the same applies to the use of ICT in education. In a European survey, the Finnish schools were ranked at the top in the opportunities to use ICT in education, i.e., the amount of technology at the schools was very high (https://ec.europa.eu/digital-agenda/sites/digital-agenda/files/KK-31-13-401-EN-N.pdf). Somewhat surprisingly, however, Finnish teachers' willingness to use ICT in education and self-confidence in their own ICT skills was found to be low. This is maybe due to factor that ICT skills and the practical application of those are not widely present and adopted in their university studies, and the leap to gain these skills through personal development is too challenging for many teachers.

As a conclusion, the rich digital resources possessed by the Finnish schools could be in a more effective and efficient use if the teachers had more readiness to use ICT in teaching. The implementation of the new K12 curriculum in 2016 brings about a growing demand for improving K12 teachers' ICT competence. The challenge is well known among Finnish policy makers, educational leadership, and management, as well as concrete learning communities at schools: teachers, students, and parents. However, the success stories are few, and the readers of this paper are invited to form their informed opinions of the potential and merits of our intervention—an intervention that expects to learn from the shortcomings of earlier initiatives.

12.1.3 Case Study Design of the Paper

The case study presented in this paper addresses the socioeconomically rooted reasons that set particular challenges to renewing teachers' ICT competences. The teachers need to become fully able to teach ICT at K12 schools in a way that prepares the current school generations to the future society that is heavily founded on information and communication technology, as explicated in the policies of most governments. The study pays a particular attention to the innovative aspects of the case and its expected outcomes: the changes in teachers' attitudes to be part of the teacher-to-teacher movement to use ICT in most diverse and creative ways. The case study takes place in the crossroads of two global trends: the change of the humankind and the change of the technology.

The case study is based on an example of a regional intervention that addresses the challenges in K12 teachers' ICT competences by a teacher-to-teacher scheme in real school contexts. The intervention builds upon analyzed tacit knowledge of the challenges and is designed as a program where an expanding group of ICT-enthusiastic teachers serve as tutors among their peers. The intervention is a bipolar interplay between learning to apply ICT in the comfort of the teacher's own classroom and showing the successes to the peers at an annual science festival.

While the intervention is a regional one, we enrich our presentation by showcasing a related Finnish intervention from another region. While our primary case was carried out in Eastern Finland, in the Joensuu region, the reflective instance is from the Turku region, in the Southwestern part of the country (see Box 12.1). The presentation aims at an informed, or triangulated, view on how ICT competences among teachers can be enhanced in way that makes a difference—a true change—by renewing the level of integrating ICT in the everyday school practice, and getting teachers passionate about this opportunity.

At the point, it is worthwhile to remind that our intervention is *not* based on a baseline study of teachers' ICT competences, neither at the national nor the regional level. However, the work is based on the expectations and ideas of the new national curriculum that, again, is based on the informed view of the current situation. Complementary to the change requirements from the policy makers, we use tacit knowledge that the authors have gained over several decades from working with teachers and their struggle for better ICT competences.

Box 12.1: The Reflective Case from Turku Region, Background

The reflective case from Turku region is based on activities of ViLLE Team research group (www.villeteam.fi) at University of Turku connecting researchers, developers and teachers for joint development of the practice.

The group has acquired and conducted many projects with cities and municipalities in Turku region funded by Finnish Board of Education, Finnish education evaluation center and Ministry of Culture and Education. The main emphasis was laid on how to utilize new educational technologies with "common sense" in teacher's everyday life. The group has organized various teacher trainings and peer/tutor trainings with ViLLE—collaborative education platform using which teachers can easily create electronic courses, lessons, exams, and automatically assessed exercises. All created exercises and materials can be shared, utilized, commented, and evaluated by other teachers.

12.1.4 *Initiative Description*

12.1.4.1 Teacher-to-Teacher Feature

Our initiative was to improve K12 teachers' ICT competence and readiness to use ICT in teaching in a teacher-to-teacher way that would empower the teachers to openly try out new ways to enrich their teaching by ICT and *share* their experiences with their peers. Trying out would take place in tutor-based training at their own schools and in their own classrooms. For sharing, the teachers, in addition to co-learning at the own schools, would join a region-wide festival where they would teach their peers hands-on, based on their own, newly acquired skills. Thus, the initiative would take place as interplay between

- the school level and a regional level;
- one's own learning and teaching peers;
- doing with learning; and the human aspect of empowerment and the digital aspect of the tools to be learnt.

We focused on K12 teachers in the Joensuu region, located in Eastern Finland. The choice of a regional approach for this study means that both the intervention and its analysis emphasizes the changes at the grassroots level, whereas a national focus would yield results at a higher level of abstraction. The context is described in more detail in the Implementation plan.

In particular, we aimed to improve teachers' ability to use ICT toward the level needed for the implementation of the new K12 curricula. The new Finnish K12 curricula are characterized by the use of ICT as both a tool and a learning outcome in all the subject areas.

12.1.5 *Overall Objectives*

As a regional project, supported by public funds, our objectives were pragmatic and based on the concrete challenges identified from the everyday school practice. Based on the authors' extensive experience in ICT training for K12 teachers in two regions of Finland, we can summarize the practical challenges in teachers' ICT competence and continuing ICT education in the Joensuu region as exemplified in the following:

1. Level of abstraction challenge. Training requested by the teachers should often be more pragmatic than the one commonly given by commercial ICT consultants.
2. Training transfer challenges. ICT training given by an ICT consultant transfers poorly to practice if the consultant is not a working teacher himself.
3. Financial challenges. Schools do not have financial resources to hire a substitute for the teacher that is taking part in ICT training outside the school.
4. Professional identity challenges. Teachers need to believe in themselves better. Teachers' professional identity need to be developed to include also the aspects of ICT use in education.

It is worthwhile to observe that all of the four categories of challenges have both a human and a technical, or digital, dimension, and the one can easily identify many more examples of them in addition to those mentioned above. For example, financial challenges have a human aspect of prioritizing and making decisions of the allocation of resources, and a technical dimension of substituting a teacher as a digital tutor. A financial challenge can also materialize as a demand for renewing the utilized digital learning platform. However, it is the above-mentioned challenges that our very initiative wanted to solve.

12.1.5.1 Innovation 1: Trying-Out by Peer Training

Our first innovation was to offer the teachers highly pragmatic ICT training that would transfer straightly into new practices better than before. We implemented it in the way that would not raise a need for hiring substitute teachers. The best trainer for that was found out to be a peer teacher with wide knowledge of both the ICT use and the new curriculum. The trainer was then asked to act as an ICT tutor to another fellow teacher or a small group of teachers.

The training took part in several manners; by private individual tutoring, by small study groups and by in-class tutoring. By *in-class tutoring* we mean training given to the teacher and his students in the class. This happened during the real school lesson. This was planned for two reasons. First, we wanted to avoid the need for hiring substitute teachers. Second, in-class tutoring helped to implement and practice the newly acquired skills as there was support and backup to the teacher while trying a totally new learning method or learning tool.

We also planned that ICT tutors would collect a group of suitable teachers for educating other teachers, thus expanding the primary peer tutor network. During their visits to the schools, ICT tutors collected information about suitable workshop holders for the incoming event of continuing education. During the ICT tutors' visit, teachers gained a new talent and afterwards they were asked to share it with other teachers by arranging their own workshops at a SciEDU continuing education event later during the semester.

12.1.5.2 Innovation 2: Sharing at SciEDU Continuing Education Festival

Our second innovation was to empower the teachers to find and recognize their existing ICT competence. To achieve this goal, we organized together a science and technology continuing education festival that we named SciEDU. It was meant for both the fellow teachers and also for the whole community of Joensuu region, for transparency and visibility. Organizing the SciEDU festival relied on the Joensuu region's teachers' cooperation and willingness to educate each other within the region.

At the SciEDU continuing education festival there were teachers from every school introducing their grassroots level ICT projects and teaching methods to their colleagues. The whole program was arranged according to the new 2016 curriculum to implement it already beforehand. This was actually the first time ever that the new curriculum was actually implemented beforehand.

Every teacher of the Joensuu region was assigned to take part in the science festival either as a visitor or as an organizer. Visitors got a 6 hours' continuing education day from their employees to take part in the program, and the organizers got if for organizing the program to the visitors. This was a real-life learning-by-doing experience for both the organizers and the visitors.

The SciEDU event was also designed to be a mobile game in itself to make the teachers familiar with the concept of gaming in education. This was arranged by using a Smartfeet mobile application that could run a game designed by the ICT tutors. See Fig. 12.1. Visiting teachers took part in the game with their own mobile phones or tablets.

To engage with the rest of the community and its various stakeholders, not least the parents of the school students, and to get visibility of the importance of learning ICT competences at school, the SciEDU festival was also open and free to access for the whole community. Anyone could come to the festival to meet the teachers of their children, see the new learning methods in action and see the new tools being demonstrated. At the same time it was also possible to see how the teachers are being trained toward the upcoming new curricula.

Table 12.1 indicates how the innovations described above were expected to meet with the identified challenges.

Funding. For ICT tutoring, we applied funding from the Finnish Ministry of Education and Culture. We received a 70,000 euros' grant for hiring one full-time ICT tutor and one part-time ICT tutor to work at the Joensuu region schools for

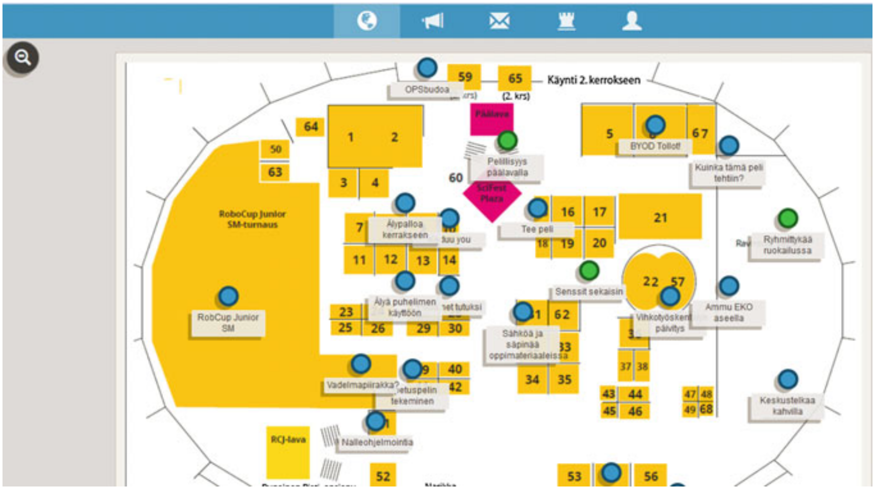

Fig. 12.1 Seppo mobile game. Seppo mobile game in SciEDU continuing education event. A player's map over the game zone Joensuun Areena. *Numbers* resemble the workshops given during the day, *dots* resemble the events in the Seppo mobile game

Table 12.1 Innovations meeting challenges

Challenge	Innovation 1: trying-out by peer training	Innovation 2: sharing at SciEDU continuing education festival
Level of abstraction	Giving continuing education in ICT competence via learning-by-doing: recognizing the organizing work also as one method of receiving continuing education	Continuing education event expanded as a mobile game
Training transfer		ICT tutors encouraging the teachers to demonstrate their new skills in the SciEDU continuing education event
Financial	Practical ICT tutoring at the schools by a fellow teacher during the lessons	Continuing education event open to all teachers of the area implementing the ICT skills needed for the new curricula
Professional	Empowering teachers' ICT competence via SciEDU teachers' continuing education event	

1.5 years. This funding was meant only for the salaries and traveling over the geographically wide area of Joensuu region.

For the science and technology festival SciEDU and its 1200 teacher participants, we did not have a specific funding at all. We made the festival mostly by voluntary work and with the strong support of SciFest Science and technology festival overlapping for the day. SciFest was arranged at Joensuu Areena building by the Joensuu Science Society and the University of Eastern Finland. Joensuu Science Society and University of Eastern Finland covered together most of the expenses of the infrastructure to the event.

Our objectives were to reach all the teachers of the Joensuu region by empowerment and to enhance the ICT competence of the teachers.

The description of the initiative in the reflective case, with its innovative features, overall objectives and funding, is presented in Box 12.2.

Box 12.2: The Reflective Case from Turku Region, Initiative Description

In Turku region, the challenges and actions were quite similar to Joensuu region. Here we present two innovations to tackle these challenges.

Innovation 1: Sharing Electronic Learning Resources Through ViLLE Collaborative Education Platform—"From Teachers to Teachers"

ViLLE is a collaborative education platform, enabling teachers to create electronic courses, lessons, exams, and automatically assessed exercises easily. All created exercises and materials can be shared, utilized, commented, and evaluated by other teachers. Moreover, ViLLE automatically gathers data about students' learning behavior and performance while they are using the platform. This creates new research possibilities as huge amount of quantitative and qualitative data becomes available.

The deliverables from teacher training and peer tutoring sessions included electronic exercises, lessons, and exams which were published in the ViLLE platform for public use. This enabled sharing electronic learning content and collaborative work between teachers in very pragmatic way.

Innovation 2: Peer/Tutor Training in Classrooms

All training sessions were connected to the ViLLE platform. The main goal for the tutoring session was to ensure that all participants achieved positive experience of using learning technologies in classroom with various learning settings. Instead of just showing how to use technologies in classrooms, teachers were given the possibility to find their own ways of adapting the platform to support their classwork.

- Teacher, peer/tutor trainings with ViLLE Team research group
- The use of ViLLE—collaborative education tool:, i.e., utilizing automatically assessed exercises with immediate feedback in various learning settings
- First four learning sessions with the teacher were peer/tutor trained by ViLLE Team research group member
- Followed by three learning sessions later in the course's timeline in which the goal was to reflect and to catalyst the adaptation process.

12.2 Implementation Plan

The implementation context: the Joensuu region

The scale of the implementation was local and regional. For this implementation, we chose the Joensuu region that covers an area of seven municipalities, with 12,000 elementary school students, 1000 elementary school teachers, and 200 high school teachers. Joensuu region is geographically challenging area for cooperation because it is scattered and wide.

The schools of the region are located in urban and suburban settings of towns and in the rural countryside. Municipalities differ in their size and resources for education. In our implementation, we planned to reach 100 % of the primary school teachers (grades 1–6) and 30 % of secondary school (grades 7–12) teachers of the region, either via peer tutoring or via the SciEDU continuing education event. We did not aim to reach all the secondary school teachers, because there was another extensive series of continuing education for two main secondary schools of the region going on at the same time and their teachers were already signed up for the events of those series.

A dual strategy

According to the initiative description, the plan was to organize a dual of ongoing ICT training and an annual gathering for sharing the competences learned at schools with peers, i.e.,

1. *Peer training* to the local schools by having an ICT tutor teacher rotating between the schools for the whole school year; and
2. SciEDU continuing education festival to be held for the teachers and for the community with the following principles: free for everyone to access; free of charge to the schools, participants, and visitors; implementing the upcoming curricula in practice; encouraging teacher cooperation and voluntary work in event organizing; having a mobile game in event itself for intensifying the participation of the teachers.

Due to the dual plan, the plan consisted of two intertwined threads: one for peer training, and the other for the SciEDU festival. The focus of both of the threads was to ensure that technology contributes to the effective teaching and learning. The effect of the intervention, and thus the outcome, was to be evaluated by how the four challenges presented in the initiative description were met.

The peer training was planned to be realized by the schools' demands, so the emphasis was on hiring capable ICT tutors (see below) for the task.

The SciEDU festival was to be arranged as a part of the SciFest festival as a set of workshops. Again, the plan was not to define the program beforehand, but to assemble the program of the festival from what would emerge from peer training. Moreover, the workshops were expected to feed back to peer training. The overall plan for the festival is given below.

