Jhing-Fa Wang
Rynson Lau (Eds.)

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Volume Editors

Jhing-Fa Wang
Tajen University, Department of Digital Arts and Multimedia Design
No. 20, Weixin Road, Yanpu Township, Pingtung County 90741, Taiwan
E-mail: president@tajen.edu.tw

Rynson Lau
City University of Hong Kong, Department of Computer Science
Tat Chee Avenue, Kowloon, Hong Kong, China
E-mail: rynson.lau@cityu.edu.hk

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Message from the ICWL 2013 Conference Co-chairs

On behalf of the Organizing Committee, it is our pleasure to welcome you to the 12th International Conference on Web-based Learning (ICWL 2013), held in Kenting National Park, Taiwan, during October 6–9, 2013. Beginning with the first event in Hong Kong in 2002, ICWL has become a truly international conference and has been held in Australia (2003), China (2004), Hong Kong (2005), Malaysia (2006), UK (2007), China (2008), Germany (2009), China (2010), Hong Kong (2011), and Romania (2012). We are pleased that this international character is also reflected in ICWL 2013, where the accepted papers come from 26 countries on 4 continents. ICWL 2013 has been jointly organized by the Hong Kong Web Society, Tajen University (Taiwan) and the City University of Hong Kong. We are grateful to many local supporting organizations, especially to the National Center for High-performance Computing, Chunghwa Telecom, Hong Kuan Technology Co., Ltd, and Taiwan Association for Web Intelligence Consortium.

The conference venue is nearby Kenting National Park, renowned for its rich landscape of hills and water, abundant wildlife, and natural resources for everyone's enjoyment. We hope that the participants benefit from its pleasant scenery.

We are proud of our renowned keynote speakers, Dr. Nick Rushby and Prof. Yao-Ting Sung, and invited speakers, Prof. Ralf Klamma and Prof. Chia-Ju Liu. We also appreciate the hard work of those who organized workshops to probe new ideas for the future.

We sincerely thank all of our chairs and committee members. Without their great effort, the success of ICWL 2013 would not have been possible. Our appreciation must go to all the authors for their valuable contributions and the other participants of this conference. The conference would not have been possible without their participation. Finally, we wish all participants an enjoyable stay during the conference period.

August 2013

Jhing-Fa Wang
Rynson Lau

Message from the ICWL 2013 Program Committee Co-chairs

Welcome to the 12^{th} International Conference on Web-based Learning (ICWL 2013), held in Kenting National Park, Taiwan, during October 6–9, 2013. ICWL 2013 is a comprehensive conference focused on the various aspects of web-based learning and its applications. It provides an opportunity for academic and industry professionals to discuss the latest issues in the area. These proceedings contain high-quality papers which are closely related to the various theories and practical applications of web-based learning. We appreciate the hard work of the workshop organizers in organizing six thematic workshops. We expect that the conference and workshops will become a trigger for further related research and technology improvements in this promising area.

This year, we received 117 paper submissions and, after a rigorous peer review process, we accepted 34 high-quality articles, which appear in these proceedings, published by Springer. All submitted papers underwent blind reviews by at least two reviewers appointed by the Technical Program Committee, which consists of leading researchers from around the world. Without their effort, compiling such high-quality proceedings would not have been possible. We are grateful for their great support and cooperation. We also feel privileged to have had the opportunity to invite two distinguished scholars, Dr. Nick Rushby (CEO at Conation Technologies and Editor of the British Journal of Educational Technology, UK) and Prof. Yao-Ting Sung (chair professor at the National Taiwan Normal University, Taiwan) to give the keynote speeches, as well as the invited speakers, Prof. Ralf Klamma and Prof. Chia-Ju Liu. Finally, we would like to thank all of you for your participation in the conference, and also thank all the authors, reviewers, and Organizing Committee members. Thank you and enjoy the conference!

August 2013

Yueh-Min Huang
Frederick Li
Qun Jin

Message from the ICWL 2013 Workshop Co-chairs

We would like to first thank the authors who have contributed their manuscripts to the workshops of the 2013 International Conference on Web-based Learning (ICWL 2013) in Kenting, Taiwan. ICWL 2013 provides a forum for researchers, educators, and industrial professionals to share research contributions and to discuss novel trends in web-based learning areas. It is our pleasure to collaborate with the Organizing Committee of ICWL 2013 and to coordinate the workshops. The themes of the workshops include ubiquitous social learning, smart living and learning, knowledge management and e-learning, cloud computing for web-based learning, web intelligence and learning, and e-book and education cloud. We would like to express our appreciation to all reviewers for their time and valuable comments. We would also like to express our appreciation to all Program Committee members for their great promotion of the workshops. Finally, we would like to express our sincere appreciation to the Organizing Committee members for their hard work in coordinating and serving this wonderful event. We truly hope that all of you will enjoy the conference program and activities in Kenting.

August 2013

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Publishing Research in Web-Based Learning: An Interesting Age*

Nick Rushby

British Journal of Educational Technology, Chantry Cottage, The Green, Otford, Sevenoaks, Kent TN14 5PD, UK
Nick.rushby@dsl.pipex.com

Abstract. Publications are a crucially important factor in our research. In recent months the traditional model of scholarly publishing has started to change with low-cost online publishing, open access and – most recently – data-sharing or open data. This keynote examines these changes and looks at the approaches that are being taken to optimise the new arrangements and some of the as yet unforeseen, and possibly undesirable, consequences.

1 Introduction

Publications are a crucially important factor in our research. Peer reviewed journal papers are perhaps the most important form of publication and it is on publication in journals that I want to focus today. There is relatively little research in our area that is the subject of research monographs, and while conference proceedings abound (there are arguably too many conferences on different aspects of learning technology) they are of variable quality and utility.

All of us are consumers of research, and most of us here are also producers of research publications (figure 1). We need it to decide what to research and how to research it and when we have finished our research (or at least, come to a point where there is something to report) we look for the best place to publish our findings. Other consumers of research are policy makers who want to make evidence-based decisions about how best to use web-based technology in learning. (Sometimes of course, we feel that we are the victims of decision-based evidence making: the decision to use web-based learning has been made and now the politicians are looking to us for evidence that will support their decision!).

And then there is the important group of research consumers who decide on the allocation of funding and on offers of employment and tenure. They are looking for evidence of our status and credibility in the field. We are often judged on the quality (and perhaps quantity) of our publications.

* "May you live in an interesting age" (Said to be ancient Chinese curse). The views expressed in this paper are those of the author and do not necessarily reflect the position of the British Educational Research Association (BERA) or that of Wiley who publish the *British Journal of Educational Technology* on behalf of BERA.

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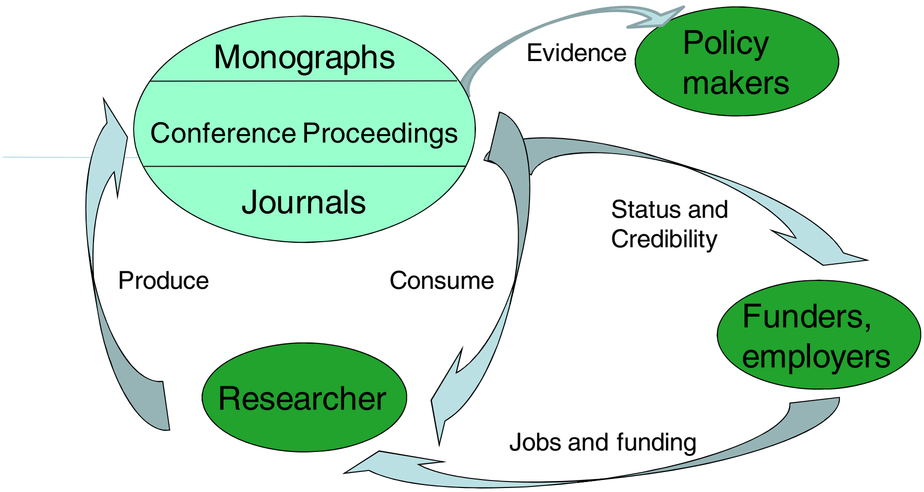

Fig. 1. Producers and consumers of research

So, publishing is vital to our research and without an effective and efficient publishing system we would literally be out of business.

2 Open Access

Let us first look at the case for open access. The argument that the results of research that has been publicly funded should be publicly available without payment of subscription fees or online access fees is very attractive. Why should I have to pay to read a paper written by a university-based researcher whose work has been funded by my taxes? There seems no good reason why.

The story of how the United Kingdom launched itself at breakneck speed down the road of Open Access (OA) is, like all the best legends, difficult to verify. However, it is said that a government minister found that, on his appointment, he had to give up his academic post and with it his free access to the university library. Upset by this, he became a strong advocate of open access - the notion that research papers should be free to every online reader. Within a relative short time, a committee (The Finch Committee) was set up, reported and some of its recommendations were adopted [1]. Unfortunately, some of the less convenient recommendations were ignored and so the United Kingdom finds itself facing a number of issues which are still to be resolved. The USA too is moving towards open access, although with rather more discussion and caution. Do not think that this is a little local difficulty, peculiar to the UK and the USA. Australia too is moving rapidly towards OA. The case was put vehemently by Simon Marginson of the Centre for the Study of Higher Education, University of Melbourne [2]:

> "Few universities can afford to maintain the full set of minimum necessary journals to be able to provide research infrastructure on a comprehensive basis. Indeed, even the strongest Australian university libraries are forced to do without material they need to hold. In New Zealand the problem is significantly worse, and in major universities in such countries as Indonesia, Philippines or Vietnam there is simply no possibility of providing even the most minimum set of necessary journals."

Figure 2 shows a model of academic publishing. Although this is somewhat simplified it is much more complex than the typical author's view of what happens in the process. The typical author writes a paper which is submitted to a journal. The author hopes that in due course it will be accepted and then published. It can be added to the author's *curriculum vitae* - and we move on to the next piece of research and more publications.

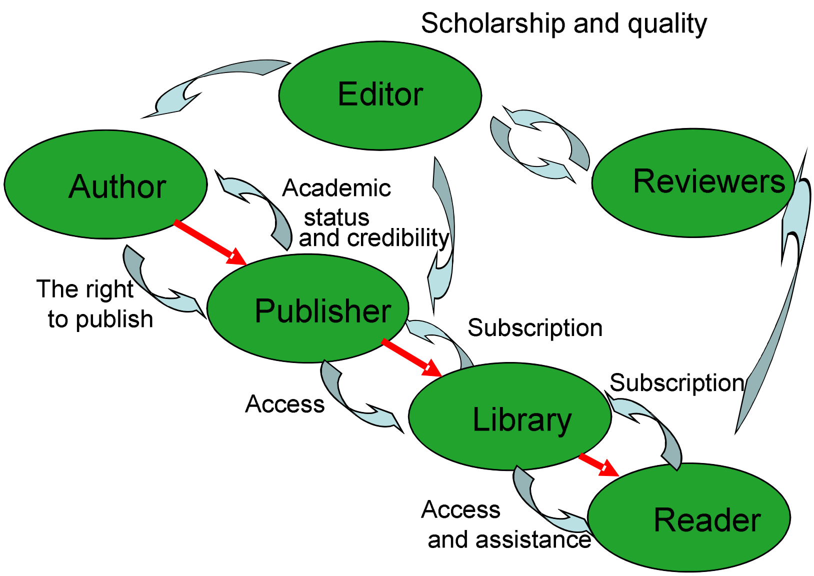

Fig. 2. A simplified model of traditional academic publishing

Some thought will show that there are many more actors involved in the process. There is a series of contracts, between the author and the publisher in which the author confers on the publisher the right to publish and the publisher undertakes to make the accepted paper widely available to the research community, thus increasing the author's academic status and credibility. There are contracts between the publisher and the libraries and readers, which give access to the paper in return for a subscription or payment. This provides revenue to finance the operation.

There are also considerations of maintaining quality which is achieved by a process of peer review. This gives an independent check that papers are important, accurate and readable. It also helps (but does not guarantee) to identify academic malpractice such as falsification of results and plagiarism.

An immediate problem is that it costs money to publish high quality papers. There are the costs of running the editorial office (and here I must declare a personal interest for I am an editor), the costs of checking and correcting manuscripts, or copy editing, of typesetting, of maintaining the server, and of making the papers both accessible and discoverable. The fees charged to readers, often through their libraries, provide the revenue which used to fund high quality journals. And here is the problem. The publishers have to protect their revenue and so control access to the papers through payment schemes. A common misperception is that publishers make exorbitant profits selling the work of unpaid authors to libraries and individuals for large sums of money. Even the majority of reviewers are unpaid! It is disgraceful and something must be done!