SciEDU Program
8.30 Doors open, registrations
9.00 Opening speech, National Board of Education
9.15–10.15 Workshops
10.30–11.30 Workshops
11.30–13.00 Lunch and exhibitions
13.00–13.45 Workshops
13.45–14.00 Coffee break
14.15–15.00 Workshops
15.00 Closure and awards

Designing the Seppo game. A Seppo educational mobile game for the SciEDU day was built beforehand. Seppo is a commercial product made by Flying Chalkboard Ltd. Seppo is alike a board game that is in the internet and that can be played via mobile phones, tablets, or computers. Our game had one task for every workshop at the event. The mission was to complete as many tasks as possible during the 6 hours' training day. The game was meant to be played in groups of ten participants. In practice, this meant that all the members of the groups were able to collect points at the same time from different tasks. This allowed participants to make individual choices about their own continuing education plans. To make the game a bit more exciting there was some mission about socializing too. For example, the group members were asked to have lunch together and post a selfie photo for the game from the lunch and form the coffee break. This was made to encourage teachers to get known with each other.

Human resources to be allocated.

12.2.1 Hired Staff

Project was to be led by the ICT coordinator of the City of Joensuu Educational services. The project organization was planned to be carried out by two ICT tutors, who would work for the Joensuu region under the supervision of the City of Joensuu Educational services. Also the curriculum coordinator of the Joensuu region was to take part in the weekly planning sessions. Some help for organizing was also to be given by the ICT group of Joensuu region, which consists of ICT specialists from the municipalities involved.

As the ICT tutors, the plan was to hire two experienced teachers with good ICT skills and a wide knowledge over the new curricula.

12.2.2 Joensuu Science Society

In addition to the schools and teachers taking part in the implementation, the group of organizers consisted of several stakeholders. An NGO promoting science education, called Joensuu Science Society, had hired one full-time person to build the SciFest event (www.scifest.fi) overlapping the SciEDU event. A lot of practical help was gained from taking into account the experience gained by Joensuu Science Society over the 10 years of arranging the SciFest science and technology festival for the children. Building up the SciFest to the venue of the Joensuu Areena gave a ready setting for the SciEDU event to occur easily.

Other stakeholders. University of Eastern Finland took part in the organizing of SciEDU event mostly via the School of Computing and the Department of Physics. Collaboration with all the municipalities of the region, several local enterprises, ICT specialists and authorities was essential. The whole ICT competence improving project was carried out together with another project about curriculum reform at Joensuu region.

12.2.3 Planning Schedule

Planning the festival was started in January 2015 by seeking for the appropriate workshop organizers and by informing the principals of the local schools for incoming training event for the teachers by the Educational services of the City of Joensuu. The amount of the participating teachers was counted in the first hand to make sure that the scale of the event would be planned correctly. The amount of workshops needed was accounted from the number of expected teacher visitors. The original plan had one workshop organized for every 20 teachers. When the amount of workshops was estimated, the ground plan for the festival infrastructure was drawn by Science Society of Joensuu.

The following 2 months were allocated for booking the workshop holders to the event. Approximately, half of the workshops were arranged by the fellow teachers working at the local schools. The other half was arranged by local companies that were connected to technology and education. The motivation for the companies to take part in the event was in both the teachers and the community, as the event would be open to all the community of Joensuu to visit during the day.

Every workshop holder was assigned for a place in the event and they were asked to bring all their supplies with them. Joensuu Science Society and University of Eastern Finland supplied the electricity and wifi for the workshops. Joensuu Science Society and Educational Services of City of Joensuu were responsible for the signs and maps displaying the arrangement and the names of the companies and workshops. All the workshop holders were called into arrange their workshops already a day before, so the festival would be ready in the morning when the event would start. This was made clear to all the workshop holders beforehand to make sure to have both a professional appearance of the event and a peaceful environment to the visitors to arrive.

12.2.4 Effectiveness Aspects of the Plan

Since the schools of the Joensuu region were already reasonably well equipped with ICT tools and other resources, the emphasis in the effective implementation of the plan was on rational allocation of the hired staff, to make sure that the program will make a difference it was expected to have. The following aspects were supposed to guarantee the results.

ICT tutors were expected to approach all the schools of the area via email and offer their services. One ICT tutor was to make careful bookings for her visits to the schools. The days of her services were to be booked up by the reservation order. She was also supposed to inform the schools for the rule of 2 weeks. This rule intended to keep her from staying over 2 weeks at the same location to ensure the rotation and allow as many schools to get her services as possible.

The ICT tutor was to be equipped with a set of 25 iPad2 devices to borrow to the school classes for a week. Her weekly plan was to go to schools on Monday to give one or two classes of the same school an iPad kickoff training. Devices were left to the class for 1 week to borrow. For the other days, ICT tutoring was to be booked to other schools to practice ICT use with their own facilities. The main idea was to demonstrate that there is much to do even with a limited number of devices.

At her visits, the ICT tutor was expected to encourage the schools to take part in the planning of the SciEDU event. The idea was that those teachers who would gain new skills via ICT tutoring would come to the event and arrange a workshop of their own. The ICT tutor was to share information about the upcoming events to the schools to prepare them for participating the event.

For a few days, ICT tutors we supposed to work at office and help with the arrangements for the SciEDU event, plan incoming training sessions, update the project website and coordinate the peer training part of the project. They were also to arrange small workshops for the teachers about media literacy and copyrights.

12.3 Implementation Process

As mentioned in the Implementation plan section, the implementation process of the planned intervention was *action-driven*. This means that the plans for the two main threads of the intervention—peer training and the SciEDU festival—were only to set up both streams, and then the implementation emerged from the actions of the streams. In addition, the peer training fed into the festival as workshops designed and carried out by the peer-trained teachers. Therefore, the implementation process was not supervised but supported, and was therefore not analyzed to the detail. Hence, this section presents the main features of the process, while the outcomes are collected and analyzed the Outcomes section.

The way of implementation was the key factor for the innovativeness of the intervention. We wanted the process to be open and attractive for the participants' ideas and actions, without deciding beforehand the topic of, e.g., the workshops. While the actions grew from the grassroots demands of the school practice, the intervention paved the way how ICT can change the conventional schooling.

The implementation process took place in school year 2014–2015, from August 2014 until July 2015. During the implementation peer training was arranged in 70 personal training sessions, in total for 275 h by ICT tutors. There were also 22 small workshops arranged by the ICT tutor in the schools during the implementation.

Peer training was given to the teachers and classes in the following themes: the use of iPads in preschool education, the use of iPads in primary education, the use of the local e-learning environment called peda.net, copyright issues, and media literacy.

Science and technology festival SciFest was held in April 23–25 and had 11,000 visitors, mainly school classes and teachers. The SciEDU teachers' continuing education festival was held on Saturday 25 of April. There were voluntary teachers from the local schools and local companies, arranging 69 workshops to over 1100 teachers that took part in a 6 h training day. The SciEDU Saturday was arranged as a part of every working teacher's compulsory 3 days allocation for continuing education. The decision to do so was given by the heads of educational offices of all the seven municipalities in the Joensuu region.

SciEDU was a mobile game in itself. While entering the building of the Joensuu Areena, the teachers also entered the Seppo educational mobile game that was designed and implemented for the SciEDU day. Teachers used their own mobile devices, e.g., tablets and mobile phones, for entering the game. They earned points for their groups by taking part in the different workshops. Groups were allocated randomly to enhance cooperation and getting involved with new colleagues. There were 6 h time to play, and at the end of the day the winner group was announced and awarded a small prize.

12.3.1 Process Management

The process was managed by a small core group of organizers. To the group belonged representatives from the City of Joensuu Educational services, Joensuu Science Society and University of Eastern Finland. Joensuu Science Society and University of Eastern Finland took together care of the infrastructure of the festival place including building the festival arena: illumination, partition walls to the workshops and basic functions of the festival. The City of Joensuu Educational services sought for appropriate workshop organizers, accepted the registrations of the visitors, informed the teachers in advance, and organized the mobile game of the day. Process management was done in the most cooperative and informal way, leaving space for the innovations and fast changes for the program of the day. Authority was replaced by shared expertise and trust.

The whole SciEDU event was arranged by a specific way of voluntary work, called "talkoo" in Finnish. That is a Finnish word for voluntarily carrying out an extensive task together, with a large group of participants for common good. The word does not translate well to other languages, as it is typical of Finnish culture. There was no money paid for the workshop organizers or other staff that worked in the event. The only expenses of the event rose from the infrastructure and lunches for the participating teachers. Compared to volunteerism in, say, the Anglo-Saxon context, the Finnish talkoo concept resembles collaborative actions occurring, e.g., in the Amish communities.

12.3.2 Change Management

The motivation for the urgency of change management in the project is rooted in the target group's, i.e., Finnish teachers' highly autonomic role at schools. They do not easily buy the givens at the continuing education courses. ICT, much too often instructed by commercial consultants (see Initiative description above), easily raises a critical or even negative attitude. Therefore, the key idea of our intervention was to renew the school from inside, by a teacher-to-teacher approach, concretized in both peer training and the SciEDU workshops. The best advertisement for new practices is success stories, shared by peers.

The whole program of professional continuing education about ICT and technology was itself a huge process of change management, applied to the teachers' community. It aimed at the transformation of teachers and school organization to a state of welcoming and being able to implement the new curriculum in teaching with the help of ICT. A major focus of the change management was the attitudes toward a continuing state of change in the school world. By both the peer training and the SciEDU festival we encouraged the teachers to embrace the change instead of being afraid of it. By inviting teachers from every school to arrange workshops, we empowered the schools and teachers by letting them to notice that they already hold the keys and tools to the incoming curricular change by themselves.

The change management orientation of the intervention allowed us to identify several factors that affect teachers' perceptions and attitudes toward the changes opened by the new technology and the skills that are required to utilize the new tools in teaching. Teachers may feel *fear for technology* so that they do not know enough about rapidly evolving ICT tools that are brought into schools. Being aware of the "state-of-art" requires a remarkable effort and motivation to follow new products and to get familiar with their possibilities. However, teachers often forget that also existing and familiar tools can be applied creatively to deliver meaningful solutions and ICT education that is well aligned with the new curriculum.

Teachers might feel that they have lack of ICT skills that are needed to reach the expected quality in teaching. This is often connected to the fear of losing control when using technology in teaching. Students are in many cases more skilled ICT users than teachers, and they have their own mobile and smart devices with them. This easily leads to a situation where technology is considered as a distraction rather than advancement in the classroom. The recent "Bring Your Own Device"

(BYOD) concept may help to overcome this issue, but BYOD approach is not often appreciated by the school management and IT departments. Furthermore, teachers, especially the experienced ones, have probably used same teaching materials and methods for years but adopting new technology in teaching causes inevitably extra work that falls to the top of other professional duties.

The implementation process of the reflective Turku case in given in Box 12.3.

Box 12.3: The Reflective Case from Turku Region, Implementation Process

In the reflective case in the Turku region, there were readymade electronic materials and exercises for many topics in the ViLLE platform. The types ranged from automatically assessed exercises to electronic exams and interactive tutorials.

The whole process included the following steps:

- **Step 1: Teacher training**
  Teachers were introduced to many success stories about utilization of educational technologies and methods in teaching with practical approach.
- **Step 2: Adopting technologies with the tutor/peer**
  Teacher was instructed to find, with the tutor's aid, the ways how she could adopt novel technologies and methods in her teaching.
- **Step 3: Tutor/peer training in classroom**
  Four to six consecutive tutoring lessons in which the tutor aided the teacher to carry out the adopted change(s) in practice.
- **Step 4: Feedback collection**
  The process was reflective and the feedback was collected from the teacher and from the students to make necessary changes to the learning methods and materials.
- **Step 2–4: Sharing of electronic resources through ViLLE**
  In all phases of this process the ViLLE platform was used for utilizing existing and sharing of created electronic learning resources.

The third step was really important because while introducing new technologies the teacher needed to overcome many big "mental" hurdles like how to get student's into the platform, how to reset passwords for students, etc. When we combine this with the teacher's low self-confidence in the use of technology, the tutor's role as mental support was crucial for getting positive experiences.

By utilizing these steps the teacher felt that she received the support she needed. Many changes were small in the beginning of this process, like introducing small number of automatically assessed homework exercises, an electronic lesson, or electronic exam, etc. After the positive experience, many teachers utilized more and more changes with growing self-confidence, motivation, and attitude ("I can do this").

12.4 Outcomes

We implemented the new Finnish curriculum for the first time in Finland for a whole training day at SciEDU2015. We arranged the SciEDU continuing education festival for 1200 K12 teachers. There were over 70 themes raising from the philosophy of the new curriculum, all implementing various uses of ICT in the education. The whole co-training event was also a mobile game in itself. We got 1200 teachers to play through it during the day. They all got familiar with the concept of using gaming in education by their first hand experience.

The implementation of our dual strategy in enhancing K12 teachers' ICT competences in the Joensuu region was successful. The set of the outcomes from the project can be outlined as follows:

1. Quantitative outcomes, like the number of the trained teachers;
2. Qualitative outcomes, like the feedback from the participants and other stakeholders;
3. Peer training materials;
4. Workshop outputs;
5. Concepts and models;
6. An analysis framework for evaluating the effects of teachers' ICT competence training actions; and
7. Other benefits for the stakeholders.

Below, we will briefly concretize our main outcomes. However, since the quantitative and qualitative outcomes do not have a general validity outside of the region, we do not address them in this paper. The same applies to peer training materials that are completely in Finnish.

12.4.1 Workshop Outputs

An analysis of the workshop outputs reveals that a grassroots level approach which relies upon the teachers' own demands yields a set of workshops that cover the diversity of the original challenges surprisingly well. The workshops supported a large spectrum of ICT competences for different school levels and met the diverse challenges.

12.4.2 Concepts and Models

As an outcome we created a new way of peer training K12 teachers in a considerate and personal way via the Carelia ICT model, developed in the project. Figure 12.2

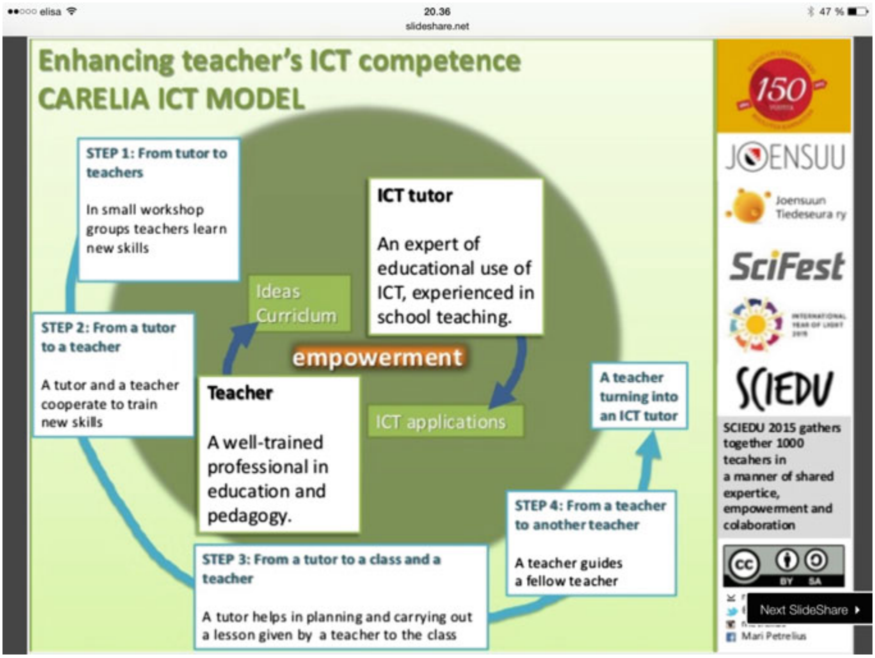

Fig. 12.2 The Carelia model

shows how the model expands ICT competence by transforming novices into peer trainers of their colleagues.

An analysis framework for evaluating the effects of teachers' ICT competence training actions. We derived a scheme that allows the organizers of a teachers' ICT competence training action to easily collect data on how the activities contributed to the growth of diverse ICT competences, checked against the challenges identified in a given context. Besides for evaluation, the framework can also be used as a planning tool for a given action.

Other benefits for the stakeholders were the following. The City of Joensuu and municipalities in the Joensuu region achieved a comprehensive training and first hand experiences for using ICT in education according to the new 2016 curriculum. Joensuu Science Society got to expand its science festival concept to the continuing education of the teachers from Kindergarten to the secondary school level. For the University of Eastern Finland, SciEDU gave a new way for recruitment and training of teacher students.

The outcomes of the reflective case in given in Box 12.4.

Box 12.4: The Reflective Case from Turku Region, the Outcomes
The outcomes of the reflective case in Turku are divided to number, pedagogic, and other outcomes.

In numbers

- More than 15,000 students are utilizing ViLLE platform
- More than 1000 teacher are utilizing the platform
- Over 750,000 exercises are automatically graded annually
- More than 7,500,000 immediate feedbacks for student while learning
- More than 15,000 public exercises in electronic form created by the teachers that are sharable
- Hundreds of readymade courses in public content

Pedagogic outcomes

- Teachers were more confident of using educational technologies
- Teachers were open minded to sharing their electronic learning content and doing collaborative work with others
- The changes are not limited just utilizing electronic learning content, the teachers found news ways to deliver education with technological support

Other outcomes

- **Data collection**: Huge amount of education data is stored while student are solving the exercise in the ViLLE platform
- **Learning analytics**: Educational data collection creates new research possibilities. For example, the researchers can conduct big scale learning analytics studies like automatic recognition of student's misconceptions and preventing drop-outs, and targeting extra support for those who are struggling.

12.5 Conclusion

Improving K12 teachers' ICT competence by pragmatic teacher-to-teacher ICT tutoring got a positive approval and feedback from the teachers, principals, and the school communities. It was given specific credit for its flexibility, personalized manner, and easy approachability from the communities. Principals and school leaders appreciated the easiness of the continuing education concept via an ICT tutor and the ready planned and carefully chosen contents of the training sessions. Teachers gave credit about the personal features of the ICT tutors as well as the reliability and good spirit in the training sessions.

The main limitation for the success was the amount of ICT tutors compared to the amount of teachers and schools. In the near future, we will increase the amount of ICT tutoring at the schools. For this we have applied and already received 600,000 euros funding from the Ministry of Education and Culture. With the help of new funding we will be able to hire four ICT tutors for the region to work until the end of 2016. By that time the new curriculum should be taken into daily use at the schools and the need for improving teachers' ICT competence has to be met.

Improving K12 teachers' ICT competence by empowerment via arranging the SciEDU continuing education festival was a success. We got to arrange an event that was a mobile game in itself and that gave a possibility to individual teachers to choose the program for 6 h training day by themselves from a selection of 76 workshops.

The four challenges of teachers' continuing education in ICT competence were met. By the feedback collected from the trained teachers it was clear that teachers' ICT training at the schools by the peer ICT tutors had got more pragmatic than training before by the ICT consultants, as we aimed in the first hand. The teachers did like the peer ICT tutoring a lot and they found it to be a good and personal way of receiving continuing education. The feedback contained a lot of personal thanks targeted at a specific trainer person. This makes us assume that the personality of the ICT trainer is actually an important tool and that teachers working as peer ICT tutors should possess accessible and friendly attitudes and therefore be selected carefully among the staff. It seems to be easier to go through one's personal professional development challenges with the support of a friend. Many of the trained teachers did get friends with their peer trainer.

As Finnish teachers do not go through a formal evaluation of their work, we have no quantitative way for measuring the trained skills transfer into the practice. Yet the feedback collected from the trained teachers gives us a signal that there has happened a change in the teaching methods and tools among the teachers trained in their class. The change pursued by this new continuing education method cannot be measured in one semester. It will show its merits in a more indirect way throughout the coming years and the implementation of the new curriculum in the schools of the Joensuu region.

There was no need to substitute teachers at the schools during this continuing education project. The training sessions were carefully planned and implemented either in the classroom with the whole class or at the time when the teachers were not involved in teaching, e.g., afternoons and jumping hours of their schedules. The SciEDU continuing education festival was arranged on Saturday when Finnish schools are not open. It was included in the amount of continuing education that the Finnish teachers need to take every year.

The change in the challenge of believing to themselves better and growing in professional identity as an ICT user is long and continuing. We believe that the amount of workshops arranged in the SciEDU continuing education festival by the local teachers was high. There is nothing to compare it with, since the event was the first of its kind. Over a thousand of teachers took part in the SciEDU continuing education event for 6 h. They all got to learn about gamification by doing it themselves during the event. Teachers were allowed to choose freely the practical workshops in the areas of their personal interest.

The reflective case from the Turku region features similarities to the Joensuu case. However, in Turku case the teachers could share their learning and new competences by the ViLLE platform. Similar and still somewhat complementary experiences indicate a need to learn from a given region at the grassroots but at the same time learn from the experiences from another region. While a national, top-down curriculum has its merits, its realization has to take place from within schools and their realities.

Future Directions

The future will bring novel opportunities for the schools to apply ICT in a way that bridge digitization with the emerging human demands. The technology can embed the school into its context, so that learning takes place in a natural setting, on demand. This is based on open architectures that allow access and sharing of others' resources. It requires a new attitude from teachers to collaborate and constructively evaluate their own and others' materials and tools. Finally, technology does not dictate the way to learn in a given way, but rather follow one's own way and style of learning, as in a buffet.

A naturalistic approach—combined with advanced learning analytics—to learning paves way to digitizing one's learning path from a toddler to a doctor, in a learning landscape that exceeds limiting and artificial boundaries in a transdisciplinary way. For the teachers' ICT competences this trend and development means a continuously increasing challenge: it is also the continuing process itself that will be embedded in the everyday school practice as its ubiquitous thread.

To fully utilize and even enjoy the opening opportunities, the learning community needs to work in a glocal way: locally within a given learning setting, and globally sharing ideas, technologies, and common ethics.

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Sutinen has been working earlier at Purdue University, University of Linköping, and University of Eastern Finland. In 2010–12, he worked as the chief technical advisor of STIFIMO, a 22 M€

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Professor Sutinen received his Ph.D. in Computer Science from the University of Helsinki in 1998. In 2010–12, he was an extraordinary professor at North-West University in South Africa and, and is an adjunct professor at Tumaini University in Tanzania. He has also a secondary school teacher's qualification.

Chapter 13
Using Learning Technologies to Enhance Numeracy Competence in Rural Public Schools

Imran A. Zualkernan and Asad Karim

Abstract Effective use of learning technologies to improve access and increase quality hold a key promise for developing countries that are plagued with low-performing educational systems. Public school systems in many of these countries have failed to provide adequate quality and access to education for their citizens. Consequently, there is a mushroom growth in low-cost private schools that typically are even more starved for resources, and often have lesser-qualified teachers. Despite their shortcomings, public schools in many developing countries have better physical infrastructure than the low-cost private schools, and the public-school teachers are better trained and are paid more than their counterparts in the low-cost private schools. This case study describes a series of learning-technology interventions in public schools of Pakistan to enable teachers to provide higher quality education in numeracy skills for grade 5 students. The interventions are based on a theory of change that postulates that just-in-time teacher training synched with delivery of topics, together with bi-weekly formative assessments and high-quality focused teacher mentoring will lead to better classroom practice. This classroom practice, should, in turn, lead to better learning outcomes. The intervention uses a host of learning technologies including a learning and content management system, a tablet-based assessment system, and an Internet-based live classroom. The delivery mechanism is a self-contained satellite-enabled van that visits each rural government school once every 2 weeks. This case study describes a three-year effort and lessons learned while scaling up the intervention from 10 to 300 schools. One key lesson from this case study is the importance of monitoring mechanisms to maintain the fidelity of the process especially as it scales.

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13.1 Case Overview

This case study describes the use of a host of learning technologies to provide just-in-time teacher training and mentoring and technology-based formative assessments to remote rural schools in Pakistan. Even though the national education policy strongly suggests a wide-spread use of ICT to promote education, actual ICT-related government initiatives on the ground are in their infancy in Pakistan. This can be partially attributed to the technologically challenged environment where more than 50 % of the government primary schools in Pakistan do not have electricity. The case study deals with improving numeracy skills for grade five students in government schools that have little or no ICT infrastructure. A self-contained learning van with a satellite-based internet connection was used to bring high-quality just-in-time tutoring, mentoring and formative assessment capabilities to teachers in their own schools. Over a 3 year period from 2012 to 2015, multiple experiments using control and treatment schools have yielded statistically significant learning effects that range from small to large. Each study lasted one full academic year. Using an evidence-based approach, the intervention has been tested so far in about 250 schools. All the interventions have been funded by donor agencies. Significant lessons in effective scale up of such interventions include need for strong mechanism to maintain implementation fidelity, importance of alignment with the implementation's social and political context, and a strong partnership with the government. Use of learning technologies in a holistic manner can yield impressive improvements in resource-constrained environments like Pakistan. However, there is also a need to continually rationalize and reduce the cost of such interventions.

13.2 Background

Effective use of Information and Communication Technology (ICT) to enhance education has been recognized in the 2009 National Education Policy of Pakistan (2009). The policy states that use of ICT will be promoted as per the National Information and Communication Technology Strategy for Education in Pakistan (NICTSE) (2005). In addition, the national education policy states that ICTs will also be used to assist teachers and students with a wide range of abilities and from varied socioeconomic backgrounds, and that ICT will be utilized to strengthen and improve the quality of teaching and educational management. Earlier in 2005, NICTSE had been passed by the federal government in Pakistan and included the following six elements:

- Use ICT to Extend the Reach of Educational Opportunity
- Apply ICT to Strengthen the Quality of Teaching and Educational Management
- Employ ICT to Enhance Student Learning
- Develop Complementary Approaches to Using ICT in Education
- Build on the Current Experiences of Existing and Successful ICT Programs
- Develop Capacity at the Federal and Provincial Department of Education Levels.

As Policy coherence (2010) points out, this comprehensive ICT policy included using locally created digital content and websites, overall curricular reform to incorporate ICT, online availability of content and search engines, and integration with international open educational resources and models for curriculum and content development.

On April 10, 2010 the eighteenth amendment to Pakistan's constitution was passed. One key feature of this amendment was the devolution of power from the federal government to the provinces; education was mostly devolved to the provinces. Consequently, the eighteenth amendment moved curriculum, syllabus, planning, policy, centers of excellence and educational standards under the purview of the provinces which made the national ICT policy effectively dormant because almost all responsibilities related to Education were devolved to the provinces (2010). The eighteenth amendment also added article 25-A to the constitution which guarantees a free and compulsory education for children between ages of 5 and 16 years of age. This right to education has been subsequently ratified by various provinces. For example, the largest province of Pakistan called Punjab promulgated Punjab Free and Compulsory Education Ordinance 2014 which was passed in November, 2014.

Some political parties in Pakistan actively support the use of ICT in their education manifestos. For example, education manifesto of PML-N, the party currently in power in the country and in the largest province of Punjab states that "Computer labs shall be established in all the government high schools in the first phase. All merit students in public universities shall be provided laptops to link them with the digital revolution." (Pakistan Muslim League (PMLN) Education Manifesto 2013). However, the second and third largest political parties (PPP and PTI) do not mention the use of ICT in their education manifestos (Pakistan Muslim League 2013; Pakistan Teherek-e-Insaaf 2013).

Currently, the Punjab province seems to be the leader in use of ICT in education. For example, based on party manifesto, free laptops have been distributed among University students and computer labs have been built in schools. In addition, currently efforts are underway to distribute Android tablet to primary school teachers in select districts of the province; a district is the next level of organizational unit within a province. Similarly, the Punjab Information Technology Boards (PITB) has established an e-learning portal (http://elearn.punjab.gov.pk/) where content and assessments for various grades and detailed lesson plans are being made available online. Primarily education comes under the School Education Department (SED) in the province of Punjab. The SED is currently implementing the Chief Minister's Road Map for education (2015). This roadmap was initially focused on retention and enrollment of children, but has recently also included increasing the quality of education as a key performance parameter. Other than mentioning the provision of Computer Labs in school, the roadmap, however, does not explicitly address how ICT will be used to enhance educational processes in Punjab. In order to provide transparency, the SED has also made available a detailed description of rankings of the various schools through a public portal (http://open.punjab.gov.pk/schools/). This portal provides monthly real-time data on various school aspects like teacher attendance, school facilities, school cleanliness, etc. to monitor and improve educational governance. Finally, The Punjab Sector Education Plan (PSEP) (2013) explicitly includes an objective to "Prepare a plan for use of technology in education/e-learning" and proposes to conduct various pilot studies to explore the effective use of technology in education.

Other provinces are not as well advanced in their use of ICT as Punjab. For example, Khyber Pakhtunkhwa (KPK) is the smallest province in Pakistan. In KPK primary school education comes under the Elementary and Secondary Education Department (ESED). The education sector plan for the KPK province (Education Sector Plan 2012) does not include the use of ICT beyond digital literacy, ICT's use in preparation of budget and provision of computer labs in schools.

Studies after studies have shown the bleak state of public primary education in Pakistan. A recent report by the World Economic Forum (2015) indicates that in education Pakistan ranks 27 out of 31 similar countries; Pakistan was ranked 34/38 in Access, 32/36 in Quality and 23/33 for Equity.

Figure 13.1 shows a typical rural government school in Pakistan. Figure 13.2 shows the profile of rural schools in Pakistan (Annual Status of Education Report 2014). As the figure shows, none of the primary schools have computer labs and only half have electricity connection. On average 2.5 rooms are used for five grades and preschool which means that about 40 % of these school go multigrade teaching.

According to ASER 2014 report (2014) 55 % of children (6–10) years were enrolled in rural government schools in Pakistan. Overall, 60.8 % of children between ages 3–5 were out of school. Only 46.4 % of grade 5 children in rural schools could read a story. For Arithmetic only 34 % of grade 5 children could do simple subtraction, and 44 % could do a two digit division.

Table 13.1 shows the education and professional education for teachers in rural public schools of Pakistan (Annual Status of Education Report 2014). As the Table shows, there is wide variation in both the number of years of schooling and professional training of these teachers. For example, 27.5 % of the teachers merely have the equivalent of a high school education.

The primary purpose of the initiative reported in this case study was to improve the quality of numeracy education in primary schools by enabling teachers using ICT in a manner consistent with the developing country constraints. These constraints include lack of basic infrastructure like electricity and computers in most public primary schools (Zualkernan 2015a). The primary expected outcome of these studies was demonstrable improved learning outcome of students.

Fig. 13.1 A typical rural government school in Pakistan

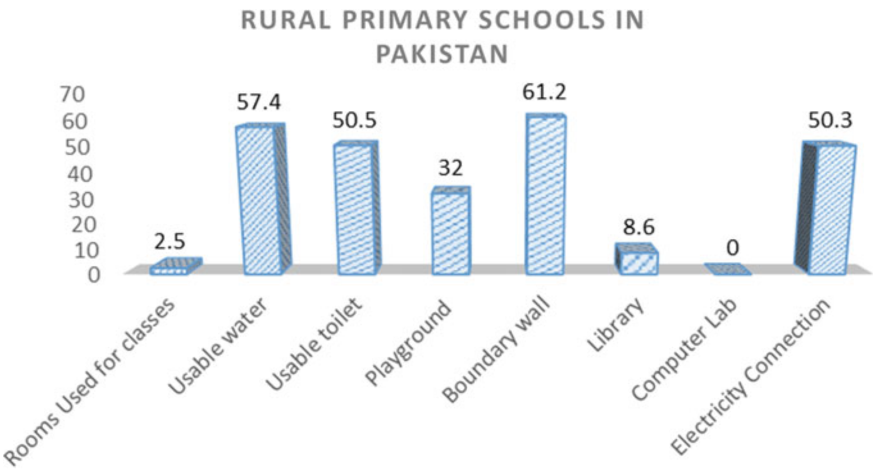

Fig. 13.2 Profile of rural government schools in Pakistan

The case study reported here conducted ICT-based educational interventions in three district of two provinces of Pakistan; Punjab, and KPK. Like Pakistan generally, the 2014 ASER study (2014) also showed that in Punjab province, in some district only 32 % of the children in grade 5 could read a simple story. Similarly, in many districts of Punjab less than 30 % of grade 5 children could solve simple

Table 13.1 Teacher qualifications of rural teachers in Pakistan

Schooling	Percentage of teachers	Professional education	Percentage of teachers
<10 years	0.4	None	4.1
10 years	11.1	One year diploma	15.4
12 years	16	Two year diploma	22.5
14 years	33.2	B.Ed.	36.4
16 years	37.6	M.Ed.	17.3
Others	1.6	Others	4.2

Table 13.2 Educational characteristics of three venues for the case study

Venue		Alif Ailan ranking (2015)		ASER survey (2014)	
District	Province	Education rank	Learning rank	Literacy—can read a simple story (%)	Arithmetic—can do two digit division (%)
Mansehra	KPK	36	21	57	71
Vahari	Punjab	50	39	63.4	44.6
Mandi-Bahudin	Punjab	11	26	58.7	53.8

Arithmetic problems. Table 13.2 shows the general educational characteristics of the three districts used in this case study. As the Table shows, Mandi-Bahahudin (MB) district had the best overall education rank (11th in Pakistan) as opposed to Vehari district that had the worst rank (50th in Pakistan) among the three districts. In terms of 5th graders ability to do simple Arithmetic (2 digit division), 71 % children in the Mansehra district were successful as opposed to 44.6 and 53.8 % for Vehari and MB districts, respectively.