The solution is open access (OA). There are several ways in which this can be achieved but the most common are

> 'Gold' OA which provides access without payment to the version of record of a publication via the publisher's own platform, and
>
> Green Open Access: access without payment to a version of a publication via a repository, usually after an embargo period.

Both approaches disrupt the traditional model.

The Finch Committee [1] recommended that the UK should adopt Gold OA and the Government accepted that proposal with such enthusiasm that the UK research councils mandated Gold OA to be in operation by April 2013! It was recognised that scholarly publication needs to be funded and so, instead of charging the readers there is an Article Publication Charge (APC) of about US$3,000. There is no fee for submission: only papers which are accepted for publishing pay that charge. Already we can see some problems. Clearly a journal which is seeking to maximise its income will think of increasing its acceptance rate. More accepted papers means more income to pay the fixed costs of the editorial office and the maintenance costs of the online library. This potential conflict of interest is quite easily overcome by separating the editorial decision-making from the sordid issue of payment. Only papers where the funding agency has mandated open access have to pay the fee and so the author is only asked after acceptance whether it is to be published open access. In theory the editor and reviewers do not know whether this will be the case: in practice, knowing the research group and reading the acknowledgements at the end of the paper, they can make a fairly accurate guess!

The intention is that the APC will be paid by the funding agency as part of the overall grant. This works better for new projects than for those funded before the advent of the new scheme for which there was no provision for publishing fees. Finch proposed that there should be additional government funding for authors who do not have research funding for the fees. There is some provision but there is less money than Finch recommended and there are fears that the administrators will give preference to established academics, thus disadvantaging early career researchers. There are also obvious problems where papers are authored by international teams, some of whom have money to publish and others who do not. Should the total fee fall on those with funding?

The UK system recognises that not all open access can be published under the Gold route and there is also a 'Green' or 'Deferred Access' route where access to the paper only becomes open after an embargo period. This is intended to give the publisher some time to recover their investment. The issue here is the length of the embargo period. In science and technology journals, a paper is often only of interest for 6-12 months. After that time the results are history and it has no commercial value. This was the initial proposal for Green OA. However, for social sciences and humanities journals the situation is very different.

The half-life of a paper is defined as "the median age of the articles that were cited in the JCR calendar year. Half of a journal's cited articles were published more recently than the cited half-life. (Only journals cited 100 or more times in the JCR year have a cited half-life.) Note: A higher or lower cited half-life does not imply any particular value for a journal. For instance, a primary research journal might have a longer cited half-life than a journal that provides rapid communications."

The half-life for The *British Journal of Educational Technology* is currently 4.6 years: other journals in the field are much longer. If the embargo period was set at 6-12 months then the great majority of citations would be made after the paper became open access. This would appear to be good news for researchers but very bad news for the publisher. In practice, there would be a significant financial impact on the Journal which could threaten its future existence.

The majority of UK-based journals have adopted a hybrid model for open access publishing which includes both Gold and Green routes as well as the traditional model (see figure 3). Australia and the USA are taking the Green route with papers deposited in an open access institutional or publisher's repository within 12 months [3-4].

Fortunately, the number of accepted papers in *BJET* where the funding agency has mandated open access is very small and for the time being it is not causing real problems. This means that we have a mixed economy in which most papers follow the traditional model and are available to those who subscribe to the Journal or pay an access fee, with a minority of papers that are freely available online to everyone. There is therefore little reason for libraries to cancel their subscriptions because their readers would lose access to most of the Journal's output.

Other journals are in a more difficult position and some face closure. Quality costs money and some of that cost in incurred in making editorial decisions on every submission. I understand that some physics journals have a rejection rate of about 6-10%. The costs of dealing with these unsuccessful submissions can be absorbed relatively easily within the revenue generated by the published papers. Major learning technology journals have lower acceptance rate (*BJET* accepts about 9% of peer reviewed submissions) and the economics are harder.

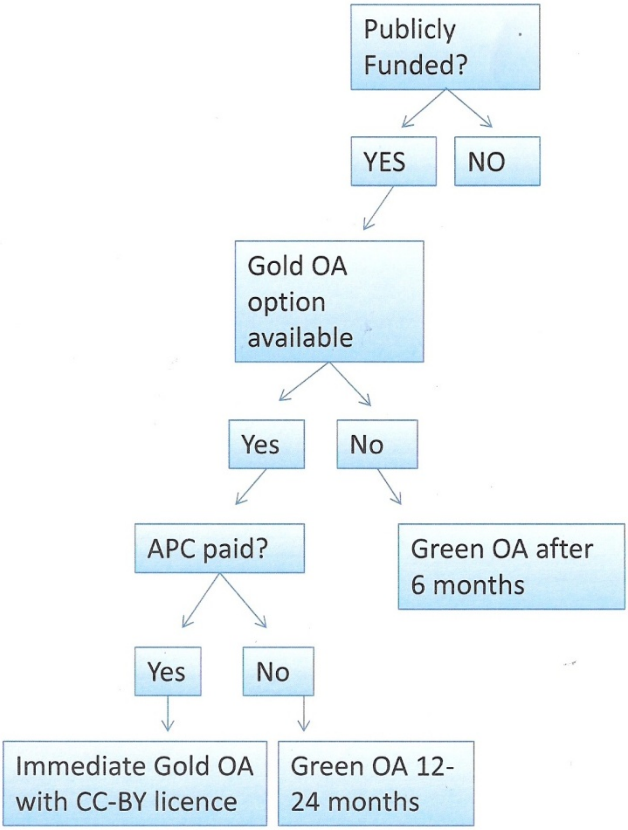

Fig. 3. UK Publishers Association open access routes

We also need to look at what happens to the profit from journals. Certainly some of the revenue provides a profit for the publishers but many journals are owned by learned societies who receive a royalty from the publisher and rely on that income to fund their activities. Many societies are their own publisher and benefit from all of the operating profit. These scholarly activities typically include organising conferences and seminars, and helping early career researchers through bursaries and awards. If the income from journals is reduced by the introduction of OA then these activities will have to be curtailed. It would be ironic if OA made it easier for researchers to access the literature at the expense of damaging the professional development of those same researchers!

On a more positive note, OA might help to solve the problem of space in traditional journals. Even though journals like *BJET* are now mainly accessed online, they are subject to a page budget because every page incurs a cost in copy editing and typesetting. If there were more space then the quality criterion could be relaxed and a greater percentage of submissions could be published.

There is an inherent contradiction in the status/credibility role that journals are asked to play by universities and funding agencies. They require faculty to publish their work in high quality journals (particularly those with high impact factors). This leads to increased submission rates and – with restrictions on the volume of papers that can be published – increased rejection rates. Gold OA changes the economics and if we were prepared to publish more papers that come with an APC (and that is a very big 'if') then the budgets could be increased. Yet, if more papers are published the criteria are inexorably raised. It is no longer sufficient that the journal has an impact factor; it has to have a high impact factor.

3 New Online Journals

If we are dissatisfied with the costs of publishing then, as a community of professionals in the web-based learning business we are in an excellent position to set up new journals that meet our needs. Indeed there is a growing number of such journals. Some are respectable but others are more suspect. Like me you will probably receive numerous emails from little known publishing houses offering to publish your work on an open access basis. These potentially predatory publishers are named in Beall's List published by Scholarly Open Access and should be treated with caution [5].

But, some are very respectable, maintain high quality and high academic standards, and provide a rapid route to publication. To achieve this at very low cost they rely heavily on volunteer labour for the editorial, reviewing and copy-editing work, and are hosted on institutional websites. There are standard tools that make it possible to set up a basic journal website in a few hours and as long as the volunteers continue to make their services available the journal can continue to operate. The problems of course, start when the load on the individuals concerned becomes too great and their employers become reluctant to continue allowing them to spend their time on scholarship rather than teaching or funded research. Several learned societies in the USA set up experimental on-line OA journals and have now discontinued them on the grounds of cost. New journals have to work very hard to attract the best papers and to build a reputation for quality. Publishing is a harsh business!

One answer is to change the notion of how we assess and achieve quality. Some journals already take a radically different approach to reviewing: every submission is accepted for publication and then readers are invited to publish their comments and criticisms as open reviews that are associated with the paper itself. The number of reviewers is potentially limitless although some moderation is needed to ensure that libellous comments do not appear on the site. Arguably this approach offers a very high degree of participative scholarship and benefits the active consumer of research. It is less useful for those who merely wish to use research publications as a quick and easy measure of credibility.

4 Data-Sharing

The notion of data-sharing follows naturally from the open publication of research papers. In a journal such as BJET there is insufficient space to include all of the raw research data. Instead, authors summarise their results in tables and graphs, and describe their analyses and findings. It is not possible for another researcher for example, to check the calculations or verify the way in which videos have been coded. If other researchers had access to the data it would provide the opportunity to confirm (or critique) published results, to extend research by building on the earlier work. It would add to the credibility of published research and reduce the possibility of fraud. Remember that when we carry out research we have a duty to report and try to explain all of the data – not just the data that supports our thesis! Boulton [6] asserts:

> "Since the seventeenth century, the progress of science has depended on the evidence (the data) that is the basis of a published scientific concept being open to scrutiny, together with the metadata that permits its replication. They are the bedrock of so-called scientific 'self-correction'. Though it is understandable why less stress has been laid on these things in a data-rich era, it is vital for the progress of science that we come to regard procedures that offend this principle as malpractice. They include non-publication of the full evidence of a published claim; cherry-picking and partial publication of data; partial reporting of results of an experiment, such as in biased reporting of clinical trials; and the failure to publish refutations, for though scientific journals may prefer a beautiful theory, we must welcome it when 'a beautiful theory is destroyed by an ugly fact'. These are responsibilities that fall both on scientists and those that publish their work."

There is also some evidence from life sciences research that the sharing detailed research data can increase citation rates – something that we would all appreciate [7].

So, there are some undoubted benefits. What are the problems? If it is to be useful then the data has to be accessible. Some institutions and funding agencies require that all research data is stored in an institutional repository. It will need to include some metadata so that others can make sense of it (for UK funders' requirements see [8]) and there need to be links from the published papers to the location of the data. The long term storage of this data is an important consideration. As we saw earlier with research literature, there needs to be a guarantee that the data will be accessible for a reasonable time – perhaps as much as 50 or 60 years. If this seems excessive, then think about some of the key experiments in learning technology. Would it be helpful to have access to BF Skinner's research data on operant conditioning [9]? (Of course, that work preceded digital data archiving, but there are other seminal projects that are more recent and whose results could still be useful in 50 years time.) While the data set from a straightforward questionnaire-based study might be relatively small, a longitudinal case study based on many hours of video could occupy terabytes of storage. Despite the falling costs of storage, would institutions commit to making that space available for such extended timescales? It would have to be backed up at regular intervals for security and all of this involves significant cost.

Perhaps the most important issue is ethical. We typically have to preserve the anonymity of our subjects. For many studies the researcher has to obtain the advance approval of an ethics committee who will review the planned procedures to collect and process the data to ensure, among other considerations, that anonymity will be preserved. Some journals require evidence of ethics approval before they will consider a paper that reports such research. At present *BJET* does not require an ethics declaration but many authors provide one without prompting and we may, in future, change our policy on this. Preserving confidentiality is relatively easy if the research data is to be kept confidential but much more difficult if it is to be shared openly with the research community.

We can this in our published papers by using pseudonyms (Subject A, subject B, etc) and by aggregating data. If the digital data is in a repository then we have to ensure that all identifying information is omitted. This not only includes the names of subjects but, for example, the name of their institution, and their IP address. It is much more problematic if the data includes video recordings. It may be necessary to obscure the faces of subjects (perhaps by blurring techniques) and other details that might enable an informed observer to deduce the institution involved (for example, from logos on clothing). This may be practical if the issue is dealt with from the outset but impossible to achieve in retrospect.

These are issues that the Journal is actively researching and will need to resolve before data-sharing can become a reality for the majority of our research papers.

5 Conclusion

In this keynote I have attempted to show that while open access and open data are attractive notions for the web-based learning research community, both come with issues that are not immediately apparent, but need to be addressed before we can reap the whole benefit. There is a saying in the UK: “Be careful what you wish for!” The face of academic publishing is changing rapidly and irrevocably, certainly uncomfortable but probably for the better.