In summary, the case study addresses grade 5 Mathematics education in the rural primary government schools in Pakistan which are characterized by poor physical infrastructure, ill-trained teachers and children whose performance in both literacy and mathematics is marginal at best.

13.3 Initiative Description

The initiative to improve Grade V numeracy skills in based on the theory of change articulated in (Zualkernan 2015b). The proposed theory of change theorizes that by providing just-in-time continuous training and mentoring which is synced to what is being taught in the classroom to public school teachers will bring about changes in teachers' competence, attitude, and skills with respect to content as well as pedagogy. In addition, using continuous feedback based on students' regular formative assessments would lead also to better teaching practice. Better teaching practice combined with an enhanced visibility of teacher's performance, in turn would lead to better student learning outcomes.

The initiative in this case study implemented the theory of change using a complex and holistic combination of technology, digital content, and process. Each is described next.

13.3.1 *Technology*

The innovation was implemented using a host of learning technologies as described in (Zualkernan and Karim 2013a; Zualkernan et al. 2014). Teletaleem's (T2) technology platform provided the technology backbone for the initiative. T2 platform provides a host of learning services like learning and content management, live virtual classroom, collaboration, and assessment tools, and provides various reporting mechanisms for teachers and administrators. The platform is based on open-source technologies and integrates Moodle, Flash Media Server, Drupal, and RTI's Tangerine platform (http://www.tangerinecentral.org/) for the Android tablets. In addition to teachers, the platform is designed to explicitly include teacher educators, educational administrators, and mentoring teachers. The T2 platform is available on the cloud (hosted on Amazon) and can be accessed anywhere using the Internet. Figure 13.3 some a sample report that is available in real-time to mentors and tutors based on formative assessments being conducted on a bi-weekly basis.

Because the initiative is addressing schools in remote rural areas with little technology infrastructure, a key aspect of this case study was the use of a self-contained traveling van shown in Fig. 13.4 to deliver the learning services.

This traveling van was equipped with a VSAT Internet connection, a server, a teacher's laptop, an overhead projector, a digital tablet, UPS, a power generator, and a bank of Android-based tablets that could be connected to the Internet via a

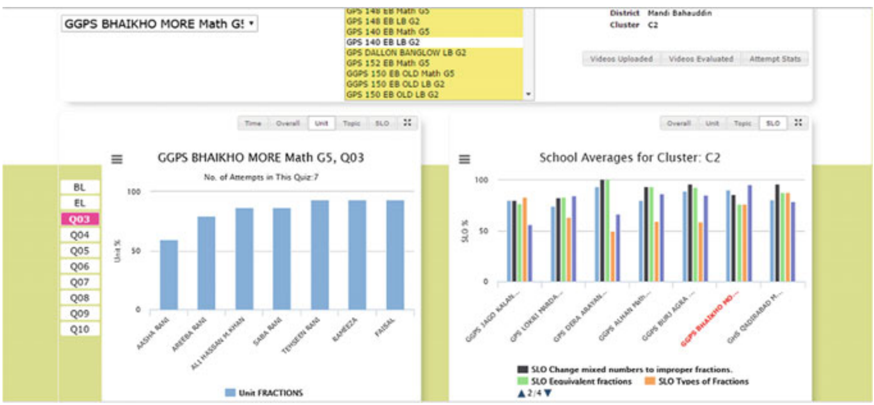

Fig. 13.3 Sample real-time reporting available to tutors/mentors

Fig. 13.4 Satellite-enabled learning van to deliver learning services

local WIFI router through the van. In fact, the learning van is a self-contained, fully equipped, Internet-enabled traveling classroom connected with the Internet using a satellite connection. This delivery mechanism is essential for a country like Pakistan where electricity is often not available even in the urban centers. In addition, each teacher was provided with their own Android tablet that included all the learning content, and uses a modified version of the Tangerine software to help teachers conduct continuous assessments of students' learning.

13.3.2 Content

Khan Academy (KA) (2015) was used as the initial source for learning content for grade V mathematics. KA typically uses a traditional teach-and-test pedagogy and topics are coupled with multiple-choice online assessments organized according to topic maps and students can take online assessment to test their mastery of the various topics. Student learning outcomes (SLOs) from KA were mapped to the 2006 National Curriculum of Pakistan for grade 5 Mathematics. However, for various reasons like curriculum, cultural, and pedagogical misalignment, only a small percentage of the KA videos (34.3 %) were eventually used. Consequently, 51 additional KA-type videos were created for grade V (Zualkernan and Karim 2013b). More recently, all the KA videos have been replaced with indigenously developed content.

13.3.3 Process

The following process was used to enact the theory of change:

1. All the teachers in a school cluster (up to 10 schools) were asked to visit the cluster center school for a day every 2 weeks.
2. On the scheduled day, the learning van arrived at the school and setup an internet connection and a physical class room with an on overhead projector to connect the teachers with a remote tutor/mentor using the remote classroom software.
3. The teachers (and grade 5 students in the cluster school) watched KA-type videos that were synched to the topics being taught in the regular classrooms in this time period.
4. The remote tutor then asked children to solve various problems based on the material being taught.
5. The children were then asked to leave and the teachers were provided training by the remote tutor on the topics to be covered within the next 2 weeks.
6. The mentor discussed the results of students' assessments of each teacher that they had carried out in the 2 weeks when the van was not present and provided mentoring advice.
7. Once every 6 weeks or so a Stalling type video of each teacher's classroom behavior was recorded, uploaded, and ranked by the mentor along various dimensions like class room management, for example, to provide advice to each teacher on how to improve their classroom practices.
8. In the 2 weeks when van was not there, the teachers used their Android tablet to conduct standardized formative assessments whose results were automatically made available to the mentor.
9. Results of each student assessment were shared with parents and administrators via SMS messages.

13.4 Implementation Plan

Implementation plans for educational interventions depend on the availability of resources and it is often not possible to formulate a multiyear plan unless ample funds are made available upfront. In this case study an opportunistic implementation plan was used. An evidence-based iterative approach was adopted where the initiative was first funded on a limited pilot stage, data was collected and analyzed and based on the results, subsequent funding for larger studies was sought. Based on this approach, the implementation plan consisted of three stages as shown in Table 13.3. Each stage lasted one academic year. Based on Pakistan's academic calendar, each stage started in September and ended in March of the each corresponding next year.

Table 13.3 The three stages of the implementation plan

Stage	Academic year	Province/District	Number of schools	Funded primarily by	Methodology
Experimentation	2012–2013	KPK/Mansehra	5 treatment schools 5 control schools	DFID	Experimental design
Exploration	2013–2014	KPK/Mansehra	24 treatment schools 12 control schools	DFID	Quasi-experimentation
Mini scale up	2014–2015	Punjab/Vehari, Mandi-Bahudin	200 treatment schools 60 control schools	Sub-national governance program	Quasi-experimentation

As the Table shows, in the experimentation stage, five schools were randomly chosen in one semi-rural valley (Balakot) in the Mansehra district of the KPK province as treatment schools. These five schools were paired with five similar schools that were chosen as corresponding control schools based on geographical location, socioeconomic background, teacher qualifications, prior school results, etc. Standardized tests using Item Response Theory (IRT) were developed and conducted to establish baseline and end line performance of students in treatment and control schools.

Based on positive results from the first year's intervention, in the exploration stage, the implementation was expanded in the same district. A total of 140 public schools in the Balakot valley were initially considered. Out of these 46 schools were purposely shortlisted for the study because these schools were within a few kilometers from the road where the learning van would arrive. Eight clusters of schools were subsequently identified where the cluster center was a school purposely chosen as being close enough to the road to host the learning van. Out of the eight clusters thus selected, four clusters were randomly chosen for the intervention. Each cluster had nine schools. Out of nine schools for each cluster, six were randomly assigned to the treatment group while the rest were used as control. This resulted in a total of $4 \times 6 = 24$ treatment schools and $4 \times 3 = 12$ control schools.

In the mini scale up phase, the implementation was further expanded to two districts in a different province (Punjab). The target was to eventually select 100 treatment schools in each district. Using a ratio of 3:1 for treatment versus control schools, 30 control school were randomly selected in each district. Data collected from Directorate of Staff Development (DSD) in the Punjab Education Department was used as the master list of the primary schools in MB and Vehari districts. A cluster-wise list of 1388 schools (982 Vehari and 406 in MB) was compiled initially. School enrolment data was used as the first filter to exclude low enrolment (5 or less students in grade 5) schools from this master list.

For Vehari district, 982 schools are naturally grouped into 63 school clusters by the Education Department based on administrative ease and geographical proximity of schools in a cluster. Out of these 63 school clusters, only those 29 clusters were considered that had more than 13 schools/cluster. 10 clusters were randomly selected from these 29 clusters; these 10 clusters included a total of 143 schools. These selected schools were further narrowed down based on a number of criteria that included school enrolment, geographical proximity to facilitate teacher's travel to the cluster center, average number of teachers, etc. Finally, in each chosen cluster, 10 schools were randomly assigned to be treatment schools and three schools as control schools. The most centrally located and accessible school was selected as a cluster center school (training center). Therefore, 100 schools were used as control and 30 schools as treatment schools.

For MB district, The DSD's list of 41 clusters containing 406 schools was initially compiled. Out of these 41 clusters, only those 18 school clusters were considered that had more than 13 schools/cluster. 10 clusters were randomly selected from these 18 clusters which included a total of 196 schools. Out of these 196 schools, 126 schools were further chosen based on similar criteria as described above. Finally, in each cluster, 10 schools from within these schools were randomly assigned to treatment school and three schools as control schools. The most centrally located and accessible school was selected as a cluster center school.

While it is often tempting to implement fully randomized designs in educational interventions, in reality given the resource, intervention-specific, and administrative constraints, this often not feasible. Consequently, different scientific approaches are used to collect evidence at each stage. In the first stage, pairs of schools were used in a traditional experimental design approach. The results from this stage can clearly not be generalized to the population, but serve as an exploratory device (Leek and Peng 2015) to determine if the approach could work in a specific situation. In the second stage, a quasi-experimental approach was used where a larger number of schools were randomly chosen within the constraints. For example, in Balakot, only those subset of schools and clusters were chosen which where accessible by the learning van and had enough enrollment. Similarly, enough control schools were randomly chosen to meet the budget constraints and to provide enough statistical power to generalize the results to the population of the subset of schools chosen in the district. In the third year, a similar approach was used but expanded to a different province with a different context and control and treatment schools were chosen randomly as well. It should be mentioned that in such studies, the resulting data on learning outcomes often does not lend itself to parametric analysis either due to lack of appropriate size (the class sizes are small) or because assumption behind parametric methods like normality, etc. are not satisfied. Therefore, parametric methods, where appropriate, were used (e.g., to conduct ANOVA, ANCOVA, etc.), but in most cases nonparametric methods were considered more appropriate for analysis. In each case, the learning effect sizes were either calculated or estimated.

A key to success of implementations was active and positive involvement of the corresponding education departments of each province. Appropriate agreements were established with the education departments at the highest level which ensured full participation of the government officials from teachers, school principals to higher level educational administrators. The funding was sought from international donors that had long-term established relationships with the Pakistan's government and implementation was done by Teletaleem (pvt) Limited in Islamabad which is a social enterprise focused on improving education in Pakistan. Teletaleem provided all the logistics including technology and training, the learning van, mentors, government liaison and hiring and firing of all the individuals like enumerators to conduct the tests, etc.

13.5 Implementation Process

The implementation process was complex because it involved scheduling of van's arrival, uploading of videos and synched content on the learning management system, uploading of formative assessment results, and monitoring to ensure that teachers were in fact following the prescribed process. Provisioning process itself where accurate lists of school children is required to create their accounts on the learning management system itself can be a challenging task. Contingencies like the van breaking down, Internet not working due to VSAT's limitation in bad weather were also taken care of. Clear business processes for daily implementation were designed and religiously followed. Wherever possible, technology was used to enforce the process. For example, SMS was used to inform the van drivers about their next location and principals and teachers were contacted to ensure that they came for the 2 weekly sessions, etc.

Cooperation and buy-in from the respective education departments were essential in change management. Because of Pakistan's prevalent culture, a top-down governance approach was used where educational administrators and principals were brought on-board and played a key role in ensuring the fidelity of implementation. It was generally found, however, that the teachers were responsive to the intervention. Key teachers as change agents were identified and show-cased in front of other teachers to further ensure implementation. Finally, senior retired and well-respected teachers from the region in question were hired to act as external change agents, and to provide additional mentoring and motivation to the teachers being targeted.

13.6 Outcomes

Outcomes from each stage of intervention are described below. For each year, pre- and post-tests before and after the intervention were used as the primary outcome metric. Pre- and post-tests were conducted by independent enumerators who were specially trained to conduct the tests. Teachers were asked to leave the classroom while these tests were conducted. In addition, student and teacher satisfaction surveys were conducted and qualitative data in the form of structured interviews and focus groups with teachers and administrators were also conduced. This case study only reports the quantitative results based on pre- and post- tests. In all results a significance level of $p < 0.05$ was used.

13.6.1 Year 1—Experimentation (2012–2013)

For the first year's interventions, out of the five pairs of schools, only three pairs of schools yielded reasonable data because despite the assumptions that schools in each pair were 'similar', the pretests indicated that indeed two of the three pairs were significantly different. In the three pairs considered, statistical differences were found ($p < 0.05$) where the treatment schools performed better than the control schools. Results from one school where two sections were used as treatment and control are presented for demonstration purposes.

Table 13.4 shows the overall learning gains calculated as the difference of each student's pre- and post-scores. A + sign against the Levene's test in each table indicates that the variance of the two sub-groups (e.g., control vs. treatment) was not different. An asterisk (*) against a statistical test in all subsequent tables indicates that the test detected a difference at ($P < 0.05$) level. Overall gain as well as gains in each student learning outcome (SLO) is shown. For example, the gain in Geometry (GEO) SLO was 21.31 % for the 26 students in the treatment group as opposed to 14.02 % for 24 students in the control group. As Table 13.4 shows, the effect size of gain or difference of difference between control and treatment groups was 1.19 (Cohen's d) indicating a large statistical effect. In other words, a shift of 1.19 standard deviations was observed in the treatment group as opposed to the control group. Since the data was not normal, Kruskal-Wallis test was used and showed a significant difference ($p < 0.05$) in the gain between treatment and control schools. Treatment had a mean gain of 32.48 % as opposed to 11.49 % for the control group. It should also be pointed out students in both groups did not perform at all on one topic (HCF/LCM). Varying degrees of effect size were observed for various student learning outcomes (SLOS). For example, large effects were observed in DIS (Distance and Measurement) and UM (Unitary Methods) as opposed to medium effects in the NUM (Numbers and Operations) outcomes. It is also interesting to note that for one SLO (Fractions), the effect was actually negative meaning that the control performed better than the treatment group. This information is fed into the next year's intervention so ascertain gaps in pedagogy and learning content. The first year's pilot simply established that it was possible to significantly increase student learning outcomes using the approach outlined in the theory of change.