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SpeakUp – A Mobile App Facilitating Audience Interaction

Adrian Holzer[1], Sten Govaerts[1], Jan Ondrus[2], Andrii Vozniuk[1], David Rigaud[3], Benoît Garbinato[3], and Denis Gillet[1]

[1] EPFL, 1015 Lausanne, Switzerland
[2] ESSEC Business School, 95021 Cergy, France
[3] University of Lausanne, 1015 Lausanne, Switzerland
{adrian.holzer,sten.govaerts,andrii.vozniuk, denis.gillet}@epfl.ch, ondrus@essec.edu, ddrigaud@gmail.com, benoit.garbinato@unil.ch

Abstract. A dynamic student-teacher interaction during class is an important part of the learning experience. However, in regular class settings and especially in large classrooms, it is a challenging task to encourage students to participate as they tend to be intimidated by the size of the audience. In this paper, in order to overcome this issue, we present SpeakUp, a novel context-aware mobile application supporting the social interactions between speakers and audiences through anonymous messaging and a peer rating mechanism. Context-awarness is achieved by bounding interactions in space and time using location-based authorization and message boards with limited lifetime. Anonymity is used as an icebreaker, so students dare writing down any question that pops in their heads. Peer rating is used to make it easy for teachers to access the most relevant ones and address them. We performed an evaluation with 140 students over five four-hour lessons that indicate that SpeakUp is easy to use and is perceived as useful.

Keywords: temporary social media, context-aware mobile interactions, backchannels.

1 Introduction

Promoting interactivity in conferences and lectures remains challenging, although it is an important success factor in classroom learning [5]. Over the last decade, the use of so-called clickers has become more prevalent in classrooms to address this issue. Clickers are special devices that look like remote controls. Clickers allow students to anonymously answer questions and afterwards teachers can access the aggregated answers. Clickers and other classroom interaction systems are generally regarded as contributing positively to the learning process [18,2,16,4].

Most of the existing systems require dedicated hardware and are typically based on a master-slaves interaction mode, meaning that only teachers can initiate interactions. With mobile smartphones hitting a very high penetration rate and the recent emergence of mobile apps and social media, it has become interesting to leverage mobile devices to design more advanced tools enabling a low setup cost to support interactions in audiences (e.g. in a conference or classroom).

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Some systems, such as MARS [10] or TurningPoint[1], have simply moved clicker-based interactions (such as multiple choice questions) on mobile phones. But with the communication services offered by these devices, it is also possible to interact more indirectly with students by tapping into secondary communication channels, sometimes refered to as backchannels.

For example, students may casually communicate using a mainstream social media platform during class. One way for speakers to get access to this interaction data is to direct backchanneling to a single defined media. This is what many conferences do when they advise their audience to post their comments and questions to generic social media, such as Twitter. Typically, the audience tweets questions using a predefined hashtag (e.g. `#icwl2013`) so they can be picked out by the conference attendees and organisers.

We believe that the recent widespread penetration of smartphones offers many exciting possibilities for construction of efficient backchannels in classroom environments.

With this in mind, in the next section we present the scope of our mobile application, SpeakUp. Afterwards in Section 3 we elaborate on the related work and then we present the requirement analysis in Section 4. In Section 5 we briefly explain the design and implementation of SpeakUp. Following this, we discuss open research questions in Section 7 and wrap up with a conclusion and future work in Section 8.

2 Contribution

SpeakUp is a novel context-aware mobile application specifically designed to support the interactions between speakers and their audiences in both educational and more general settings. At its essence SpeakUp can be seen as a shared message board for the audience of a talk with the following four specific features:

- *Location-based authorisation.* SpeakUp targets an audience located together in the same physical room by restricting access to a virtual chat room based on location.
- *Absence of login barrier.* SpeakUp aims at encouraging participation by allowing anonymous posting with no registration and login overhead.
- *Peer reviews.* SpeakUp filters out irrelevant inputs, by providing a peer-reviewed rating system and relevance-based sorting.
- *Here and now conversations.* Conversations in SpeakUp keep some of the properties of real-world conversations with an audience. Since messages in SpeakUp are bound in time as well as in space, the sense of privacy increases as only people present *here and now* can participate in conversations and ratings.

3 Related Work

As mentioned, the major commercial tools used for supporting audience interactions are clicker-based software, such as TurningPoint or H-ITT[2] [17] and social media such

[1] TurningPoint, www.turningtechnologies.com
[2] H-ITT, http://www.h-itt.com

as Twitter[3]. The first two are only designed for two-way interactions between speakers and audiences and generally do not support multi-sided interactions where members of the audience can interact with each other as well as with the speaker. Twitter provides such multi-sided interactions, but not specifically aimed at speaker-audience interactions. They therefore fail to leverage on specific features of these environments, such as physical proximity and the possibility of real-life interactions. There are also more specialized tools in the research literature. We review several of them hereafter and compare them to SpeakUp.

ClassQue.[4] A tool that is both dedicated to speaker audience interactions (specifically in classrooms) and that also uses social media features [13]. It allows students to ask questions and they can also anonymously comment each other's answer. However, ClassQue is a Java desktop app and there is currently no mobile version. Furthermore it does not offer context-aware facilities.

m-Learning. An early attempt at providing mobile learning support [11] allows student to access the course's content and post questions though the course's wapsite *wapsite* (i.e. a website using the now extinct WAP technology). There is no rating system for students and it is not clear whether questions are accessible to other students and whether they are anonymous.

TXT-2-LRN. To overcome the burden of dedicated hardware, Scornavacca et al. proposed TXT-2-LRN [15]. This tool allows students to freely ask questions or answer quizzes via SMS directly from their cell phones. The instructor connects her mobile phone to the management tool on her laptop. Students can either send messages on the *open channel* or answer *m-quizes*. TXT-2-LRN does not offer any social media features, such as ratings and a message stream.

SHERPA. A recent mobile app targeting students and educators that provides support for social features [14]. This app is used for teacher-student and teacher-teacher interactions. It allows instructors to record attendance and to gather in-class evaluation information. It also allows students to find information about their classmates. SHERPA also enables students and instructors to easily send messages and communicate with each other. However, it does not provide location-based facilities, anonymity, nor support message reviews.

Backchan.nl. A website that aims at collecting all comments and questions of conference attendees [7]. Messages can be rated up or down and the top eight questions are displayed on the presenter's display. Backchan.nl uses pseudonyms as a loose identification mechanism to avoid double voting. From their experience, most users seemed to use their real names and affiliations. However, user names can be changed during a session and thus it is easy to rig the system. In one notable occurance, users coordinated to get eight posts containing the lyrics to "Never gonna give you up" by Rick Astley

[3] Twitter, `www.twitter.com`
[4] ClassQue, `http://vip.cs.utsa.edu/classque/`

in the top eight, effectively managing to “rickroll”[5] the audience. In backchan.nl rooms are identified by URLs and cannot be discovered by geographical proximity.

4 Requirement Analysis

For the requirement analysis, we rely on the Value Proposition Canvas [12] as guiding framework, since it provides a simple yet powerful way to think how to establish a good fit between a user’s expectations and a tool or service, which could be offered to her (see Figure 1). The canvas has two sides. On the right side, the assumptions about the user are listed. The *jobs-to-be-done* are the tasks that the user wants to complete. These jobs are associated with *pains* and *gains*. Identifying the pains and gains help to have empathy for the user in order to better answer her needs. On the left side, there is the value proposition description. The idea is to list the *features* of the products and services. More than the specifications, we would like to know how our value proposition can be a *gain creator* and *pain reliever* for users.

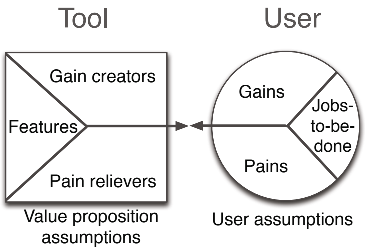

Fig. 1. Value Proposition Canvas [12]

As teachers, students and regular conference attendees, we answered a number of questions related to the different dimensions of the canvas before starting the develoment. The objective was to better understand what jobs students want to solve, what pains they currently have, and what gains they would like to get from a system that aims to improve in-class interactions between teachers and students.

Jobs-to-be-done. For the list of jobs-to-be-done, we found that students may want to be able to participate more actively even when the class is large, exchange ideas in real-time during class, or ask questions whenever they want.

Pains. For the pains, we found that shyness and fear of being ridiculed intimidate many who then fail to engage [8]. Nevertheless, they might have interesting questions, but do not know if others would find them useful or not. Another pain is the amount of irrelevant questions that can be asked. At large conferences, where the Q&A time is limited, there is a good chance that someone will use up much of the available time elaborating the context of a question that is of no special interest to others. Finally, a general pain associated with using technology in the classroom is the login hurdle that might hinder adoption.

[5] Information about rickrolling can be found on wikipedia: `http://en.wikipedia.org/wiki/Rickrolling`

Gains. Possible gains include that the audience can learn from the input of others, participation increases the overall interest, and the most relevant questions can be asked.

Features. During the focus group, we also established a number of features that could create *pain relievers* or *gain creators*. For instance, the features of SpeakUp are:

- anonymous question sharing and posing
- a transparent login and location-based room discovery
- viewing of others' questions
- rating of questions and relevance-based ordering

Anonymity addresses shyness and encourages participation [6,9]. A transparent login and location-based room discovery reduce usage barriers. Gains are increased by allowing users to view each other's questions. Finally, being able to rate and sort questions allows to filter out irrelevant content and address relevant questions.

5 The SpeakUp App

Based on this requirement analysis we devised SpeakUp as shown in Figure 2.

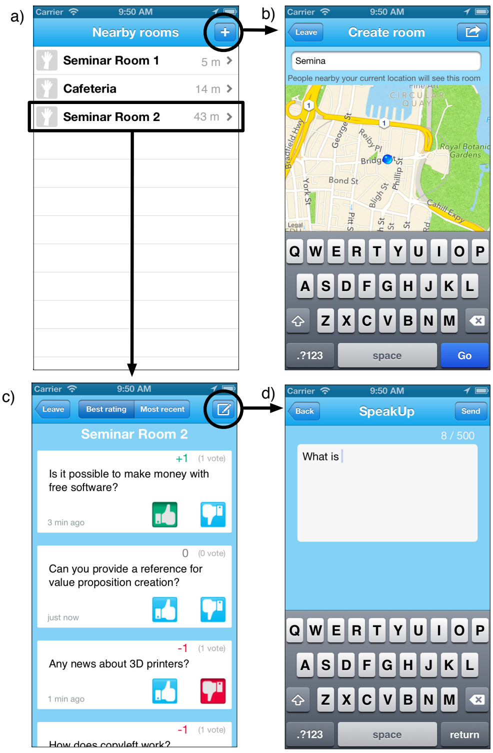

Fig. 2. The SpeakUp app

Questions and comments are listed in location-bound chat rooms that function as a virtual metaphor for the physical rooms where the discussions take place. When SpeakUp is launched, the chat rooms in the user's vicinity are displayed (i.e. rooms within a 200m radius) as shown in Figure 2-a. Note that the user is never required to enter any personal information in order to use SpeakUp. Figure 2-b shows how users can create their own room at their current location by pressing the plus button on the top right corner. Upon selecting a room, the messages of this room are listed and users can assign a rating to a message by clicking the *thumb up* or the *thumb down* icon, as illustrated in Figure 2-c). The messages can be ranked either according to their publication time or to their relevance. The relevance is determined by the rating, i.e. the number of *thumbs up* minus the number of *thumbs down* received by a message. Finally, Figure 2-d shows how users can write messages. Note that SpeakUp is implemented for both Apple's iOS and Google's Android.[6]

6 Evaluation

We have evaluated SpeakUp in an educational setting over the period of one semester. The evaluation was conducted in a business course on information systems at the University of Lausanne in the fall of 2012 with second year Bachelor students majoring in management and economics. Out of the 350 enrolled students, 140 students between the age of 20 to 25 years, used SpeakUp, as not all students had access to a smartphone. We experimented during the semester with different usage scenarios of SpeakUp. We used SpeakUp in five four-hour sessions. Figure 3 present the results of a voluntary survey we performed after the first session, which inquired about usability, usefulness and the impact on the course (48 out of 140 students completed the survey).

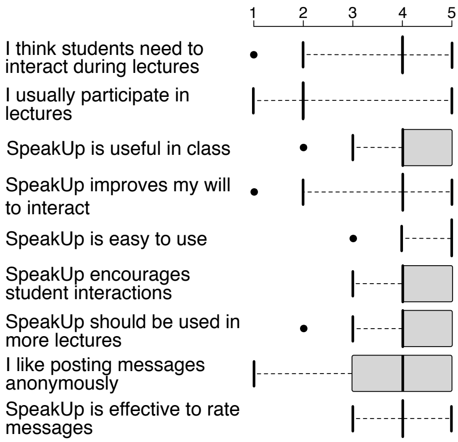

Fig. 3. Boxplot of the likert scale analysis of survey questions (the •'s are outliers)

[6] Both versions are freely available at `http://doplab.unil.ch/speakup`.

Usability. Some of the survey questions originate from the SUS [1] and PUEU [3] usability surveys but have been recontextualised to SpeakUp. Figure 3 presents the Likert scales (*'1 - strongly disagree'* to *'5 - strongly agree'*) and their results in a boxplot. A boxplot reads as follows: (1) the vertical lines represent respectively the lowest, the median and the highest value; (2) the outer boundary of the boxes indicate the first and third quartile and (3) the dots correspond to outliers. When the box is missing, the first and third quartiles coincide with the median.

The first two questions were used to further assess our user assumptions from the requirements analysis. That is, whether students thought that part of their *jobs-to-be-done* was participating in class, and whether they usually engaged in class. The results confirmed these assumptions by showing that most students indeed consider participation as quite an important aspect of a lecture (high median with wide range), but they admit that they usually do not participate (low median with wide range).

Ease of use. The SpeakUp's ease-of-use was rated very high (very high median). Several questions relate to the usefulness of SpeakUp. Students perceived SpeakUp as useful in lectures (high median) and would also like to continue using SpeakUp in other lectures (high median). SpeakUp also seemed to motivate most students to actually interact more (high median, but wide range) and students felt more encouraged to interact when they had access to SpeakUp (high median). From the social media perspective, rating was perceived as an effective means for filtering out irrelevant messages (high median) and most students also preferred the anonymity that SpeakUp provides (high median, but wider range). We did not specifically inquire about the location-boundness of the messages as SpeakUp was always used at the same location.

Ratings. The SpeakUp messages were logged (in total 267 messages and 4354 votes) and three external experts categorised the messages as related to the course organisation, to SpeakUp itself, to the course content or irrelevant (i.e. spam). Figure 4 shows

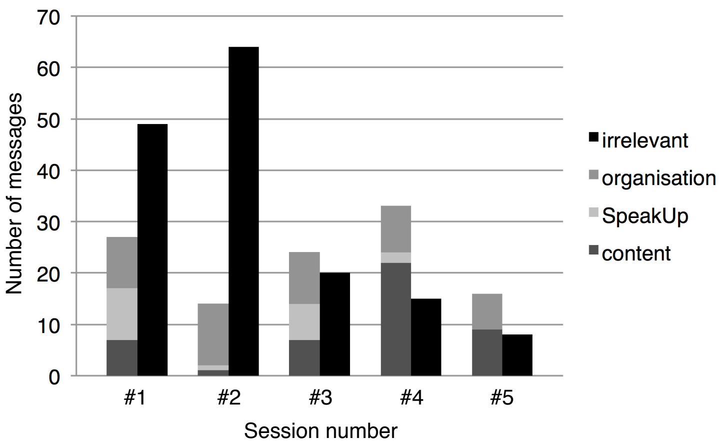

Fig. 4. The categorised number of messages per session

this categorisation. The left bar of each session illustrates the relevant messages and their different categories. The right bar summarises the spam messages. In the first session SpeakUp was freely used. During the second session, we moderated the messages, which introduced more spam messages often related to the moderation. In the third lecture, the lecturer discussed the spamming issue with the students. This might have caused the reduced number of irrelevant messages in the last three courses. Figure 4 suggests a novelty factor: in the first sessions SpeakUp is used most, while the total number of messages decreases gradually over the later sessions. Although the total number of messages decreases, the number of relevant messages is more stable. This indicates that SpeakUp is useful for the students. The messages related to the course content are fluctuating, which might be related to the topic of each session.

Figure 5 shows the quantities of positive and negative ratings per category. Overall, it shows that the rating mechanism is effective in discriminating spam. Interestingly, irrelevant messages (e.g. "Please like Christo's page on FB" 45 dislikes, 5 likes, or "Let's all go to the swimming pool" 24 dislikes, 12 likes) get the most ratings and the positive ratings are high. Students seem to try to game the system by upvoting spam, but this is suppressed effectively by the 'wisdom of the crowd'. Both Figure 4 and 5 show that organisational messages (e.g. "Can we have the slides before the lecture" 10 dislikes, 65 likes, or "Close the blinds, we can't see anything", 6 dislikes, 43 likes) are very popular and get many positive ratings. The real course content messages are rated less frequently. This might be because organisational questions often affect many students, while content messages might only relate to problems that few experience. Note that the SpeakUp category contains messages that provide feedback on SpeakUp itself (e.g. "I prefer SpeakUp with filter" 9 dislikes, 3 likes, or "To avoid spam, one should be required to log in with the university credentials", 4 dislikes, 9 likes).

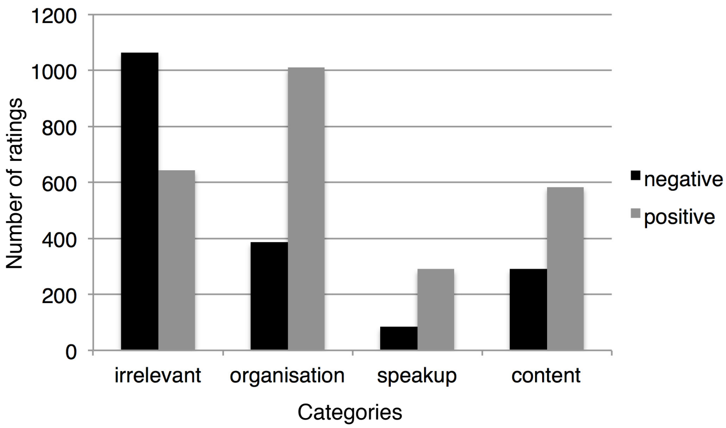

Fig. 5. The positive and negative ratings per category

Overview. Overall, we can conclude that SpeakUp seems to be easy to use and useful for the students in this setting. Moreover, SpeakUp motivates most students to participate more in class. The relevant content is filtered out well by SpeakUp's rating mechanism.

7 Discussion

Our experience with SpeakUp led to several open issues that are still unresolved by current research and that we believe are worth exploring. In this section, we discuss these issues as open research questions.

How can anonymity be preserved and what is the impact on users? There are certainly situations where users benefit from being anonymous, for instance SpeakUp users are anonymous within a confined group which encourages participation. However anonymity can sometimes lead to spam. The feeling of anonymity within a group can depend on its size (smaller $\rightarrow$ less anonymous). We believe that such parameters of anonymity should be further investigated and might provide a balance between engagement and potential spam.

How do we filter relevant content? Social media can generate information overload and is often targeted by spammers as we witnessed in our evaluation. Therefore, better filtering techniques that sift relevant, novel, interesting and personalised content and that are resilient against spam are needed.

Do social media traces have to exist forever? SpeakUp users can only access messages at a given location for a certain amount of time.[7] We believe interesting user experiences can be designed with traces limited by time, by location or by action.

Does social validation encourage students to interact directly? After receiving social approval for their questions (i.e. a good positive score), students might find it less intimidating to raise their hand and ask their question directly. We believe it is important to evaluate whether and how SpeakUp really changes the behaviour of students and we plan to evaluate this in the coming months.

8 Conclusion and Future Work

Encouraging live audience interaction is challenging, especially in large classrooms. Existing tools do not fully capture the essence of these interactions, which are inherently local in space and time. To fill this gap, we introduced SpeakUp, a real-time mobile message board that has a strong here and now nature as it restricts access to a virtual space based on physical presence in a certain place at a certain time. This provides an implicit authorisation filter allowing SpeakUp to offer complete anonymity and no login barrier with limited risk of malicious use. Furthermore, it provides support for

[7] In SpeakUp, messages are purged after 12 hours.

virtual social interactions as users can see and rate each other's messages, filtering out irrelevant messages.

We evaluated SpeakUp with students and our results convey that SpeakUp is successfully used to address the problem of classroom interaction that they find important. We plan in the next months to deploy SpeakUp in different classrooms and in a conference settings to further evaluate its use. Furthermore, as we pointed out this research raised several unresolved questions that can lead to new exciting research avenues. Finally, this study has focused on student-teacher interactions, future work could expand to investigate how SpeakUp could support interactions among students.

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Gesture Identification Research and Applications in Evaluation Systems

Shou-Jen Lin[1], Jui-Le Chen[1,2], Yu-Chen Tsai[1], Ping-Chun Chang[1], and Chu-Sing Yang[1]

[1] Institute of Computer and Communication Engineering, National Cheng Kung University, Taiwan
[2] Department of Multimedia Design, Tajen University, Taiwan
{lsr,celia}@tn.edu.tw, {reler.chen,moneyhomeya}@gmail.com, csyang@ee.ncku.edu.tw

Abstract. By introducing computer-assisted identification technique into the evaluation system design for elementary and junior high schools, the users gestures, acquired through cameras, are transformed into effective interactive information, which is further applied to the digital evaluation system. Such a new-styled interactive method is expected to enhance the communication model between the learners and the information system. Without touching any interactive devices, the users can communicate with the system through gestures, from which the messages are determined and compared through image processing to further control the system interaction. The integration with an evaluation system could promote the education popularity.

Keywords: Gesture identification, human-computer interaction, computer vision.

1 Introduction

The advance of technological media in recent years has broken through the interaction model of human-mouse-machine that body postures or gestures allow the control becoming simpler, without extra hardware, e.g. wii. Furthermore, the rapid progress of the operational speed of a computer, with the identification technique requiring a large amount of processing, allows real-time processing and interaction. In this case, when gesture identification is integrated into a digital evaluation system [1], which could instinctively operate the interface to enhance the users acceptance of digital evaluation systems and make the learning easy and interesting. This study tends to introduce gesture identification into the human-computer interaction design, expecting to instantaneously catch the users gestures through the visual identification of a computer and transforming them into effective information for interacting with a digital evaluation system. Such a new-styled interactive method would break through the restrictions of traditional interaction that the users could enter the designated evaluation system, without touching any interactive devices, for online tests. All questioning

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activities could be completed through gestures that the students would be glad to participatein the digital evaluation system.

Referring to scholars suggestions, a common evaluation system is designed the test compilation and practice interface. According to the teaching environments in elementary and junior high schools and the correspondence to the general scholastic ability index, the test difficulty is designed and normal-type and comprehensive-type tests are applied to designing the web interface and making the test database.

Furthermore, to avoid the seriousness and monotony of contents, an external projecting device is combined to pre-identify the user, who answers questions with fingers, and USB is connected as a different data input, besides a mouse, to enhance the fun in the evaluation process and increases the promotion value.

2 System Interaction Development

2.1 System Design Idea

In this section, we will describe the system design concept as follow.

1. Testing in games, Making meaningful learning,
   Finger gestures expressing the number (1,2,3,4) and true-or-false are used for image identification [2, 3], or the operation of a mouse and keyboard allows accessing to the test system through the Internet to complete the designated evaluation. Game-based tests are the core of the design to achieve the learning objective.
2. Open space, Observing on the Internet,
   The combination of online evaluation systems and digital cameras could extend the students learning at schools to individual houses. The parents could understand the children browsing the Internet, but not being restricted in closed computer rooms, and assist and join in the learning activities.
3. Making gestures, Showing true-or-false,
   The system is designed to identify images with finger gestures expressing numbers (1,2,3,4) and true-or-false, allowing the users showing the answers with different methods. The combination with photographic elements achieves the test objective and makes the dull interaction full of learning fun.
4. Learning to share, Parent-child interaction with game-based tests,
   With the combination of simple Internet equipment and camera functions, parents and students could commonly participate in the learning tests and share the test results, providing the interactive environment of parent-child learning with pleasure.
5. Feedback curve, Aware of the performance,
   A student can log in the system, select the test, and immediately acquire the result, explanation, and relevant material links. With the feedback analysis, parents could view the childrens learning effects and processes and understand their learning conditions at home. The children, on the other hand,

could understand the learning conditions through the feedback information to adjust the learning conditions and methods.

6. Providing educational decision platform, Distributing resources fairly, The back-end evaluation system [1] is the recombination of present materials with the test database and learner achievement analyses. The evaluation feedback system could fulfill adaptive learning and differentiated instruction, master the system use conditions and respond to the learning feedback, and reinforce the ability of tutoring use. The administrators could clearly understand the differences of learning effects among various schools in the county/city through learning feedback analyses, pick out the areas with learning gap, fairly distribute the teaching resources, and offer proper resources for the schools with learning disadvantage.

2.2 Interactive Design Principle

From the research on gesture interaction, the human-computer interaction showed different interactive device design, such as sensor, camera, and touch pad, in addition to traditional keyboard and mouse. This study applies gestures to triggering the information system for interaction, uses cameras as the input device for acquiring the users gestures, and completes the human-machine interaction (Fig. 1,2). The design principles are organized as follows.

1. Cameras are used as the input device and screens as the output device for replacing traditional interactive devices.
2. The users operate the system with hands, through the image acquisition of cameras, without touching any interactive devices.
3. The users could interact with the system without wearing any devices that it could be applied to public space.