13.6.2 Year 2—Exploration (2013–2014)

Table 13.5 shows the results from the exploration phase. As the Table shows, 760 children from 24 schools were included in the treatment and 160 children from the 12 control schools. An estimated learning effect of 0.86 was observed which is considered a large effect. Cliff's delta was used to calculate the effect size because the data was not normal and the variances were not the same hence Kruskal-Wallis test could not be used. Unlike the previous year's intervention, positive effects were

Table 13.4 Gains in student learning outcomes for grade V (two sections of one school)

	Student learning outcomes								
		GAIN	NUM	HCF	FRC	DEC	DIS	UM	GEO
	N	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)
Treatment	26	32.48 (19.11)	33.52 (31.80)	−15.38 (46.41)	−1.65 (15.45)	44.02 (29.56)	55.38 (31.90)	37.82 (33.52)	21.31 (21.17)
(Median)		37.51	28.57	0.00	−4.46	44.44	70.00	50.00	22.22
Control	24	11.49 (16.70)	11.31 (30.37)	4.17 (20.41)	11.98 (24.70)	23.61 (29.36)	4.17 (27.49)	−1.39 (23.01)	14.02 (21.27)
(Median)		14.13	0.00	0.00	16.07	33.33	5.00	0.00	11.90
Mean(t-test t)		N/A	N/A	N/A	−2.32*	2.45*	N/A	N/A	1.21
Median(KW Ch-sq)		14.12*	5.82*	3.55	N/A	N/A	20.50*	17.61*	N/A
Variance(Levene F)		0.10+	0.20+	3.84+	3.09+	0.10+	0.23+	1.30+	0.011+
Tr. est. median		34.45	35.71	N/A	−2.68	50.00	60.00	41.67	22.22
Tr. 95 % CI		[26, 42]	[21, 50]	N/A	[−10, 4]	[33, 61]	[45, 75]	[33, 58]	[13, 32]
Co. est. median		12.06	14.29	N/A	11.61	27.78	10.00	−8.9e−05	15.08
Co. 95 % CI		[5, 19]	[−0, 36]	N/A	[3, 24]	[11, 39]	[−10, 25]	[−17, 17]	[5, 25]
Cliff's delta		0.62	0.39	N/A	−0.38	0.36	0.74	0.68	0.21
Cohen's d		1.19	0.63	N/A	−0.67	0.69	1.65	1.41	0.34
Effect size		large	Medium	N/A	Medium	Medium	Large	Large	Small
Kol.Smir (D)		0.57*	0.35	N/A	0.33	0.26	0.69*	0.69*	0.28

Table 13.5 Balakot intervention control versus treatment schools for grade V

	Student learning outcomes								
		GAIN	NUM	HCF	FRC	DEC	DIS	UM	GEO
	N	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)
Treatment	760	22.73 (20.17)	27.12 (30.14)	29.49 (62.04)	19.73 (28.04)	31.25 (27.58)	24.89 (29.59)	28.52 (31.58)	21.76 (23.25)
(Median)		21.26	28.57	0.00	25.00	33.33	22.22	33.33	22.22
Control	160	5.18 (15.85)	11.83 (29.48)	−8.82 (52.85)	2.61 (26.35)	14.03 (25.82)	4.49 (27.33)	10.32 (25.57)	8.13 (21.96)
(Median)		7.04	14.29	0.00	0.00	11.11	0.00	16.67	11.11
Mean(t-test t)		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Median(KW Ch-sq)		N/A	29.03*	N/A	46.14*	51.14*	55.92*	N/A	45.62*
Variance(Levene F)		20.93	0.28+	12.49	1.16+	0.90+	1.78+	8.19	0.50+
T est. median		22.58	28.58	N/A	25.00	33.33	27.78	33.33	27.77
T 95 % CI		[21, 24]	[29, 36]	N/A	[19, 25]	[33, 39]	[28, 28]	[33, 33]	[22, 28]
C est. median		5.99	14.29	N/A	3.5e−05	16.67	5.56	16.67	11.11
C 95 % CI		[4, 8]	[7, 21]	N/A	[−0, 6]	[11, 22]	[0, 11]	[8, 25]	[6, 17]
Cliff's delta		0.50	0.25	N/A	0.29	0.36	0.34	0.30	0.28
Cohen's d		0.86	0.35	N/A	0.42	0.55	0.52	0.44	0.42
Effect size		Large	Small	N/A	Small	Medium	Medium	Small	Small
Kol.Smir (D)		0.43*	0.19*	N/A	0.25*	0.26*	0.27*	0.25*	0.28*

* $p < 0.05$

observed for all SLOs except HCF/LCM where although treatment groups performed well, it was not possible to make valid conclusions while comparing these results to the control group. Small to medium effects were observed for the various SLOs.

Educational interventions often effect various types of students differently depending on their prior level of competence. Results based on the four quartiles based on the pretest are shown in Table 13.6. For example, Q1 represents those students who were in the lowest 25-percentile based on the pretest while Q4 represent the students in the highest quartile. Since neither t-test nor Kruskal-Wallis test could be used due to violation of assumptions, Kolmogorov-Smirnov test was used and was significant at $p < 0.05$ indicating that were a change in the distribution between control and treatment groups. This combined with nonoverlapping confidence intervals for the median and high Cliff deltas strongly suggests learning effects in each category.

As Table 13.6 shows, medium effect was observed for the lowest quartile while large effects were observed for the higher quartiles. So even though, as expected,

Table 13.6 Quartile-based results for Balakot intervention control versus treatment schools

		Q1 gain		Q2 gain		Q3 gain		Q4 gain
	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)
Treatment	188	32.60 (21.32)	171	27.98 (18.51)	202	20.30 (17.79)	199	11.37 (16.21)
(Median)		30.88		28.80		19.92		13.42
Control	43	15.38 (12.14)	58	8.35 (10.68)	28	0.69 (8.49)	31	−10.83 (19.77)
(Median)		14.08		8.30		−1.30		−10.02
Mean(t-test t)		N/A		N/A		N/A		N/A
Median(KW Ch-sq)		N/A		N/A		N/A		N/A
Variance(Levene F)		28.17		30.01		16.44		4.61
T est. median		32.60		28.27		20.76		12.22
T 95 % CI		[30, 36]		[25, 31]		[18, 23]		[10, 15]
C est. median		14.74		7.84		0.36		−10.12
C 95 % CI		[11, 19]		[5, 11]		[−3, 4]		[−18, −3]
Cliff's delta		0.47		0.62		0.67		0.61
Cohen's d		0.79		1.18		1.35		1.16
Effect size		Medium		Large		Large		Large
Kol.Smir (D)		0.42*		0.56*		0.61*		0.48*

the average gain was higher for weaker students (32.6 % as opposed to 15.38 % for control) and the gain decreased as students' ability increased, the corresponding effect was similar within each quartile.

13.6.3 Year 3—Mini Scale Up

Results for the mini scale up for the Vehari district are shown in Table 13.7. As the Table shows, Kruskal–Wallis test shows that there was no difference between the control and treatment groups. Statistical differences were found in FRAC (Fractions), DEC (Decimal), and GEO (Geometry) SLO's but the effects were negligible as well.

As Table 13.8 shows, no differences were detected for weaker students but the students in the highest quartile did show a statistically significant small effect of 0.43.

Results from MB district are shown in Table 13.9. Table 13.9 shows that small effect of 0.31 was observed. Small effect sizes were also observed in UM and GEO SLOs while it was not possible to compare the results for HCF/LCM.

As Table 13.10 shows, small effects were observed for weaker students while a negligible effect was observed for the strongest students, however, the overlapping estimated confidence intervals indicate that this result is not robust.

13.6.4 Discussion

Since the mini scale up resulted in learning effects which were much smaller than the previous interventions, an investigation was carried to narrow down the causes. It is generally known that scale ups in educational interventions do dilute learning effects for a variety of reasons. After extensive discussions with the mentors/tutors, individuals carrying out the implementation on the ground and informal interviews with teachers, several themes were identified as potential causes of this effect dilution. The foremost and an unanticipated cause was a key difference in the social and political context of the teacher which had a direct effect on their willingness to participate fully in the intervention. The significant difference between KPK and Punjab in general stems from the fact that unlike the KPK province, the Punjab government has been engaged in a large-scale structured program to bring an overall educational reform in their schools. This program was started in 2004 and is continually being refined every year to yield the results outlined in Punjab's Chief Minister's road map for education. This continuous professional development program includes the conduction of monthly exams in four subjects in each primary school and in each class by representatives of the DSD. Teachers are evaluated on a

Table 13.7 Vehari intervention control versus treatment schools for grade V

	Student learning outcomes								
		GAIN	NUM	HCF	FRC	DEC	DIS	UM	GEO
	N	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)
Treatment	909	22.81 (22.06)	19.46 (31.89)	19.36 (64.69)	18.23 (25.61)	23.29 (29.93)	26.11 (35.06)	24.40 (35.42)	21.61 (29.93)
(Median)		22.82	14.29	0	22.22	25.00	22.23	20	20
Control	277	19.62 (20.13)	15.63 (27.56)	20.22 (70.88)	12.76 (25.03)	17.42 (28.53)	23.07 (32.07)	22.24 (32.43)	17.62 (28.39)
(Median)		22.16	14.29	0	11.11	12.50	22.22	20	20
Mean(t-test t)		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Median(KW Ch-sq)		3.06	N/A	N/A	10.27*	7.93*	1.41	N/A	4.74*
Variance(Levene F)		2.94+	7.52	6.33	0.23+	0.033+	3.21+	4.04	0.022+
T est. median		22.85	21.43	NA	22.22	25.00	27.78	30.00	25.00
T 95 % CI		[21, 24]	[21, 29]	NA	[22, 22]	[25, 31]	[28, 33]	[30, 40]	[25, 30]
C est. median		20.26	21.43	NA	16.67	18.75	27.78	30.00	20.00
C 95 % CI		[18, 23]	[14, 21]	NA	[11, 22]	[19, 25]	[22, 33]	[30, 40]	[15, 25]
Cliff's delta		0.069	0.073	N/A	0.13	0.11	0.047	0.042	0.086
Cohen's d		0.09	0.096	N/A	0.17	0.15	0.06	0.053	0.11
Effect size		Negligible	Negligible	N/A	Negligible	Negligible	Negligible	Negligible	Negligible
Kol.Smir (D)		0.082	0.062	N/A	0.11*	0.072	0.074	0.042	0.074

Table 13.8 Quartile-based Vehari intervention control versus treatment schools for grade V

		Q1-gain		Q2 gain		Q3 gain		Q4 gain
	N	Mean(SD)	N	Mean(SD)	N	Mean(SD)	N	Mean (SD)
Treatment	230	39.04 (19.44)	219	28.09 (18.31)	230	16.90 (18.85)	230	7.47 (17.71)
(Median)		36.54		29.92		16.54		10.82
Control	67	36.45 (15.09)	77	25.21 (13.37)	66	16.54 (16.27)	67	−0.60 (15.85)
(Median)		36.10		26.98		19.35		−1.00
Mean(t-test t)		N/A		N/A		N/A		N/A
Median(KW Ch-sq)		N/A		N/A		N/A		12.90*
Variance(Levene F)		6.92		18.73		5.14		1.41+
Treatment est. median		38.81		28.35		17.09		8.36
Treatment 95 % CI		[36, 42]		[26, 31]		[15, 20]		[6, 11]
Control est. median		36.84		25.90		17.07		−0.62
Control 95 % CI		[33, 40]		[23, 29]		[13, 22]		[−4, 3]
Cliff's delta		0.057		0.11		0.0086		0.29
Cohen's d		0.074		0.15		0.011		0.43
Effect size		Negligible		Negligible		Negligible		Small
Kol.Smir (D)		0.15		0.23*		0.13		0.3*

monthly basis based on the results of these tests. These results are discussed with the Chief Minister in a stock-taking meeting conducted every month. Teachers and schools found lacking are strongly encouraged to take corrective actions to improve their performance. Consequently, teachers in Punjab are highly motivated to align their learning activities to ensure that their students perform well in each such test on a monthly basis. The retrospective interviews found that topics being taught in the intervention were not entirely synched with this activity. For example, the topic being taught and reviewed by the tutor had already been covered by the teacher in their classroom and their students had already been assessed on these topics by the DSD. Therefore, the teachers had little interest in the training because they were focused on trying to get better performance on the current topics they were teaching. This is, therefore, a classical example of misalignment between the context and implementation. In addition, several other factors were identified which could have contributed to the lesser performance in the scale up. One was that unlike the previous year, where a mentor was handling only 24 schools, in the current intervention each mentor had to cope with 100 schools which perhaps was more demanding and somehow effected the quality of interaction with the teachers despite the technology support. It was also observed, that in the previous year the

Table 13.9 MBD intervention results control versus treatment for grade V

	Student learning outcomes								
		GAIN	NUM	HCF	FRC	DEC	DIS	UM	GEO
	N	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)
Treatment	1010	19.76 (19.50)	18.43 (31.26)	11.88 (68.52)	16.46 (23.07)	18.16 (27.77)	27.10 (30.88)	19.05 (32.41)	23.50 (25.21)
(Median)		20.27	14.29	0.00	11.12	12.50	22.23	20.00	20.00
Control	363	13.01 (17.24)	14.09 (28.00)	−1.38 (67.09)	12.09 (23.24)	16.32 (26.65)	24.21 (29.52)	4.96 (33.67)	12.42 (28.14)
(Median)		12.20	14.28	0	11.11	12.50	22.22	0	10
Mean(t-test t)		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Median(KW Ch-sq)		N/A	N/A	N/A	8.66*	1.76	3.59	50.67*	39.73*
Variance(Levene F)		9.16	5.01	N/A	0.97+	2.57+	2.68+	0.38+	3.23+
T est. median		20.09	21.43	N/A	22.22	25.00	33.33	30.00	25.00
T 95 % CI		[19, 21]	[21, 21]	N/A	[17, 22]	[19, 25]	[28, 33]	[20, 30]	[25, 30]
C est. median		12.82	21.42	N/A	16.67	18.75	27.78	6.5e−05	15.00
C 95 % CI		[11, 15]	[14, 21]	N/A	[11, 17]	[19, 25]	[22, 33]	[0, 10]	[10, 20]
Cliff's delta		0.22	0.077	N/A	0.10	0.046	0.067	0.25	0.22
Cohen's d		0.31	0.10	N/A	0.14	0.06	0.087	0.36	0.31
Effect size		Small	Negligible	N/A	Negligible	Negligible	Negligible	Small	Small
Kol.Smir (D)		0.19*	0.072	N/A	0.093*	0.07	0.079	0.19*	0.18*

Table 13.10 Quartile-wise results MBD intervention results control versus treatment grade V

		Q1 gain		Q2 gain		Q3 gain		Q4 gain
	N	Mean (SD)	N	Mean (SD)	N	Mean(SD)	N	Mean(SD)
Treatment	263	32.76 (15.95)	254	23.26 (16.41)	254	15.01 (17.16)	239	6.80 (18.43)
(Median)		32.82		23.11		14.64		9.99
Control	81	23.81 (17.36)	89	15.78 (15.01)	89	11.24 (14.54)	104	3.73 (15.79)
(Median)		18.84		15.45		11.12		6.29
Mean(t-test t)		N/A		N/A		N/A		N/A
Median(KW Ch-sq)		18.43*		12.61*		N/A		4.41*
Variance(Levene F)		0.076+		1.31+		4.76		3.51+
Treatment est. median		32.69		23.16		15.12		8.15
Treatment 95 % CI median		[31, 35]		[21, 25]		[13, 17]		[6, 11]
Control est. median		22.67		15.56		11.39		4.74
C 95 % CI median		[19, 27]		[12, 19]		[8, 15]		[1, 8]
Cliff's delta		0.32		0.25		0.13		0.14
Cohen's d		0.47		0.36		0.17		0.19
Effect size		Small		Small		Negligible		Negligible
Kol.Smir (D)		0.3*		0.22*		0.15		0.22*

first part of the session where KA videos were shown was integrated with the second part of training where teachers were tutored on the respective topics. However, this was not the case in the mini scale up and consequently there was a misalignment between what the videos showed and what teachers was taught in the class session afterwards. Finally, because of the scale up, technological and governance processes for monitoring the fidelity of the implementation was perhaps lacking as well. For example, the misalignment of the curriculum should have been conveyed to the program director immediately and corrective action should have been taken in time.