Fig. 1. Concept of design

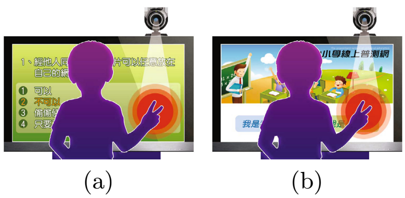


Fig. 2. System interactio

2.3 Identification Flow and Method

A camera is used for acquiring hand images, which are analyzed with a personal computer. The identification results are transformed into keyboard information through the agent and transmitted back to the server host, through the browser, for processing. The signals are divided into Answering and Control types [4].

1. Answering type. The gestures 1, 2, 3, 4 stand for the answers of multiple choice questions, and 1 & 2 for true-or-false questions, (Fig.3).
2. Control type. It contains the gestures of send, correct, forward, and backward, (Fig.4).

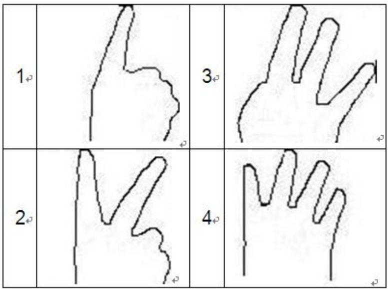


Fig. 3. Gestures corresponding to answer types

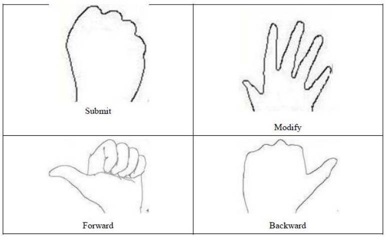


Fig. 4. Control-type gestures

(Fig.5) shows the interaction flow of the system which starts from image acquisition, then the static processing of (a)noise removal, (b)background subtraction, (c)face identification, and (d)skin color detection, and dynamic processing of (e)closing of morphology processing, (f)edge detection and contour search, (g)segmenting gestures, and (h)finger number identification. The results are transformed, by the agent, into the users input value for the operation of the evaluation system. The relevant process is shown as below.

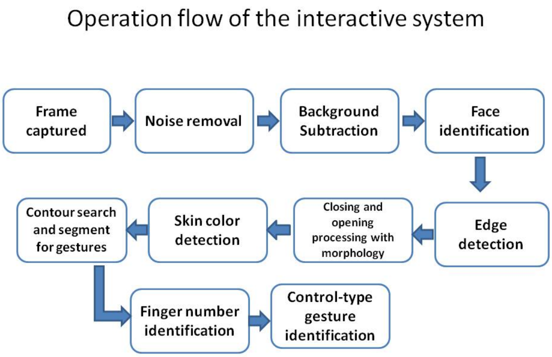


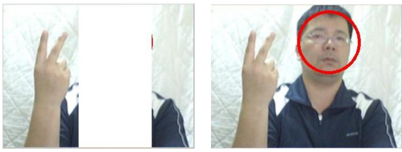
Fig. 5. Operation flow of the interactive system

Noise Removal. A smoothing filter is used for blurring and reducing noise. The former is used for pre-processing, such as removing small details from the image before extracting the object and linking the small gap on the lines or curves. In this case, a linear filter [5-7] can be used for blurring the image for reducing noise.

Gaussian Blur is generally used for decreasing image noise and reducing the level of details. Gaussian Smoothing also enhances the imaging effects with different sizes through the pre-processing in computer vision algorithm. From mathematical aspect, Gaussian Blurring an image is the convolution of image and normal distribution. Since normal distribution is also named as Gaussian Distribution, it is called Gaussian Blur. Fourier Transform is a different Gaussian Function that Gaussian Blur is regarded as a low-pass filter.

(a) Background (b) Background Subtraction result

Fig. 6. Background Subtraction



(a) Face detection (b) Upper and lower parts excluding the face

Fig. 7. Face identification

Moreover, a method is searched for brightness compensation in order to improve the effects of light change on gesture identification. Darker gesture images being adjusted the brightness is a simple way, but could make the bright area become over-bright. Histogram Equalization [8] therefore is utilized for calculating the transfer function with the global intensity of the image and the proper intensity distribution so that the image pixels present the same intensity.

Background Subtraction [9,10]. The methods using image processing for detecting moving objects contain (1) Temporal Differencing [11-13] and (2)Background Subtraction [14-16].

Background Subtraction is more popular than Temporal differencing, as it could acquire the complete shape of an object, show better tolerance on noise, and reduce the effects of shadow resulted from the moving object.

A background Iback is acquired from the environment as the base, and the acquired image Inow is compared with the base Iback for the changing areas. The equation is shown as below.

$$I = 255, if(abs(Inow - Iback) < 10) I = 0, else$$

where the value 255 is white color in grayscale, the value 0 is black, and the value 10 is the reference threshold. (Fig.6(a)) and (Fig.6(b)) show Background and the results of Background Subtraction, respectively.

Face Identification [17]. Haar-feature [18] is utilized as the identification feature, and AdaBoosting [19] algorithm is further applied. The input image is first segmented into small areas, each area is identified as a part of human face, and update weighting is used for making accurate identification. Cascade classifier established in OpenCV (Open Computer Vision Library) [2] is directly utilized for marking the areas of human face.

The marked human face is regarded as the hidden Background Subtraction for excluding the upper and lower areas of the face. It tends to focus the morphology process on hand areas in the next phase after skin color detection. (Fig.7(a)) shows the results of face detection, and (Fig.7(a)) displays the upper and lower areas excluding the face, after face detection.

Edge Detection. Edge detection is a fundamental problem in image processing and computer vision, aiming to mark the spots with brightness change in the image. The remarkable change of image attributes normally reflects the key events and changes of the attributes, including (i)discontinuous depth, (ii)discontinuous surface direction, (iii)material property, and (iv)light change in the scene.

Canny[20] algorithm is commonly used, but two thresholds need to be determined for Canny detection [21]. The first threshold functions to generate wave crests when the edge is affected by noise. The second threshold tends to solve the problem when the edge breaks into pieces because of noise.

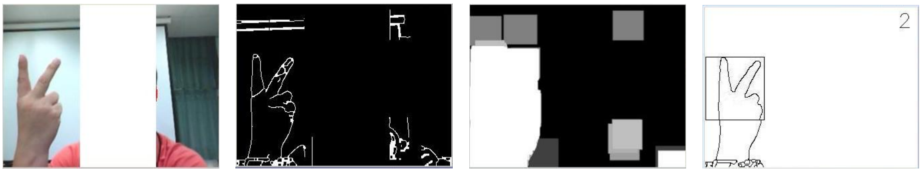
Accordingly, Canny edge detection presents the following advantages.

1. Favorable detection. It finds out all edges with grey changes and do not appear fake boundary points.
2. Favorable positioning. The detected boundary position is close to the real boundary position that the less distance reveals the more accurate positioning.
3. Favorable response value. All points on the edge appear response values that the detected line is not over-rough.

Closing and Opening Processing with Morphology [22, 23]. Closing and opening processing are acquired by differently ordering erosion and dilation. Closing processing, first dilation and then erosion, functions to fill in the tiny holes on the object, but not obviously change the area. On the contrary, a process with first erosion and then dilation is called opening processing.

After face detection and excluding the upper and lower areas of the face and the face, (Fig.8(a)), the edge-detected image is proceeded closing processing to remove the broken holes on the image, and then the processed image is further proceeded opening processing to remove noise. The complete hand areas are then acquired after the closing and opening processing, (Fig.8(b)).

Skin Color Detection [24]. HSV, which distinguishes skin color and non-skin color areas with hue, saturation, and value, is used as the reference color space for skin color detection and presents more accurate detecting results than various



(a) Face detection and processing (b) Closing and opening processing (c) Skin color detection and dilation. (d) Gestures identification results

Fig. 8. Closing and opening processing with morphology

skin color detections with YCbCr [25]. Nevertheless, the transform of HSV is not the linear transform as YCbCr that it consumes more processing time. The skin color detection reference after HSV transform ranges $0 < H < 20, 30 < S < 150, and 80 < V < 255$. The skin color detection result is further proceeded 10 times dilation, (Fig.8(c)), to remove the non-skin color edges generated from edge detection.

Contour Search and Segment for Gestures. The image with edge detection, closing processing, and skin color detection is further combined with the dilated image to remove non-skin color edge lines. Contour search is further proceeded to find out the largest edge contour so as to remove other smaller contour lines of the hand shape and acquire the clear contour curve. Finally, the maximal contour frame is acquired. It is worth noting that this study aims at finger images, but not palm and arm. The simplest and most effective way is to refer the gesture height to the detected face length in order to acquire the relevant areas for finger number identification, (Fig.8(d)).

Finger Number Identification. For identifying the finger number form the last gesture, (Fig.8(d)), the image is first scanned for the pixels of the hand-shape edge, which are further judged by Mode.

Control-Type Gesture Identification. emplate Matching Method is applied to proceeding control-type gesture identification, as such type of gestures presents highly clear features. The success rate of Template Matching is then enhanced and the processing efficiency reveals good performance. Similar to the above method of segmenting the identified areas (ROI) for small-area processing, they are further compared with the preset control-type template pattern that the ones with the returned probability larger than 0.85 are regarded as similar images.

3 Digital Evaluation System Design

According to the field analyses in elementary and junior high schools, various functions of the evaluation system are explained as bellow. (1) Log-in system.

The user keys in the account and password, and the system would verify the identity by connecting to the governmental webs. After successfully logging in the system, the log-in procedure starts to ensure the security of personal information. (2) Noticeboard system. The manager publishes the latest news and activities. (3) Test database system. It provides complete test appending, deleting, and managing interface, allowing the users and the test database managers compiling test paper. Each test covers field, chapter, and difficulty for the reference of test compilation and test database maintenance. (4) Item generation system. It offers quick search and easy compiling functions for teachers that the system-assisted questioning is about automatic. (5) Test system. It offers the teachers creating tests, in which the participants activities are recorded and the test paper can be randomly changed the questions or the order of options for fair tests. In comparison with traditional tests, it could enhance the test efficiency. (6) Discussion. The teacher and the students could publish articles for interactive discussion. (7) Feedback system. With unit lessons being the development structure, this system focuses on feedback analyses according to students participation in online tests and the records of the learning process. After completing the test, the participants are analyzed the performance and recorded in the system. Several test analyses could be considered as the feedback of the test database. The test questions are judged the distraction according to the analyses so as to find out the questions with low fitness and allow the test makers or test database managers efficiently maintaining and modifying the questions. What is more, the test analyses could provide students with learning suggestions and teachers with references to improve or reinforce the teaching methods and contents.

4 Evaluation and Application

To have the users adapt to the interaction with gestures expressing answers, the self-practice flow is explained as follows.

1. Making test paper:
   (1) Key in test name, type of test, and covering range. (2) Set difficulty, number of questions, and score. (3) Make confirmation.
2. Establishing evaluation
   (1) Select type of evaluation. (2) Select test paper, score distribution, and passing score. (3) Set evaluation time, time limit, and make-up examination.
3. Challenging practice
   (1) Start test. Precede key-in, selecting test or setting, entering the test, and starting the test respectively. (2) When not passing the test, it can be redone according to the setting of make-up examination. The combination of grade, class, and student number can be set as the key-in account, and four number of the birth date as the password. The main menu contains (a) enter test select subject select test pater start test and (b) machine setting, including web cam test and gesture correction.

5 Conclusion

This study provides a new-styled human-computer interaction interface, which combines the concepts of computer vision interaction and digital guide and develops the gesture interactive guiding system to enhance the users instinct operation environment and computer application. The conclusion is drawn as follows.

1. Applying the gesture interactive system to window display or outdoor interactive design could improve one-way information communication model into interactive information communication model and enhance the information interaction.
2. The new-styled interaction breaks through the traditional application of computers with lively operation, expecting to achieve invisible computing and bring computers into human life so that the users would not perceive the existence of computers.
3. Computer vision technique presents a more flexible interaction model than traditional interactive devices, but light disturbance and identification rate are the problems. It is expected to introduce an updated identification technique to enhance the interaction effect.

Based on the experts suggestions of online evaluation, the digital evaluation system combines test database and learner performance analysis, establishes an evaluation feedback system, assists teachers in evaluating the students learning conditions and adjusting the teaching contents and schedule, provides students with reflection after learning in order to enhance the learning effectiveness and acquire meaningful learning. For students, this system offers test explanation and relevant knowledge links so that they can acquire knowledge and enhance learning fun with the gesture evaluation system through the contest in the digital evaluation system. Besides, the online make-up system provides feedback for students modifying the learning concepts and enhancing the learning efficiency. More importantly, the simple camera functions allow the parents and the students commonly participating in the learning tests and sharing the test results and offer an interactive environment with learning pleasure.