13.7 Conclusion

Scaling up technology-based educational interventions in the real world is a complex process and an iterative evidence-based spiral approach has been for learning about the various aspects of the intervention whose success or failure goes beyond the technology itself and may include social and political aspects. Context becomes increasingly important as scale widens. Technology scales up readily but the associated business and human processes also need to scale up as well and perhaps represent a tougher challenge.

Overall, the three year experience has shown that it is possible to use learning technologies in real-world settings in a holistic fashion in technologically-challenged environments of developing countries. Clear learning effect was observed in all instances. In addition, teachers' and student motivation and governance seemed to also have improved.

Clearly the case study is limited to a few hundred schools and a quasi-experimental approach was used which makes it difficult to claim generalizability of the results beyond the immediate contexts. However, once the process is further streamlined, further funds can be sought to scale up the intervention on a larger scale.

Key lessons from this case study are the importance of monitoring mechanisms to maintain the fidelity of the process especially as it scales. Similarly, automation of even the mundane tasks like scheduling, etc. that go beyond the traditional learning technologies can potentially have a significant impact during scale up. As demonstrated by the mini scale up, context of implementation is extremely important and explicit steps should be taken to ensure that there is no misalignment between the current context and the educational intervention being introduced. On the positive side, a good working relationship and buy-in from the top echelons of the government is essential to the success of any such intervention. In addition, an explicit identification of change agents within the teachers as well as government administrators is a critical part of this process.

Several aspects are being considered for future interventions. The first is to align the intervention to the context to ensure that teachers have appropriate motivational construct to engage with the technology. The second is a continual effort to reduce the overall cost of the intervention. Third, there is an effort to enhance the pedagogy well beyond the passive teach-and-test paradigm typical of KA-type videos to incorporate constructivist practices in teacher training. A blended learning approach is also being considered in this regard that asks the teachers to view the videos on their Android tablets before they come to the mentoring session. Finally, big data techniques (Zualkernan 2015) are being used to provide more informed feedback to correct any deviations during the implementation process.

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Author Biographies

Dr. Zualkernan's primary area of research is learning technologies. He has published over 150 papers in refereed journals, conferences, and workshops. He has taught at the University of Minnesota, Minneapolis and at Penn State University, University Park and is currently at the American University of Sharjah, UAE. His research publications span cognitive science, management science, and computer science. Dr. Zualkernan has been involved with startup technology companies in senior management positions (founding CEO and CTO). He has been a recipient of the global IBM Faculty Research awards for his research in just-in-time and game-based learning technologies, and is a pioneer in wearable game-based learning. He has played an advisory role for a number of technology companies in the technology-enhanced learning space. He has consulted for the World Bank, Asian Development Bank, GIZ, and UK's DFID-funded projects in educational strategy, curriculum/assessment alignment, and continuous professional development systems for primary school teachers. His is currently interested in using technology to enhance numeracy and literacy education in primary schools of developing countries. He is a member of the Phi Kappa Phi, Tau Beta Pi, and Golden Key National Honor Societies. He holds a B.S. (high distinction) and a Ph.D. from the University of Minnesota, Minneapolis.

Asad Karim is a serial entrepreneur with 30 year work history of setting up new businesses in diversified market segments including social sector. He has enjoyed a rich portfolio of job assignments, graduating from being a technologist to a CEO. Asad and cofounders incorporated Comcept in 1992, a startup doing custom development for telecom service providers. Comcept has matured into a multi-segment business house, over the last 23+ years, with accumulated revenue of US$ 75m. Asad is credited with inception of WorldCall in 1995, taking it to commercial launch in 1996. In 2004, Asad launched Burraq Telecom, a long-distance Telecom Operator, and then positioned it for acquisition to Qatar Telecom. Starting mid-2009, Asad lead the transformation of Comcept group into a social enterprise, creating three separate ventures to service education, healthcare, and agriculture sectors. Personally managing TeleTaleem, Asad effectively launched innovative educational solutions to achieve recognition within the public education system and development financial fraternity. Asad has been a major contributor to Pakistan's IT policy and was a member of the IT Advisory Board; also served as General Secretary PASHA. He has a M.S. in Computer Engineering from the University of Texas at Austin and B.S. from University of Houston, Texas.

Chapter 14
Synchronous Remote Classroom Connecting K-12 Schools in Developed and Undeveloped Areas: A Case Study from China

Liang Yu and Shijian Chen

Abstract The shortage of high-quality teachers is the crux for the undeveloped areas to improve education quality. With the development of digital technology and the Internet, Synchronous Remote Class (SRC) is one of the methods to solve this problem. SRC uses the video conferencing system to connect K-12 classes in developed and undeveloped areas to share the high-quality teacher's class with cyber face-to-face communication between classes. This chapter introduces the case of Chengdu NO. 7 online school in which the SRC model is developed and used to help classes in rural areas.

Keywords Synchronous remote classroom · Online school · Teaching system · Remote live education

14.1 Introduction

The unbalanced development of regional economy leads to the education gap between the developed areas and undeveloped areas. The shortage of high-quality teachers is the crux for the undeveloped areas to improve the education level. Synchronous Remote Classroom (SRC) is defended as using video conferencing systems to connect K-12 schools in developed areas and undeveloped areas, with the aim to share the high-quality teacher's class in urban school to classes in

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undeveloped areas. SRC is believed as a good way to solve the problem of the shortage of quality teachers in rural areas. Moreover, SRC allows learners from different locations to participate in class together through cyber face-to-face interaction, which gives the sense of “being there together”, or the so-called “presence” (Short et al. 1976). Many researches addressed the use of synchronous communication in online learning (Giesbers et al. 2013; Hrastinski 2008; Hrastinski et al. 2010). Teng et al. (2012) reported a method of holding an international online research seminar based at a computer-mediated synchronous learning environment, the Synchronous Cyber Classroom (SCC), which includes audi–video conferencing, text messaging, desktop sharing, joint web browsing and electronic whiteboard, allows learners to participate in class meetings. The SCC is launched for doctoral students in Canada, New Zealand, Italy, and Taiwan (Chen and Ko 2010; Chen and Wang 2008; Hastie et al. 2007; Wang et al. 2010). Mcbrien et al. (2009) explored the role of a virtual classroom in distance education and analyze the ways in which a synchronous learning environment affects students’ learning experiences by the software Elluminate Live. Kuo et al. (2014) reported research on the implementation of a web-based videoconferencing tool (Interwise) for synchronous learning sessions on an industrial technology course. Web video conferencing allow for more direct social interaction and feedback among learners and teachers and may lead to higher levels of learner engagement (Carr et al. 2004; Hrastinski et al. 2010; Strømsø et al. 2007). Most of these research focused on the learners, learning process and some items related to learning results. But little have been done to narrow the education divide between developed areas and undeveloped areas by the SRC. This article explores the way of using SRC to connect K-12 schools in developed areas and undeveloped areas in China by the case of Chengdu NO. 7 Online School.

14.2 The Development of Synchronous Remote Education in China

In 1999, Jiangsu Radio and Television University conducted an online teaching pilot. They established a two-way interactive synchronous television teaching system and opened a remote live classroom, using the provincial public communications network (ISDM). Moreover, they organized experienced teachers to teach and counsel students in the whole province by SRC in allusion to the curriculum lack of teachers relatively.

In 2012, University Network Alliance SRC was implemented by the cooperation of Beijing Normal University, East China Normal University, Northeast Normal University, Southwest University, Central China Normal University, and Shanxi Normal University. The synchronous classroom created a new type of live teaching platform and learning environment consists of two-way interaction and real-time communication. It can make students together to learn and conduct real-time interaction. In addition, it realizes intercollegiate cooperation teaching mode, which means that students can choose courses in other schools and make the advantages of featured majors and faculty have a strong complementarity among the member universities in the end (Luo 2013).

101 Online School, established in 1996, is the first distance education web for K12 in China. It creates a new mode of Domestic distance education, realizing online teaching and braking through the restriction of time and space of learners. The school maximizes the outstanding education resources, and makes education ways more convenient. The interactive classroom of this online school carries out real-time teaching by the use of video. Furthermore, the classroom uses audio and video synchronous interpretation with dynamic blackboard writing to teach.

The online school of Beijing NO. 4 High School is the nationwide distance class to provide learning counseling for K12 students. Synchronous class combines classroom teaching with network technology, realizing real-time online teaching. Online school releases schedule in advance to remind students to enter the classroom on time. In the class, teachers will interact with students in the form of video, audio or text and assign homework for students to consolidate learning. The online school of Beijing NO. 4 High school has already realized real-time online course support system that allows almost 5000 learners to study at the same time. What is more, it also provides text, animation, video, audio and other multimedia forms for constructing learning materials.

The online school of Chengdu NO. 7 High School is a famous online school for K-12 in China, which has academic education qualifications and can issue the high school diploma (Zhang and Chen 2005). Its full-time synchronous remote teaching is a unique form of education, simply called "same lectures in different places", which means that the same teaching activities take place at the same time but different physical space. Chengdu NO. 7 High School Synchronous Remote Teaching Mode found a "FOUR IN UNION" (Preparing simultaneously, Teaching simultaneously, working simultaneously, examining simultaneously) teaching realization mode and "FOUR IN ONE" (instructors, checking teachers, remote teachers and technology teachers) teaching organization mode, which can better ensure the Chengdu NO. 7 High School excellent educational resources to implement the whole teaching process of the school in the branch. It realizes the organization and management of distal students in the whole curriculum learning process and better promote the integration of teaching and learning.

14.3 The Case Study of Chengdu NO. 7 Online School

14.3.1 The Development Road

Chengdu NO. 7 Online School is established by Chengdu NO. 7 High School and Chengdu Eastedu science and technology development co., LTD Jointly. It is the first high school diploma distance education school all over the country. Besides it is the distance education information source of ethnic minority areas determined by Sichuan Provincial Government.

In 2001, Sichuan Province formulated "The decade action plan of education development in ethnic minority areas of Sichuan province", in order to bring good education resources to ethnic minority areas. Synchronous Remote education has become the important means of this plan. Then NO. 7 Online School emerged at the right moment and developed taking advantage of the opportunity. In support of Sichuan Provincial Education Department and other units, the online school of Chengdu NO. 7 High School was located in the high-tech zone. Since September 2002, the high-quality classrooms in Chengdu NO. 7 High School have been broadcast live to the schools of remote areas by a full-time synchronous remote teaching system (Wang 2014).

The synchronous remote teaching form is beneficial to promote the teaching cooperation and information communication between good high schools and partner schools, to achieve full sharing of high-quality education and teaching resources, to narrow the gap between urban and rural areas in terms of education quality of running schools and education teaching level, as well as to improve the balanced development of basic education.

14.3.2 The Teaching System

The full-time synchronous remote teaching system is a comprehensive education private online system that relies on high-quality teaching resources, uses modern information multimedia technology, and combines hardware and software platform. Ren (2015) introduces that the hardware system consists of front-end teaching system, satellite transmission network system and terminal teaching system as shown in Fig. 14.1.

1. **Front-end Teaching System**

Front-end teaching system shown in Fig. 14.2 is comprised of the communication facilities and the equipment in the service of satellite live teaching, involving the online school front-end studios, digital lines, managed devices in the satellite master station and so on, which are used to finish capturing the video and audio signal of field teaching, making multimedia courseware, sending teaching information, managing teaching and dealing with technical issues, etc.

2. **Satellite Transmission Network System**

The satellite signal covers from the air without being limited by the Yamagata landforms. So compared with other communication mode, it has incomparable advantages in the regions where Yamagata landforms are complex, living is relatively dispersed, and terrain conditions are complicated.

Satellite communication distance is basically consistent with ground communication distance. And the cost of links has nothing to do with the transmission distance. What is more, the satellite network stability is strong. It supports multiple IP. The networking is flexible. The maintenance quantity is small. And the construction

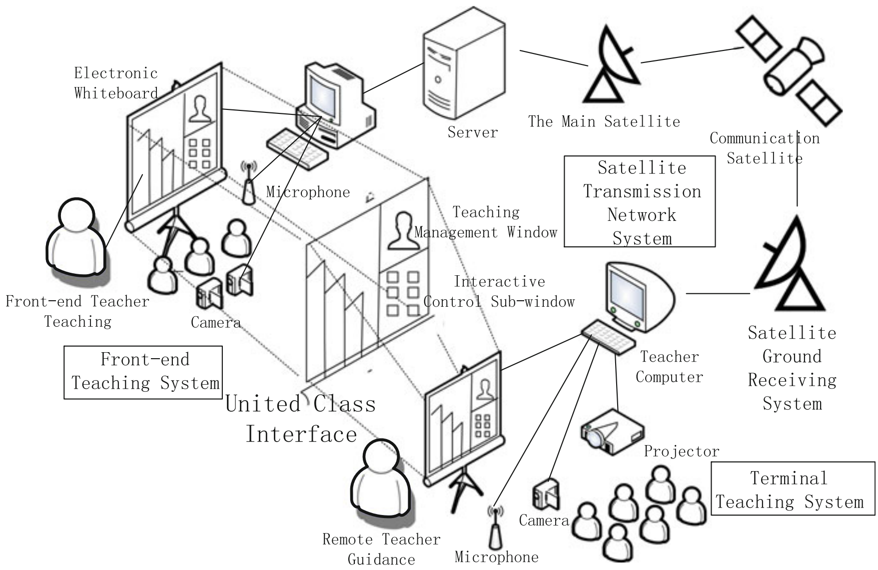

Fig. 14.1 Hardware system of Chengdu NO. 7 online school

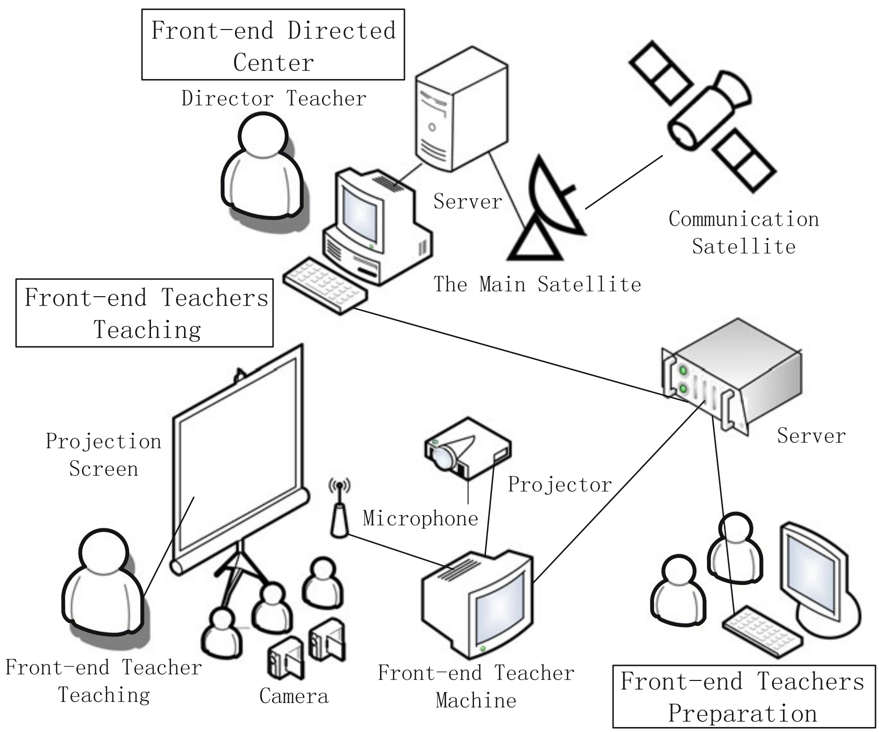

Fig. 14.2 Front-end teaching system shown

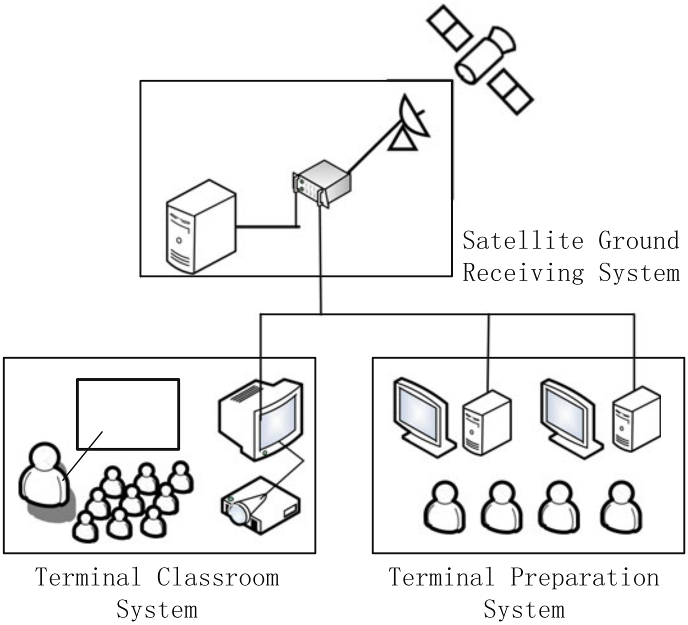

Fig. 14.3 Terminal teaching system

period is short. So, satellite communication becomes an important means to solve the communication problem in remote areas and underdeveloped areas.

Therefore, satellite transmission system is the network system supporting full-time synchronous teaching in the online school. Satellite transmission network system mainly includes the satellite and the equipment and facilities in the satellite master station, such as servers, switches, routers which support data exchanging and monitoring, as well as the satellite repeater, etc.

3. **The Terminal Teaching System**

Terminal teaching system consists of three subsystems including satellite ground receiving system, terminal classroom system, and terminal preparation system as shown in Fig. 14.3. The satellite ground receiving system needs to access online school satellite education network.

14.3.3 The Teaching Model

1. **Four in Union**

"Four in Union" is the teaching realization model of full-time synchronous remote school. It's also the basic requirement and embodiment of "same lectures in different places" in remote schools and Chengdu NO. 7 High School. Only by guaranteeing the "Four in Union" can the teachers of remote cooperative schools take part in the real-time collaborative teaching. And students can enjoy the pure lesson teaching of Chengdu NO. 7 High School vividly. "Four in Union" is specifically divided into four parts involving preparing simultaneously, teaching simultaneously, working simultaneously, examining simultaneously. The students of remote cooperative schools need to use the same daily schedule, curriculum schedule, learning materials, and test questions with the students of Chengdu NO. 7 High School. In addition, there is live preparing lessons at the same time in all subjects once a week. In this time, teaching teachers and remote teachers discuss the teaching and learning methods together. Through the "Four in Union," live teaching transmits the classroom teaching and the corresponding management requirements of Chengdu NO. 7 High School to every remote school authentically and achieves the integration requirement in the key teaching links.

2. **Four in One**

"Four in One" is the teaching organization mode of full-time remote live teaching and the basic guarantee of teaching efficiency. "Four in One" means that four kinds of teachers with different roles and functions (instructors, checking teachers, remote teachers and technology teachers) perform the scheduled work at the same time in different positions according to the requirements of the full-time synchronous remote teaching form. Front-end teaching teachers complete the universal multimedia classroom teaching of live subjects under the guidance of checking teachers to ensure the quality of teaching in the teaching source. Remote teachers conduct a class at the same time in the whole process. They should finish the teaching organization, create the teaching situation and do a good job on the students' individualized teaching and counseling by using the different places' conditions.

3. **Four in Interaction**

"Four in Interaction" is an important means of overcoming the lack of remote teaching interaction and creating same lectures in different places. It includes real-time interaction, virtual interaction, alternative interaction, and transfer interaction.

Real-time Interaction: The full-time remote live teaching uses the two-way satellite system. Teaching teachers of Chengdu NO. 7 High School can carry out the real-time audio and video teaching Q&A with the students who are having the same class in other resource deficiency schools through the satellite network system.

Virtual Interaction: In the live teaching process, students of remote schools are asked to answer the teacher's questions in time like the students of Chengdu NO. 7 High School. Actually, the interaction is between remote students and the teachers on the screen. It aims to ensure that remote students can participate in the thinking and meaning construction of new knowledge.

Alternative Interaction: Student representatives replace the other students who have the same opinions or questions and interact with teachers to make the common problems of remote students be solved.

Transfer interaction: Transfer interaction is the most important interactive mode of the “Four in One” design. It means that the interaction between teaching teachers and remote students is transferred to the interaction between remote teachers and remote students in order to solve the problem of students’ personality development in the scale situation of distance education.

14.3.4 Implementations and Impact

14.3.4.1 The Teaching Implementation of Chengdu NO. 7 Online School

Using modern communications technology, Chengdu NO. 7 High School Remote Live Teaching Mode shares the classroom teaching in the main campus of Chengdu NO. 7 High School entirely within online classroom. The images, sounds, text, multimedia animation, video materials and others, which is used in class by the teachers of Chengdu NO. 7 High School, present in the branch of Chengdu NO. 7 High School at the same time, to enable students in the branch to participate in the teaching activities of Chengdu NO. 7 High School in real time and to communicate with the teachers of Chengdu NO. 7 High School concurrently in two ways, which truly make same lectures in different places. In addition, according to physiological and psychological characteristics of students in secondary school and the partner schools’ actual demand of improving teaching quality and training teachers, Chengdu NO. 7 High School Synchronous Remote Teaching Mode found a “Four in Union” teaching realization mode and “Four in Union” teaching organization mode, which can better ensure the Chengdu NO. 7 High School excellent educational resources to implement the whole teaching process of the school in the branch.

“Four in Union” means teaching realization model, which is a teaching mode that teachers, respectively, from the main campus and the branch campus of Chengdu NO. 7 High School prepares lessons simultaneously and teach students simultaneously, as well as students, respectively, from the main campus and branch campus make schoolwork simultaneously and take an examination simultaneously. Preparing simultaneously: aim at five live main courses, instructor and remote teachers have a synchronous meeting together once a week, discussing one week teaching arrangements and teaching and learning method; Teaching simultaneously: students, respectively, from the main campus and the branch campus of Chengdu NO. 7 High School has the same timetable and curriculum. Moreover, they share same lectures in different places and real-time voice communication; working simultaneously: the main campus and the branch campus of Chengdu NO. 7 High School uses the same textbooks and supplementary materials, and students in the branch complete the assignments arranged by the teacher of Chengdu NO.

7 High School at the same time; examining simultaneously: the main campus and the branch campus of Chengdu NO. 7 High School uses the same exam papers at the same time, and the scores in periodic exams need to upload online teaching management unit, which is easy to analysis and research. “Four in One” means teaching organization mode, which is a teaching model that instructors, checking teachers, remote teachers and technology teachers cooperate with each other to promote synchronous remote teaching. Instructors: there are outstanding teachers in Chengdu NO. 7 High School and eighteen superfine teachers in Online School; checking teachers: the education specialist in Chengdu NO. 7 High School, consist of two professors awarded government allowances of the State Council and two doctoral tutors, guide instructors and supervise the teaching process; remote teachers: teachers in the branch of Chengdu NO. 7 High School is responsible for student teaching organization, management, teaching counseling and teaching subjects other than live courses; technological teachers: Chengdu Eastedu Technology Development Corporation computer professionals provide live technology and technical support.

“Four in Union” teaching realization mode (preparing simultaneously, teaching simultaneously, working simultaneously, examining simultaneously) can better ensure the Chengdu NO. 7 High School excellent educational resources to implement the whole teaching process of the school in the branch. Besides, aim at the lack of interaction between Front-End and Remote in live class, “Four in Interaction” teaching interaction mode–Real-time Interaction, Virtual Interaction, Alternative Interaction, Transfer Interaction, applied with “Four in Union”, which make up for the lack of face-to-face interaction between Front-End and Remote to a certain degree, promote the re-integration of teaching and learning in synchronous remote teaching.

In school-running mode, both sides have a division on the basis of parties areas of expertise at present. Chengdu NO. 7 High School is in charge of teaching and resource supply. The company is responsible for market and support services. For the schools in the branch, they are in charge of teaching and student management in synchronous remote class, and provide learning support for students. In the live teaching services, Chengdu NO. 7 High School is in charge of teaching investment, teaching activities and business support, and the Chengdu Eastedu Technology Development Corporation is in charge of equipment investment, technical inputs and business activities. Furthermore, after buying live teaching service, the schools in the branch themselves also need to invest in equipment and management. From the above we know this mode gives full play to each superior points of tripartite cooperation, and closely linked to their needs. This win-win symbiosis mode will stimulate partner’s greater ability, and improve cooperation effect.

Although Chengdu NO. 7 High School Synchronous Remote Teaching Mode lack the flexibility of distance learning, it still has some characteristics, such as full teacher–student interaction, real-time guide of the learning process, strict learning management systematically, etc. This mode achieve the organization and management of the full course of learning process for students in the branch, including classroom activities and school assignment and exams after classroom, which, as to senior high school students who have the lack of self-learning ability, can better promote the re-integration of teaching and learning and ensure the quality and effect of learning.

Besides, in the form of live classroom, Synchronous Remote Teaching Mode not only share many resources with schools in the branch, such as excellent teaching handouts and information, but also realize the sharing of front-end teachers' teaching methods, teaching experience and teaching art. The teachers from the schools in the branch not just have the access to high-quality teaching resources, what is more, they study the front-end teachers' advanced teaching concept, teaching methods and techniques, which become an effective way for their professional development.

14.3.4.2 The Influence of Chengdu NO. 7 Online School

1. Student Growing

Full-Time Synchronous Remote Teaching, which makes students in different regions walk into Chengdu NO. 7 High School's classrooms, achieve the maximum and most comprehensive balance of high-quality educational resources in remote and core areas. Not only do remote students make prominent progress in study, but also self-learning ability, psychological quality, learning motivation and comprehensive literacy, which is improved.

Due to Full-Time Remote Live, students in the branch have the sense of belonging to Chengdu NO. 7 High School, and excellent teachers and resources of Chengdu NO. 7 High School enhances their learning self-confidence. Moreover, various cultural events that Chengdu NO. 7 High School and remote schools together participate in, organized by the EASTEDU, also increase the students' knowledge and overall quality. At the same time, the Chengdu NO. 7 Online School also reduces the financial burden on students, whose learning conditions requirement for students is lower, and it has better availability.

2. Teacher Promotion

By Remote Live Teaching Mode, the teachers from the schools in the branch not just have the access to high-quality teaching resources, what is more, they study front-end teachers' advanced teaching concept, teaching methods and techniques by collaborative teaching, which make their teaching philosophy constantly update, creative thinking constantly grow, professional development faster and information technology and curriculum integration capacity upgrade, then there is more sense of cooperation among teachers. In addition, teachers in the branch make use of "doing by learning, learning by doing." They participate in collective preparation for teaching on the virtual online platform, then they inspect and rethink the effect of preparation for teaching in the real online class teaching practice, which makes them learn Chengdu NO. 7 High School teachers team's practical knowledge by joining in discussion and practice.

3. School Development

Front-End schools and remote schools become a teaching practice community by the cooperation of Full-Time Synchronous Remote Teaching Mode. Because of the convergence of practice community awareness, remote schools consider the teaching research, student management, school culture, education concept and school-running idea in Chengdu NO. 7 High School as a target. This mode leads the remote school to adapt to coordinate and efficient management requirements, and guides the promotion of overall management efficiency, as well as the construction of the management mechanism. Moreover, it can promote the development of school management, which make partner schools' information technology upgrade, management efficiency promote, students backflow, ethos improve and academic atmosphere strong. In the end, with the promotion of school achievements and social recognition, the partner schools widen their horizons and improve their position, forming the ability of sustainable development.

4. Region Cooperation

Synchronous Remote Teaching Mode promotes cultural communication and cooperation between schools and regions. The mode combines Chengdu NO. 7 High School with each remote schools, making a large community of live teaching and study. The community organizes a variety of teaching, research and cultural activities on the subject of Live Teaching. These activities give the opportunity for teachers and students from different regions and schools to learn various education and cultural, widening their horizons. At the same time, with the deep development of remote live teaching, students in the branch make continual progress and school social reputation is promoted constantly. People from parents to residents have changed their attitudes from the questioning and negation into acceptance and support for remote live teaching. Hence, gradually, residents start to accept this way of distance education, and believe in the quality of distance education.

14.4 Problems and Suggestions

14.4.1 Problems

1. **The deficiency of interaction between teaching and learning remains the major obstacle**

The lack of the interaction between teaching and learning remains the core teaching issue in the teaching model of remote live broadcast. Although many schools of long-distance education take various measures, it is difficult to completely compensate for the lack of interaction in the live broadcast education. As a matter of fact, the lack of interaction is a common problem in all kinds of teaching models of distance education, from the basic laws on remote teaching and learning. In order to solve this problem, the study suggests that the front-end teachers design and distribute teaching and activity plans before the class. Meanwhile, teachers who know more about the features and needs of the far-end students are able to make lesson plans, and also prepare various pre-class strategies and resources to aid teaching, with the purpose of promoting the various interaction in the live classes.

2. **The selection of students and the education of them according to their different aptitudes**

The teaching model of remote live requires students with high quality in certain aspects. Chengdu NO. 7 High School aims at elite education, so the live courses from this school are designed for the students at high academic levels. As a result, this type of teaching is featured by high starting point, extreme difficulties, high speed and large capacity, which is a little difficult for those ordinary students or students with poor academic qualities. To ensure the teaching effect, when the online schools organize the live broadcasting classes, they not only try to select the local schools with comparatively good teaching foundations, but also suggest the remote schools to select the most excellent students to attend the live class. As a result, the selection of students limits the spreading of this teaching model. If we want more students to get benefits from it, this teaching model is supposed to spread to a larger scope, which results in taking various means to educate different students according to their different aptitudes.

3. **The influence of the external circumstances on the sustainable development of the live broadcast teaching model**

The influence of the policies made by the central and local governments is decisively significant to the expenditure sources and the reasonable development of the remote live education. The governmental departments of all levels in the regions where many online schools are located have offered different forms of support for the synchronous remote education, but the supporting strength is not satisfactory, which is related to the situation that the country's educational authorities and relevant departments have not provided policy guiding and support for the rationalization of this model. Meanwhile, the remote schools lack policy guiding and regulations of carrying out the synchronous remote education, which restricts the local governments of all levels to integrate the online schools and the relevant local programs. As a result, the advantage of online schools is unable to be performed to the greatest extent, and in the same way limits the popularization of them in a larger range.

The more areas which are covered by the synchronous remote education, the stronger impact by the curriculum and college entrance examination reform. Because the synchronous remote education completely replaces the formal classroom teaching, it is better that the teaching materials and students' evaluation such as syllabuses and textbooks is in line with the front schools, and only in this way can be achieved more significant effects. However, the curriculum reform will lead in the schools in different areas to have more right of selecting textbooks by themselves, and each province is allowed to make its own papers after college entrance examination reform, therefore, that will influence the effects of the synchronous remote education.

14.4.2 Suggestions

1. **It is better to be applied in improving the educational quality in the educationally undeveloped areas**

The synchronous remote teaching model is more suitably applied in the areas where primary and middle schools' educational sources do not meet the requirement, as well as the central and western regions. It is regarded as one of the means to improve the local schools' educational quality, share the teaching sources and develop teachers' professional capabilities, so it is better to be applied in the areas where the syllabuses, textbooks and, student evaluation are close to each other.

2. **The integration of the relevant policies and programs promotes the rural educational quality**

Education is a system and needs to be planed and implemented with an overall view. It is suggested to integrate the synchronous remote teaching model with the relevant national, regional and organizational programs and resources such as Modern Distance Education Project in Rural Schools, with the purpose of promoting the optimizing and utilization of the resources.