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Develop and Evaluate the Effects of Multi-image Presentation System on College Student Learning Achievement and Satisfaction

Fang-O Kuo[1,2] and Pao-Ta Yu[1]

[1] Dept. of Computer Science and Information Engineering,
National Chung Cheng University, 621, Taiwan
{kfo,csipty}@cs.ccu.edu.tw
[2] Dept. of Digital Media Design, TaTung Institute of Commerce and Technology,
Chiayi, 600, Taiwan

Abstract. The purpose of this study is to develop and evaluate the effects of multi-image presentation system (MIPS) on student learning achievement and satisfaction in the college English as second language (ESL) course. This paper utilizes the MIPS, based on Mayer's cognitive theory of multimedia learning (CTML), to present the recording/recorded facial movements of both teacher and practitioner on the same screen. This means to improve the vocabulary learning by effective pronunciation practice. The instruction supported by MIPS was compared with a traditional English teaching using whiteboard. An experimental research design was employed and 59 freshmen from an institute of technology in Taiwan were involved in this study. Evaluation of the instruction was based upon data from test scores and questionnaire related to student learning satisfaction. The results revealed that there were statistically significant differences between the students in experimental group and control group on measures of learning achievement and satisfaction.

Keywords: Multi-image, English Pronunciation, Vocabulary Learning, Multimedia.

1 Introduction

Vocabulary is perceived as an essential foundation to language learning and people's communication. Numerous of second or foreign language scholarly works have introduced its importance to the academic world (Chen, 1999; DeCarrico, 2001; Knight, 1994; Laufer, 1997; Lewis, 1993). Wilkins argued (1972) that "Without grammar very little can be conveyed, without vocabulary nothing can be conveyed." Several research claimed that many English as second language (ESL) learners consider vocabulary is the first priority and spend lots of time learning vocabulary (Cortazzi and Jin, 1993; Hedge, 2000; Horwitz, 1988).

However, vocabulary is often seen as the greatest source of problems by ESL learners. "When students travel, they don't carry grammar books, they carry

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dictionaries" (Krashen in Lewis 1993: iii). Oxford (1990) pointed out that language learners typically have significant difficulty remembering large vocabularies. If ESL learners cannot make a breakthrough in vocabulary learning, the lack of vocabulary will become an obstacle to developing language skills like listening, speaking, reading and writing. Vocabulary learning difficulty has also been encountered by Taiwanese ESL learners, especially for private college students whose speed of vocabulary improvement is relatively slow. Students were frustrated by too many new words that occurred in an English text and thus caused their reading failure or difficulties (Hsieh, 2000). One of the efficient methods for improving the vocabulary learning is through the learning of correct pronunciation of the word. Politzer and Weiss (1969) suggested that there is high correlation between English pronunciation and retention of vocabulary. The study of Chen and Chung (2008) recognized that over 82% learners think that the length and pronunciation of a vocabulary word are also factors affecting learning outcome when memorizing words. Dóczi (2011) claimed that 50% of the students using the vocabulary learning strategy of "studying the pronunciation of the word". Therefore, it is clear that learning of correct pronunciation of a vocabulary word is able to improve the spelling skills and thus to spell the vocabulary out without rote memorization.

It is recognized that clear lip movements are crucial for the learning of vocabulary pronunciation. The study of Hirata and Kelly (2010) concluded that seeing lip movements during training significantly helps learners to perceive difficult phonemic contrasts of second language. According to Mayer's (2001) cognitive theory of multimedia learning (CTML), learning from distinct channels leads to a general improvement in learning. While listening to the teacher's pronunciation the students can also watch the facial movements of the teacher, in the meantime the pictorial representation of mouth, lip, tongue and jaw movements provide the visual information, and try to enunciate the same sound. Conventionally, the most popular vocabulary teaching technique is teacher-centered ways. In this way, new vocabulary items are presented in text-centered format on a whiteboard and the students read directly following the instructor. However, in the classroom, distance from the students to the teacher may make the students unable to notice the facial movements of the teacher completely and clearly, and vice versa. Thus, the students may not be able to clearly compare their pronunciation differences with the teachers. Meanwhile the teacher may not be able to correct the students' pronunciation errors. Besides, as all the students face to the whiteboard, while one of the students standing up and repeating the vocabulary word, only the teacher can see the practitioner's facial movements. The students may lose the opportunities of learning from others' mistakes. Fortunately recent information technology has enabled an explosion in the availability of visual ways of presenting materials. In addition, taking advantage of computer technologies and software within the classrooms has become a modern teaching method. Large amount of multimedia English learning materials and computer assisted language learning software have been developed to enhance the learning performance of English pronunciation, spelling, phonics, and word attack skills (Beatty, 2010; Lee et al., 2005). However, to the best of our knowledge, the software is insufficient in providing clear teacher's facial movements to the learners for the purpose of imitation and comparison of the pronunciations in-between.

As a result, this study develops a multi-image presentation system (MIPS) to present multimedia instructional materials and manage interactive learning activities in the classroom. More specifically, the MIPS is used to support the corresponding visual information, including the mouth, lip, tongue and jaw movements of teacher and practitioner, of the vocabulary pronunciation in the interactive instructional activity. In addition, learning achievement and satisfaction are the major objectives of learning activities (Lu et al., 2003), this study thus to explore the learning achievement and satisfaction of English learning activity by use of the MIPS.

The remainder of this paper is organized as follows. Section 2 reviews pertinent literature on the research of Mayer's cognitive theory of multimedia learning (CTML). Section 3 then describes the architecture of the multi-image presentation system (MIPS) and section 4 presents the experimental design and process. Section 5 presents the experimental results, as well as discussion on the findings. Finally, Section 6 addresses conclusions, limitations and directions for future research.

2 Literature Review

2.1 Mayer's Cognitive Theory of Multimedia Learning (CTML)

Multimedia is defined as the presentation of materials using both words and pictures and thus focused on the auditory/verbal channel and visual/pictorial channel (Mayer, 2001, 2005). Mayer (2001, 2005) presents a theory of multimedia learning in terms of an information-processing model, called cognitive theory of multimedia learning (CTML), by integrating Sweller's cognitive load theory (Chandler & Sweller, 1991; Sweller, 1988), Paivio's dual-coding theory (Clark and Paivio, 1991; Paivio, 1986), and Baddeley's working memory model (Baddeley, 1986, 1999).

3 The Architecture of the Multi-image Presentation System

According to the modality principle of instructional design, learning outcomes will be optimized by presenting the verbal and visual representations of the knowledge in auditory and visual modalities (Moreno and Mayer, 2007). An interactive multi-image learning environment is the one in which the presented words and pictures depend on the learner's actions and the communication is multidirectional during learning. Figure 1 shows the architecture of the multi-image presentation system (MIPS). The MIPS in the environment consists of four primary components, which are Office Card Component, Media Card Component, Annotation Card Component, and Manager Card Component. This multi-image presentation software, equipped with 2 web cameras, was designed to present the recording/recorded facial movements of both teacher and practitioner on the same screen and then meant to improve the vocabulary learning by effective pronunciation practice.

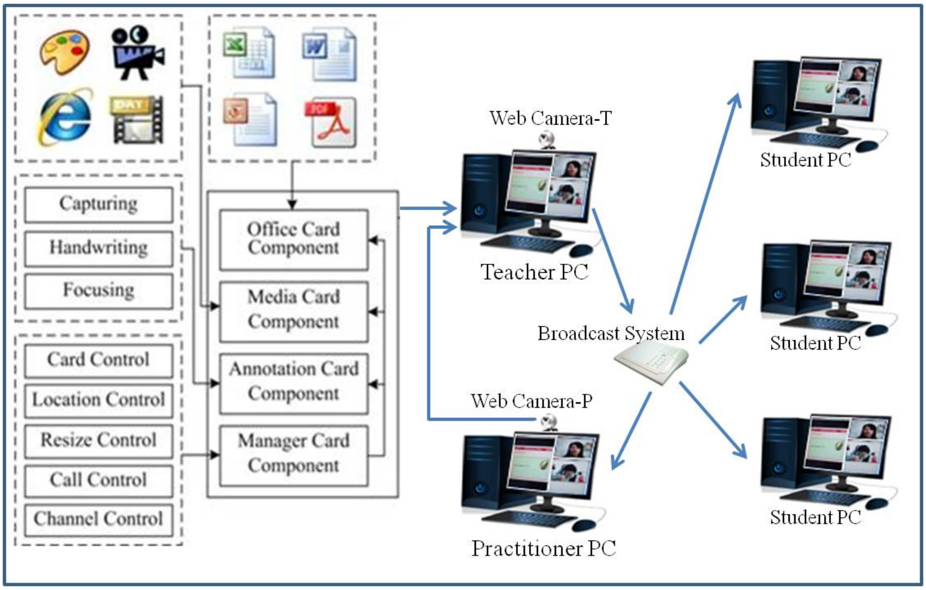

Fig. 1. The architecture of the multi-image presentation system (MIPS)

Web camera-T is connected and located on the teacher PC, where the MIPS installed, to capture the facial expression of the teacher during teaching and correcting while the practitioner is practicing. Web camera-P is connected to the teacher PC but located on the practitioner PC to capture the facial expression of the practitioner during practicing.

Office Card Component is used to manage software applications simultaneously, especially for Microsoft Word, Excel, and PowerPoint software. Media Card Component is used to manage media object containers. For example, Digital Video is used to connect video devices and audio devices to display and record as a real-time streaming. Annotation Card Component supports three major functions. Capturing is used to record screen operations and sounds into video movie files. Handwriting is used to support teacher's lecturing handwriting with mouse. Focusing is used to emphasize the teaching materials by changing the background or frame color of the object containers. Manager Card Component is used to manage authoring and presenting containers of materials.

4 Experimental Design

One purpose of this study was to evaluate the college students' learning achievement and satisfaction within classroom English vocabulary acquisition by utilizing the multi-image presentation system (MIPS). At the end of the learning students took a post-test for measuring the learning achievement and questionnaires for measuring the learning satisfaction. Procedures of the experiment are described as follows.

4.1 Participants

The participants were 59 freshmen from two classes of a private institute of commerce and technology in Chiayi City in Taiwan. In order to provide adaptive teaching for students, every freshman has to take a campus English proficiency test. These participants were ranked in the lower third of all the freshman on their test scores. Thus, all subjects, aged 19 to 21, were with low-achievement in the subject of English. The instructional approaches were assigned randomly to two classes. The experimental group (31 students) was lectured with MIPS and the control group (28 students) was lectured with whiteboard. The experiment was held in the "English as a second language" course and lasted for three months from October 2012 to December 2012. Lectures were given 2 sections a week, and each section was taught for 50 minutes. Both groups were taught with the same learning materials by the same teacher. The teacher is a well-trained English teacher, with Master degree in English teaching and Ph.D. degree in Education. She has been teaching English for fifteen years and owns a native-like English accent. Although this type of experimental design is not completely followed by a randomized selection and assignment, it is often necessary in educational settings because intact classes are already constructed before the research is begun.

4.2 Teaching Phase

Both groups were taught with the same learning material but provided with different tools for presenting the contents. In the learning setting of experimental group, the teacher's facial expression was captured by a web camera (Web Camera-T) and processed by the MIPS to present on the teacher monitor where the broadcast system published the whole screen to the students' computers. Figure 2 shows the teaching scenario with the MIPS. In contrast, the teacher managed the teaching and drew the learning contents on the whiteboard in the learning setting of control group.

Fig. 2. The teaching scenario with the MIPS

4.3 Practicing and Correcting Phase

In the learning environment of experimental group, as shown in Figure 3, the practitioner's facial expression was captured by another web camera (Web Camera-P), connected to the teacher computer, and processed by the MIPS to present on the teacher monitor where the broadcast system published the whole screen to the students' computers. While the practitioner practicing, all of the classroom members including the practitioner himself/herself could clearly and completely observe the facial movements of both of the teacher and practitioner. It was much easier for the practitioner to compare the pronunciation differences in-between and then quickly adjusted the facial movements to match with the teacher's. Besides, as all the students had the same scene on their computers, every student could be the assistant while one of the students was practicing. This makes the students more get involved in the teaching and learning. In the meanwhile, the students could have more opportunities for learning from others' mistakes, and thus made greater improvement. In contrast, the teacher managed the practicing and correcting in traditional way in the learning setting of control group.

Fig. 3. The practicing and correcting scenario with the MIPS

4.4 Post-test

At the end of the learning the students took a post-study test of the vocabularies taught. The test score is used as the objective measurement of academic achievement.