3. **It is significant to provide supporting service for the teaching and learning process**

It is very important to provide supporting service for the teaching and learning process, and the running of the model requires the professional organizations or institutes to offer service for teaching and learning. Therefore, some enterprises with the quality of providing teaching service are able to take advantage of offering customer service and managing customer relations in a better way.

4. **The synchronous remote broadcast education is better to be applied Flexibly according to the schools' reality**

The management and support by the remote schools for the synchronous remote teaching is the key to the success of the synchronous remote education. The school synchronous remote education will be more successfully carried out and the potentials of it is better performed only by targeting at the different schools and their different stages of development, applying the synchronous remote teaching model flexibly, and providing more targeted service.

14.5 Conclusion

This chapter puts forward the method of SRC connecting K-12 schools from developed areas and undeveloped areas to solve the problem of unbalance development of education to some degree in China. It introduces the case of Chengdu NO. 7 online school in which the SRC is the most distinctive, elaborates development road, teaching system, and teaching model of it, and then analyzes the problems and gives some suggestions. Because we have not done empirical research about Chengdu NO. 7 online school, the results may be not enough rigorous. Therefore, further studies will trace the instructional practice and survey on stakeholders related the Chengdu NO. 7 online school.

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Chapter 15
Developing, Sharing, and Using of Micro-lectures in Region: Implications Derived from a Government-Oriented Micro-lecture Project in Shanghai

Yongbin Hu, Jinbao Zhang and Ronghuai Huang

Abstract Micro-lectures are an effective educational resource, which not only benefit students' learning but also benefit teachers' professional development. There is a growing interest in developing, sharing, and using of micro-lectures for teachers, schools, local governments, researchers, and other stakeholders. This chapter introduces a typical government-oriented project, "J class" micro-lecture project, which is an ICT in education project with the vision that provides quality learning resources, supports individualized learning, and balances inter-region education in Putuo district, Shanghai. Three implications with regard to teaching innovation are further made in order to provide a point of references for other district to implement micro-lectures inter-region application.

Keywords Micro-lectures · J class · Educational resources · Balanced education

15.1 Introduction

Rational and abundant allocation of high-quality educational resources is the fundamental measure to improve social justice and education quality (D'Antoni 2009; Huang et al. 2015). However, scattered resources construction funds lead to diffi-

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culty in economies of scale; low level repeated construction results in varying quality of resources; inadequate high-quality resource sharing makes limited beneficiaries of resources. A new mode of "inner-region co-construction and sharing, inter-region exchange and sharing" for basic educational information resources allocation has been used in some regions in China (Wenzheng 2014).

On a global scale, there have been three typical models on developing, sharing, and using of micro-lectures. The first model is called teacher-oriented model. In this model, video is created, used, and shared by the teachers themselves. The teachers determine how to record, how to share, and how to organize students' learning with micro-lectures in their classes. Majority of the micro-lectures cases belong to this model. The second model is called organization-oriented model. In this model, an organization (nonprofit or for profit) is in charge of determining what kinds of micro-lectures would be created, what subject, and how to share. Starting from the needs of the community, the organizations will ask for corporations with schools, and help schools to organize in-class or after-class learning. The third model is called government-oriented model. In this model, local government plays a leading role in developing, sharing, and using of micro-lectures.

In this chapter, "J class" project, belonging to government-oriented model, would be introduced. The chapter is organized as follows. The second section gives an overall introduction on this project. The third section presents the background of "J class" micro-lecture project. In the fourth section, the development, sharing, and using of micro-lectures in this project is outlined. The fifth section presents the implementation and its tasks. The sixth section concludes this chapter, including benefits and shortcomings.

15.2 Case Overview

Putuo district is located in northwest of Shanghai city. In January 2013, the Putuo district government carried out the "J class" project as an inter-region ICT project in Shanghai to provide quality learning resources, support individualized learning, and balance inter-region education. In this project, the elite teachers are invited by the local government to record their teaching processes as short videos, which are micro-lectures within 10 min. All these videos are uploaded to "J class" platform, which has access to all students to support their self-regulated learning. All learning traces are marked and learning assessment is carried out automatically. Now, 557 micro-lectures are updated on the platform, several subjects, such as math, physics, and chemistry are covered. 432 teachers and 9,038 students coming from 35 schools use this platform in the daily teaching and learning. This project provides quality learning resources both for students and teachers, which is an effective way to realize learning in practice.

15.3 Background

15.3.1 Overview of Micro-lectures

Today, we live in a technology and media-driven environment with rapid changes in technology tools (Partnership for 21st Century Learning Skills 2011). With these rapid technological advances, the using of computing devices and videos imply that the way of learning and teaching is different than before. In the classroom learning, lecture videos are used for many pedagogical and logistical reasons, such as supporting students who are unable to attend class, providing a study tool for review and revision, catering for individual learning strategies and styles, supplementing face-to-face lectures, etc. (Gosper et al. 2008). For this reason, an increased interest on educational videos have been observed during recent years (Giannakos 2013).

Traditional lectures may no longer primarily serve the purpose of disseminating information, which can be easily found in many online video lecture repositories at any time. Many top universities offer lectures (e.g., Stanford, Oxford, MIT, EPFL, and Harvard) offer video lectures in most subjects through a public platform, such as iTunes U, making course material accessible on a range of devices, like smart phones and tablets. Also, there are many video platforms where people can find lecture video (e.g., teachertube.com, khan academy, mylearningtube.com). In addition, the number of for-profit organizations who use training or advertising videos is increasing rapidly. Currently, Massive Open Online Courses (MOOCs) are a widely discussed phenomenon in education (Giannakos et al. 2015).

Recently, the interest surrounding the use of micro-lectures has continued to grow in the world. The term “micro-lectures” is instructional content that is formatted for online and mobile learning using a constructivist approach (Wikipedia 2015). Many people found that teacher-created micro-lectures combined with specific strategy are better than micro-lectures (Lipowski 2009; Loginquitas 2009; Robledo 2009). For example, in the shadow of Colorado’s Pike’s Peak, veteran Woodland Park High School chemistry teachers Jonathan Bergmann and Aaron Sams developed and uploaded micro-lectures for absent students, and the students had the opportunity to see what they missed (Tucker 2012). Another example is Khan Academy, which was founded by Salman Khan in 2006, is a nonprofit educational organization to provide “a free, world-class education for anyone, anywhere” with micro-lectures (Kundart 2012). Micro-lectures benefit both teachers’ professional development and students’ learning; therefore there is a growing interest for teachers, schools, local governments, researchers, and other stakeholders.

15.3.2 Context of Putuo District Education

Putuo district is located in northwest of Shanghai city which lives with more migrant population than local population. In this district, there are about 181 kindergartens, primary schools, middle schools, and universities. 87,276 students and 9,212 teachers are learning or teaching in these schools.

However, with the increasing of enrollment scale of education in K-12 education, a widespread phenomenon is the unbalance of educational resources, educational conditions, and teacher salaries. The experienced teachers have more chances to teach in elite schools; majority of the beginning teachers have to teach in general schools. The gaps between teachers and schools lead to the students in different regions have different academic performance.

In the past 10 years, the gap is getting bigger and bigger. With more and more children of migrant workers in other provinces come to Shanghai and study here, they have been lagged behind their classmates who are native Shanghai. Also, it is a great challenge for their teacher to face the students who have so big achievement gap.

15.4 Implementation Plan and Tasks

Putuo district is one of the first ICT in education pilot district entrusted by Ministry of Education in China. The Putuo district government tends to build this district as a demonstration district in ICT in education. In order to let every student can access to quality educational resources, and to save time and money for each school, Putuo district government proposes the project objectives which are narrowing the gap between students and enhancing the learning quality of every student. Shanghai Putuo district government carried out “J Class” project to meet needs of teachers and student. The expected outputs of this project are to exploration and promotion the methods and strategies in using micro-lectures enhance learning and teaching.

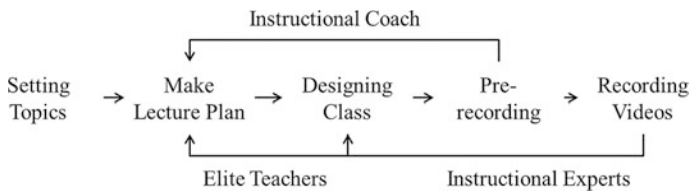
In order to implement the project objectives, the Memorandum of Understanding (MOU) on micro-lectures was signed between Putuo district government and Shanghai Huashi high-tech development Co. Ltd. In this MOU, the company provides technical supports in video recording, cloud service platform building and maintaining.

The research team of this project is led by Putuo district government; bureau of education officials, researchers in educational institutions, IT professionals, instructional experts, innovative young teachers take part in this project. Front-line teachers are encouraged to find the breakthrough in using the micro-lectures. This project builds three teams, including a video team which focuses on developing quality micro-lectures, a platform team which focuses on building a robust cloud services platform to share micro-lectures, and a using team which focuses on the strategy to use micro-lectures for students’ learning.

15.4.1 Developing of Micro-lectures with Professional Teams

The video team is composed of instructional experts, instructional coach, elite teachers, and technical engineers. The task of this team is to develop high-quality, knowledge-based, 10-min micro-lectures. Instructional experts, who are experienced teachers with more than 30 years of teaching experience, are in charge of curriculum design, time management, and micro-lecture quality. With the help of the experts, the elite teachers are invited to select teaching contents, design activities, and give class shows. The technical engineers take charge of video recording, editing, and packaging.

As is shown in the following figure, the development process including five key steps, such as setting topics, making lecture plans, designing class, prerecording, and recording lectures.



Development process of micro-lectures

Till now, more than 600 micro-lectures are published on the platform, several subjects, such as covering mathematics, physics, and chemistry in junior middle schools are covered.

15.4.2 Sharing of Micro-lectures with a Cloud Service Platform

The platform team is composed of 20 technical engineers from Huashi High-Tech Development Co. Ltd., which is a professional IT company and the modern education technology center in Putuo district. The task of this team is to develop cloud service platform and share micro-lectures. As is shown in the following figure, this project builds a cloud service platform which is called "J Class" (http://schoolspace.jclass.pte.sh.cn/).

Webpage of “J Class” platform

This platform is not just a repository, it supports video podcast, learning traces record, and learning analysis. The access to this platform is free to all teachers and students within Putuo district. The students login the platform with their own account and begin their own self-regulated learning. All learning traces are marked and learning assessment is carried out automatically. When preparing a new class, teachers check students’ learning traces to confirm teaching difficult points and learning progress. By this platform, all the quality micro-lectures are shared within schools in Putuo district, and all the learning data are recorded in this platform.

In order to ensure an efficient operation, three measures have been taken. The first measure is to invite IT talent teachers to take part in this platform management, which motivates teachers with high ICT abilities. The second measure is to build a learning community to provide platform using WeChat group or QQ group. The third measure is to hold meetings or workshops to promote ripe experience and ideas.

15.4.3 In-and-Out Classroom Using of Micro-lectures

The using team is composed of instructional experts and young teachers with innovative teaching enthusiasm. The task of this team is to explore how to use the micro-lectures effectively. Considering the needs of schools and interests of teachers, 7 schools were selected as pilot schools.

Almost all the micro-lectures are designed to help students prepare lessons before class. All pilot schools and teachers are encouraged to attempt to innovative teaching in the light of subject needs and school characteristics. In practice, three typical using models are built by innovative teachers such as pre-learning model, in-class-assisting model, and individual coaching model.

Pre-learning model, originated from flipping classroom, includes two phases, such as pre-class learning and classroom learning. In the first phase, the students need to watch micro-lectures and finish task to realize the first learning on one knowledge point. In the second phase, the learning actives are designed judged by the pre-learning level. Normal, the higher level knowledge point would be presented to foster students' abilities. The key steps in this model include online pre-learning, online learning evaluation, classroom learning, and classroom learning evaluation.

In-class-assisting model is used to select and use specific micro-lectures to assist classroom teaching. In practice, subject teachers face lots of challenges in teaching key points or difficult points, which is difficult to deal with in traditional ways. In this model, specific micro-lectures are selected by the subject teacher, and they are used as instructional video to clarity key knowledge point in classroom teaching.

Individual coaching model focuses on individualized learning and individualized development. Plentiful micro-lectures are provided to the students to realize self-regulated learning. With the help of learning analysis in the cloud service platform, the problems posed by the students would be answered at any times. In addition, this model supports after-school learning with wider topic.

In pilot schools, different teachers have different research interests. Some teachers research how to use micro-lectures as supplementary materials or advance organizers in classroom teaching. Also, some teachers research how to use micro-lectures to provide individualized learning. In addition, due to lack of qualified teachers, four middle schools for migrant students carried out a teacher professional development project, which provides periodic seminar to training teachers.

Till now, 432 teachers and 9,038 students coming from 35 schools use this platform in the daily teaching and learning. Several excellent schools have formed distinctive ways in using of micro-lectures. Tens of talent teachers serve as innovative agent in this project.

15.5 Implications

15.5.1 Benefits

Micro-lectures have the goal of supporting teachers to enhance professional development and to cultivate students who are able to proficiently and ethically use ICT for day-to-day learning. Based on the experiences of "J Class" micro-lecture project, this section summarizes two benefits related to this project in region.

The first benefit is related to students' learning. As mentioned above, the gap between students in different schools is a common phenomenon in general. This implies that quality lecture resources from elite teachers should be shared to all the students in district to narrow the gap. In this project, micro-lectures are developed, shared, and used in district schools, which proved is an effective way to narrow the gap between students in different schools.

The second benefit related to teachers' teaching. As one kind of teaching resources, micro-lectures increase the teaching methods for the teachers. On the one hand, micro-lectures could be presented in classroom, which enhance the vividness of the classroom teaching. On the other hand, micro-lectures could be used after classroom teaching, which enhance the learning quality of student.

The third benefit is related to teacher's professional development. Teacher is the key in classroom instruction. This implies that taking effective measures to enhance teachers' teaching ability and promote their professional development is urgent. By quality micro-lectures, inexperienced teachers have the opportunity to learn from elite teachers. In this project, pilot teachers have developed a habit of research micro-lectures before classroom preparation, which is an effective way to narrow teaching gap between teachers in different schools.

15.5.2 Shortcomings

Until now, this project has made positive progress in region which produces a significant radiation from pilot schools to others schools. However, due to limitation of a number of factors, there are still three shortcomings need to be perfected in promotion and using of micro-lectures.

The first shortcoming is the number and qualities of micro-lectures need to be enhanced. From the beginning, quality and development speed of micro-lectures are always challenge to the development team. Unstable development process and inexperience in the development lead to the development of low speed and low quality. With increasing number of students carrying out their individualized learning, video development team feels more pressure on number and qualities of micro-lectures.

The second shortcoming is the function of the cloud service platform is incomplete. "J Class" platform has been used for more than one year. Now, it provides the function of the initial e-learning platform, which can be used for pilot schools for effective teaching and learning. However, this platform still has some functions that need to be perfect, such as graphic express on learning outcomes, user experience in learning, more dimensions in learning analysis, etc.

The third shortcoming is the teaching model of micro-lectures needs to be increased. Currently, under the leadership of talent teachers, three typical teaching models have been popularized. However, through in-depth analysis of the teaching model, it can be found that the current application model is not rich enough and innovation in teaching is still relatively weak.

15.6 Conclusion

This chapter introduces a typical government-oriented project which operated in region. In this project, the local government plays a leading role in developing, sharing, and using micro-lectures. "J class" micro-lecture project is an ICT in education project with the project objectives that provide quality learning resources, support individualized learning, and balance inter-region education in Putuo district, Shanghai. In this project, under the leadership of local government, video team, platform team, and using team are built. The video team is in charge of developing high-quality, knowledge-based, 10-min micro-lectures. The platform team is in charge of a cloud service platform. And the using team focuses on the strategy about how to use micro-lectures for students' learning. The results of this project show that this project benefit students' learning, teachers' teaching, and teachers' professional development. In addition, several aspects need to be enhanced, such as the number and quality of micro-lectures, the user experience of the platform, and the teaching model of micro-lectures in classrooms.

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