4.5 Satisfaction Assessment

At the end of the post-test the students completed a self-questionnaire with regard to understand the student learning satisfaction. Particularly, our assessment of learning satisfaction is based on the questions proposed by Hui et al. (2008), with additional translations into Traditional Chinese to tailor the questionnaire to Taiwanese students in this study. This questionnaire was composed of 6 items and each item was measured on a 7-point Likert scale where 7 indicated a strong preference and 1 indicated a weak preference for student's satisfaction. Internal consistency reliability, as represented by Cronbach's alpha, was 0.82, revealing an acceptable level of reliability (Chin, 1998).

5 Results and Discussions

The t-test is used to test the null hypothesis that the population mean in each of the two groups is equal (Hair et al., 2010). Given the need to measure the differences between the experimental group and the control group in this study, regarding to the learning achievement and satisfaction, the independent samples t-tests were carried out.

5.1 Learning Achievement

Table 1 shows the statistical results of the experimental group and the control group on measuring the post-test scores concerning learning achievement. The mean of scores was 75.65 (SD = 14.49) for the experimental group, higher than the 49.29 (SD = 17.22) for the control group. There is a significant difference between these two groups, t(57) = 6.381, p < .001.

Table 1. t test result of the test scores

	Groups	*N*	*Mean*	*SD*	*df*	*t*	*p*
score	Experimental group	31	75.65	14.49	57	6.381***	.000
	Control group	28	49.29	17.22			

*$p < .05$, **$p < .01$, ***$p < .001$

The empirical analysis results reveal that the students who used the multi-image presentation system (MIPS) obtained a better result on average, implying that the system is able to lead students to significantly better learning achievement in English vocabulary learning, and is therefore useful. Previous studies of vocabulary learning (Chen and Chung, 2008; Dóczi, 2011) proved the positive improvement in developing the learner's learning achievement.

5.2 Student Satisfaction

Table 2 shows the statistical results of the experimental group and the control group on measuring the 6 survey items related to the learning satisfaction. The mean of overall satisfaction was 29.13 (SD = 5.51) for the experimental group, higher than the 23.46 (SD = 3.42) for the control group. There is a significant difference between these two groups, t(50.768) = 4.797, p < .001.

Table 2. Means (*M*), standard deviation (*SD*), and *t* value for learning satisfaction

	Groups	*N*	*Mean*	*SD*	*df*	*t*	*p*
satisfaction	Experimental group	31	29.13	5.51	50.768	4.797***	.000
	Control group	28	23.46	3.42			

$*p < .05$, $**p < .01$, $***p < .001$

6 Conclusions and Future Research

The purpose of this study was to develop and evaluate the effects of multi-image presentation system (MIPS) on student learning achievement and satisfaction in the college English as second language (ESL) course within the classroom setting. The results show that there are statistically significant differences between the students in experimental group and control group on measures of learning achievement and learning satisfaction. Here the mean of test scores was 75.65 (SD = 14.49) for the experimental group, higher than the 49.29 (SD = 17.22) for the control group. In addition, the mean of overall satisfaction was 29.13 (SD = 5.51) for the experimental group, higher than the 23.46 (SD = 3.42) for the control group. The MIPS facilitates the ESL learning achievement and satisfaction at the interface of technology, providing high level of interactivity and multi-image presentation, which are critical to the improvement of the whole-class teaching and learning processes.

This study contains several limitations that suggest future research directions. First, this study does not completely follow a truly randomized selection and assignment. Efforts to replicate this study using a truly random design would be helpful. Second, this study evaluates the learning achievement and satisfaction of elementary student in the context of ESL subject. Further research should investigate the potential of its use in other subject areas, such as Japanese or Korean, or for students with higher achievement in the subject of English to generate empirical evidence with greater generalization.

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Using Kinect for Holodeck Classroom: A Framework for Presentation and Assessment

Worapot Sommool[1], Batbaatar Battulga[1], Timothy K. Shih[1], and Wu-Yuin Hwang[2]

[1] Dept. of Computer Science & Information Engineering, National Central University, Taiwan
{title.wo,timothykshih}@gmail.com, btta_1@yahoo.com
[2] Graduate School of Network Learning Technology, National Central University, Taiwan
wyhwang@cc.ncu.edu.tw

Abstract. “Holodeck” was appeared in the fictional StarTrek universe and show up in a movie name “Star Trek: The Next Generation.” It is depicted as enclosed room simulates objects and people as the interactive virtual environment look like a real world such as a living room, an outdoor environment and etc. This study applied this concept to enhance smart classroom into an interactive learning environment classroom name “Holodeck classroom”. This paper presents a framework for presentation and assessment in Holodeck classroom. We designed an interactive framework using Microsoft Kinect Sensor for e-Learning, created new items of gesture-based questions in supporting QTI-based assessment, and created a rich set of gesture commands for practical usage in classroom. Proposed system was experimented with teachers and students then collected users’ satisfactory feedbacks by usability questionnaire. And also evaluate the system functionality by comparing the proposed system with other related studies. The results shown the significantly participants’ satisfaction indicate that the system is simple to use better functionality and motivate student learning by assessment.

Keywords: assessment, education, gesture, holodeck, kinect, presentation, QTI, smart classroom.

1 Introduction

Teaching in a classroom is a routine work for the teacher who provides education for the students. In a traditional classroom, the instruction performs by teacher gives an example on a blackboard and explains the solution for students. Emerging of computers and technologies for education enhance the teaching experience and turn the traditional classroom into Smart classroom [1,2]. A smart classroom has been developed from a traditional classroom by integrating with computing devices. It aims to facilitate teacher to use varies teaching media such as video, audio, slide presentation, computer and internet. There are many researchers who studied this for almost a decade attempting to improve the traditional classroom smarter by integrating with varies technologies. Such as Y. Shi et al.[1] proposed Seamless Tele-Education for smart classroom. They integrated smart classroom with voice recognition, computer vision and internet benefitting the teacher to freely move and

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provide more interaction with students. Y. Suo [3] and Y. Shi [2] proposed smart classroom that support distance learning using web 2.0 technology simulating real-time interactive virtual classroom with tele-education experience. For support teaching and assessment in the smart classroom, they did not mention about gesture-based teaching and learning experience. In our research, we propose a teaching framework that using Kinect sensor for presentation and assessment in the classroom.

After teaching, teacher provides the examination for assessment of student learning outcome. With the aim of facilitating teachers the use of good techniques in Computer based assessment is to support students and lifelong learner to be independent, self-motivated and self-regulated. As a result, students should be provided with enhanced approach of learning and assessment that support them to set their learning goals effectively to plan and use effective strategies in order to achieve their goals, to manage resources, to monitor their understanding and assess their progress towards their goals [4]. The IMS Question and Test Interoperability specification (QTI) is a specification of assessment that have been developed to support the creation of reusable and pedagogically neutral assessment sceneries and content as started by IMS Global Learning Consortium. The use of technology-based assessment continues to increase as systems become more practical and cost-effective. Such as H. C. Yang [5] using AJAX novel technology and have been developed Web-Based Assessment (WBA) systems, helping an instructor to collect formative assessment data, and reflecting the effectiveness of learning and teaching. Chang [6] proposed the presentation of QTI structure in digital TV, for archiving better performance on digital learning, it is necessary for integrating quiz and testing components with current e-learning systems. It is the best way to arise the learning efficiency by checking students' learning achievements using test mechanism and correcting the wrong answers they made. Ibanez [7] tried to take full advantage of the interactive and immersive capabilities of 3D environments to recreate real or imaginary places to be explored by the students, and have used these 3D settings as working places where assessment takes place in the context of the content under evaluation. We designed Kinect based QTI system for students.

Gesture recognition is an interpreting human gesture via mathematical algorithms. Gesture can originate from any human motions such as face, hand, and finger. Gesture recognition can enable humans to communicate with the machine and interact naturally without any mechanical devices. There are many applications that using gesture-based recognition such as gaming (i.e. Xbox360 with Kinect), sign language recognition[8], alternative computer interface[9], and education [10,11].

Speech recognition (SR) also known as automatic speech recognition (ASR) and speech to text recognition (STR) is the translation of spoken words into text. Tony et al. [12] reported the result of applying STR for group learning activities was significantly effective for student achievement in the cyber classroom. H. Kim [13] used voice commands recognition for fighter pilot using grammar tree that significantly improved the performance of the command recognizer.

In our framework, we designed the complete system that supports teachers from prepares course content until resulting of student assessment. It may benefit teacher cover all job activities in the smart classroom.

2 Proposed System

The proposed system is designed to cover teaching activities in a smart classroom that consists of (1) course authoring tool, (2) presentation application for the classroom, (3) item authoring tool and assessment application for classroom as shown in figure 1.

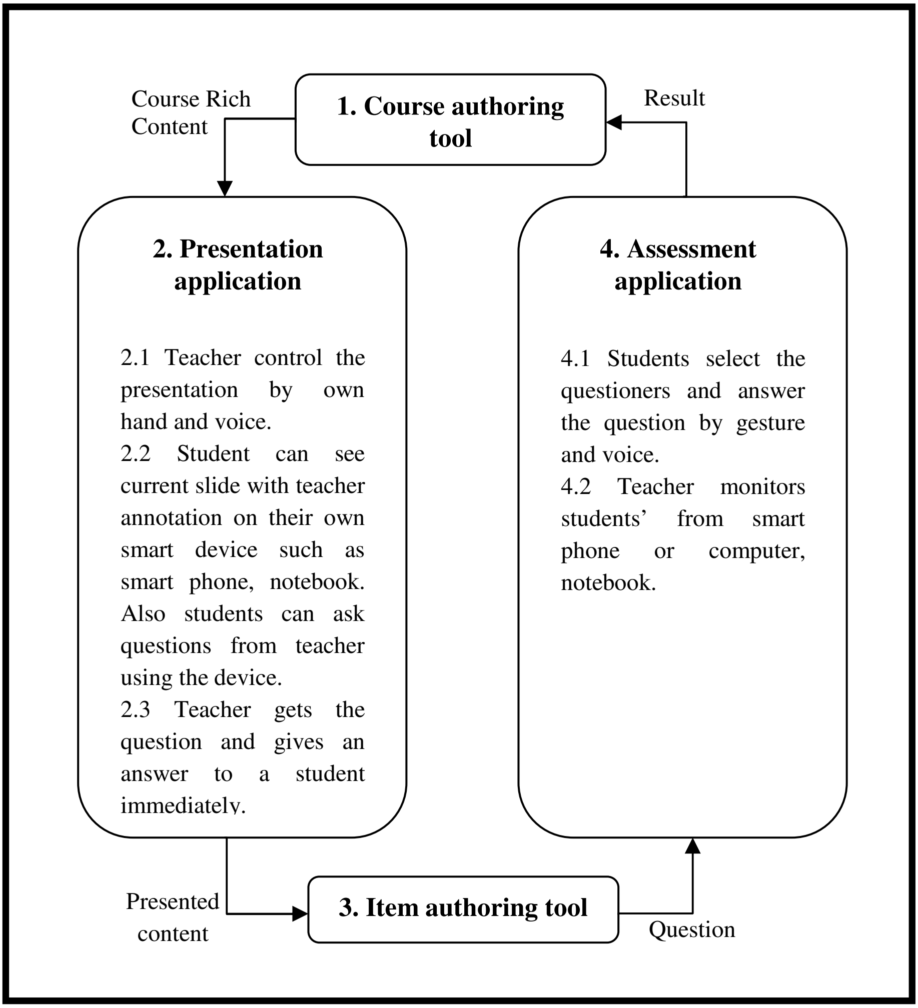

Fig. 1. General system architecture

2.1 Authoring Tool

Authoring tool provides an interface to create and manage content. There are two authoring tools: (1) course authoring tool is a web-based interface that is used to create and modify course materials such as uploading presentation files (i.e. PowerPoint slide) or each slide of the presentation file. Even it can be used by the teacher to take a note, attach 3D object or example source code. (2) The item authoring tool is a windows application that is used to make questions about assessment application.

2.2 Presentation Application

In this section we consider about developing the teaching tool that helps teachers in organizing and controlling the flow of his/her discussion. Normally in the smart classroom, teacher usually uses presentation software (i.e. Microsoft Word, OpenOffice Impress) with projector to describe the lesson. We designed gesture-base controlling using a Microsoft Kinect sensor to enable teacher freely and closely interacting with students based on the slide presentation. The command is based on two techniques; hand gesture based recognition and speech recognition (voice command).

Hand Gesture Recognition for Presentation. We get user's body skeletons position from Kinect sensor and matching user's hand movement (gestures) with conditions that we predefined. For example, user's hand move to right side changes to the next slide. All of the commands based on hand gesture are presented in table 2. Figure 2 demonstrates an example of hand gesture commands.

Voice Command for Presentation. Besides hand gestures-based commands, we designed voice commands for presentation. Supporting teacher interact with the PPT's window. We defined dataset of voice commands as showed in table 1.

Table 1. List of voice commands

Voice command	Description
"Show/Hide PowerPoint"	Show/Hide the minimized PowerPoint slide on the screen.
"Switch PowerPoint"	Show another minimized PowerPoint slide on the screen.
"Exit"	Quit presentation mode.
"Home"	Jump to first page.
"Full screen"	Activate presentation mode.
"Show/hide pointer"	Show/hide cursor pointer in presentation mode.

2.3 Assessment Application

This part was designed as a Kinect based assessment application for classroom to enhance the use of the traditional QTI. Kinect enables to use human pose making it easy to control for the interaction with the computer without traditional input devices like keyboard and mouse. Also Silverlight was used to develop 3D object and content in 3D environment.

Table 2. List of hand gesture commands

Gesture	Description
Slide control	• Start presentation mode by move two hands over head. • Changing page of slide such as go to next page, go to previous page. • Exit presentation mode by cross arms in front of a chest.
Cursor control	• Moving mouse cursor by moving hand in threshold area, we define area in the front of user body so when user move right hand in that area then the cursor can be move. Left-click by fisting right-hand for click and open hand to release.
Active Voice command	• Activate voice command by touch right-ear by right hand and move out to deactivate.

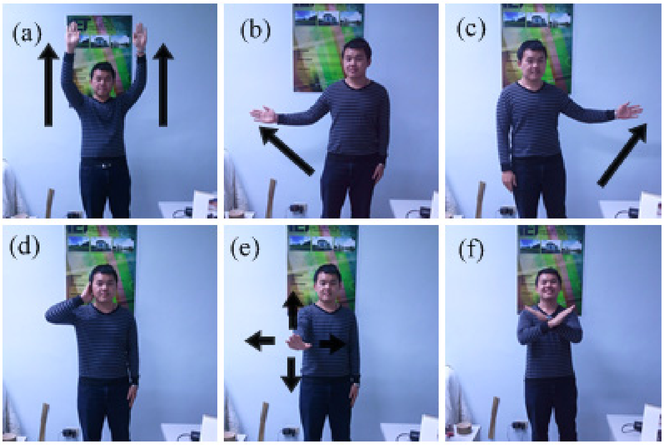

Fig. 2. List of gestures for presentation. (a) start presentation, (b) move to next slide, (c) move to previous slide, (d) activate voice command, (e) move mouse cursor, (f) exit presentation

Application Architecture. The proposed application divided into following parts:

- Control window: a windows application for teacher in monitoring the student's perform with assessment application interface and see the result (i.e. Score) of students.
- Background process: evaluating students' feedback, calculates the total score and real time synchronize the information between student and teacher.
- For Students: is a WPF and Kinect based application for students to interact with the system. Student only use the Kinect to open/close program, select the quiz and give the answers.

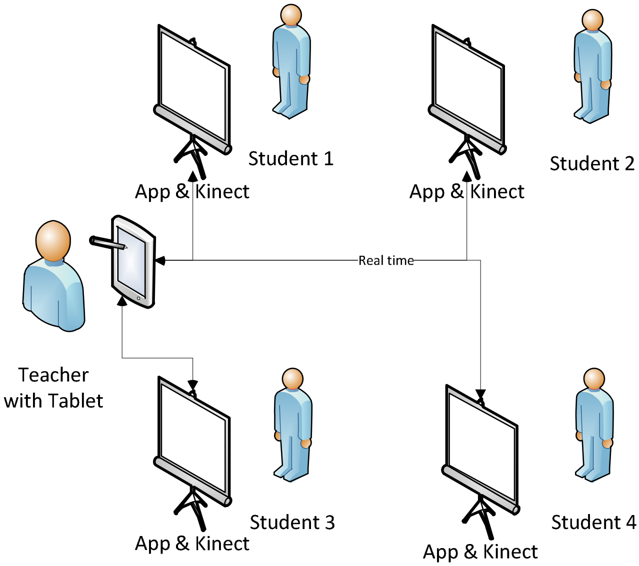

Fig. 3. Assessment architecture

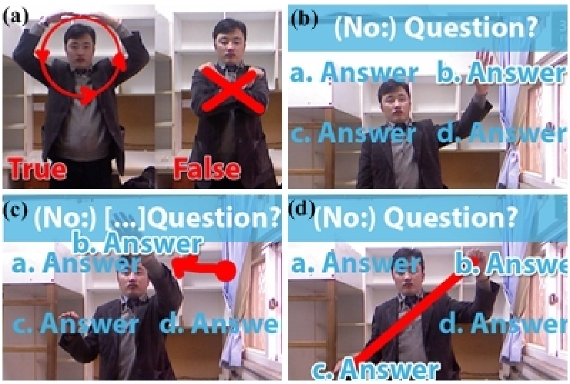

Fig. 4. Gesture for assessment application. (a) True or False, (b) Single, Multiple choice, (c) Fill in blank., (d) Pattern match

The Assessment Item. There are 20 types of quizzes defined in QTI. We used several major items such as "True or False", "Single choice", "Multiple choices", "Fill in blank", and "Pattern match". Also we designed new items based on the Kinect feature based assessments:

- Kinect angle: Kinect is capable of detecting angle of shoulder-elbow-hand. We used this feature to display the answer for "Angle" in Percentages, Fractions and Decimals.

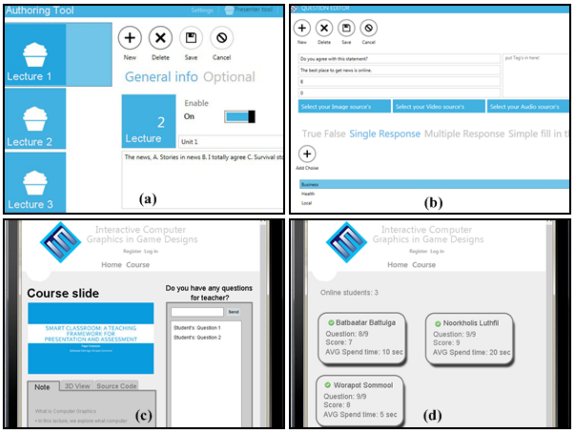

Fig. 5. Application interface. (a) course authoring tool, (b) item authoring tool, (c) presentation viewer in mobile tablet, (d) assessment monitor in mobile tablet

- Voice recognition: Use the Microsoft Speech Recognition SDK to recognize the student's speech when answering the question.
- Drawing gesture: Detect and follow the hand movement and can draw the shape. After that "Template based search" algorithm is used to detect, recognize and draw the shape.

We designed user interface using web-based application that user can access by internet browser (i.e. Internet explorer, Firefox, Google chrome) in any computing device such as desktop computer, notebook, tablet, and smart phone. Figure 5.a represents a course authoring tool that helps the teacher to manage course contents. Figure 5.b shown an interface of the item authoring tool for creating and manage question types and items. Figure 5.c represent a presentation viewer that provide many functions facilitate students view the current slide, take annotations, and send teacher the question while teacher giving a lecture. Figure 5.d represent an assessment monitoring interface that design for teacher to monitor a students' assessment result.

3 Experiment and Evaluation

This section is separated to 2 methods: the first is focused on evaluation users' satisfaction, and the second is to evaluate the system functionality by comparing the functions with other related studies. In the first method, we create a usability questionnaire modified from IBM computer usability satisfaction questionnaire proposed by James R. Lewis [14]. The study was conducted at Department of Computer Science and Information Technology, National Central University. The data were collected from MINELab members and professors who have teaching experience or familiarity with the pedagogy. There are 20 participants in this experiment. Before performing the experiment, the participants were trained on the system. Each subject tested all functions of the system and was asked to perform likes the real situation in the classroom. After subjects tested the system, we collect the user's usability satisfaction from them. The result of the questionnaire indicates that for a general opinion of the user were satisfy of the overall usability of this system. The participants agree about functions and the ease of use of the presentation application. For assessment application, most of users satisfy about the types of question is cover assessment usage and it is easy to understand.

Table 3. The result of user's usability satisfaction from questionnaire

Item	**(n = 20)**	
General opinion	**Mean**	**SD**
1. It was simple to use this system.	3.9	0.85
2. I feel comfortable using this system.	4.05	0.89
3. It was easy to learn to use this system.	3.95	0.83
4. The interface of this system is pleasant.	4.3	0.80
5. Overall, I am satisfied with how easy it is to use this system.	3.9	0.79
6. Overall, I am satisfied with this system.	3.8	0.89
The System facilitate teacher for teaching (presentation)		
7. This system has all the functions and capabilities I expect it to have.	3.85	0.81
8. This system make your presentation easy and smooth.	3.85	0.88
9. Voice commands help the presentation more functionality.	4	0.79
The system motivate student to learn by assessment		
10. I like using the interface of this system.	4.05	0.83
11. This system has all type of question that I can easily understand.	4.4	0.88
12. I think this system make me interest in doing interactive-quiz.	4	0.92

The second method, we compare the functions of our system with the other related studies as shows in table 4. The result show out system has more functions than other that may convenient teacher to create teaching contents, supporting a gesture-based interaction, providing more item type of questions for student assessment, and also supporting a 3D interaction.

Table 4. The comparison of proposed system with other related studies

Feature\System	**Our system**	**H. C. Yang**	**H. B. Chang**	**M. B. Ibanez**
System feature				
Environment	3D	Web	TV	Second life
Course Authoring tool	☑			
Item Authoring tool	☑			☑
Smart Classroom Component	☑			☑
Implemented Item Type	8	6	6	4
Text-based	☑			
Gesture based	☑			
Voice Recognition based	☑			☑

4 Discussion and Conclusion

In this paper we have presented an interactive framework using Kinect for e-learning specific in presentation and assessment. We proposed a set of gesture commands for practical usage in classroom such as gesture-based controlling of the Microsoft PowerPoint slide presentation, and interactive question answering. We created new items interaction question supporting QTI-based assessment. The proposed system is easy to understand and easy to setup. The system was evaluated by 2 methods that consist of the users' satisfaction by using usability questionnaire and system functionality by comparing our system features with the other related studies. The first method, the usability questionnaire collected from twenty participants who have an experience related to pedagogy and students in smart classroom. Based on the questionnaire, the results are encouraging in terms of functionality and simplicity. And the results indicate that this interactive framework it's facilitate the teacher for teaching and motivate students to learn by interactive assessment. The most comments and suggestions of users are about the user navigating interface to convenience the user using the functions such as play/pause video in presentation application sections. The functionality comparison result indicated that the proposed system provides more essential functions for the smart classroom that may provide an appropriate environment to teachers and students for enhance teaching and learning in the classroom.

Our future works will refine the user interface to improve user experience and to provide more intuition. For example, the tutorial mode provides the beginner guiding step-by-step instructions. In addition, we will design more gestures for presentation and assessment, and add more question types for assessment section. Furthermore, we can apply the system to the Holodeck[1] room to create a virtual environment of smart classroom enhancing the classroom more interactive and exciting.

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[1] Holodeck is the virtual world that simulate the room into the virtual environment process by computer. More info. `http://www.dailymail.co.uk/sciencetech/article-2262706/Microsoft-shows-new-holodeck-turn-ENTIRE-living-room-screen.html`

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Web-Based Learning in Remote Areas: An Evaluation of Learning Goals, Scenarios and Bidirectional Satellite Internet Implementation

Andrzej M.J. Skulimowski[1,2]

[1] Decision Sciences Laboratory, Chair of Automatic Control and Biomedical Engineering, AGH University of Science and Technology

[2] Technology Transfer Centre, Progress and Business Foundation, Kraków, Poland

ams@agh.edu.pl

Abstract. This paper presents the findings derived from a series of EC-financed projects aimed at supporting web-based learning in rural communities and other remote areas of Europe. The findings are mainly based on the case studies of ten pilot local learning hubs in the Beskidy Mountains, Poland. The results of four subsequent projects supported by different EU programs and conducted from 2006 to 2013 contributed to this study. These projects were conducted in Poland and 16 other countries of European Research Area (ERA). We will present the learning and research goals as well as the predominant learning scenarios. We will also show how innovative local social networks emerged to foster web-based and blended learning. A common feature of all the learning hubs was the need to use DVB-RCS bidirectional satellite internet technology for learning. We will present a multicriteria performance evaluation of the learning hubs in connection with their learning goals, adopted scenarios, and future development prospects.

Keywords: Learning Scenarios, Web-Based Learning Bidirectional Satellite Internet, Multicriteria Evaluation, Outranking Methods.

1 Introduction

The digital divide problem affects over one third of the adult population of Europe, predominantly elderly people and those living on islands, in mountainous or other remote areas, where access to ground-based broadband internet is scarce. An improvement in broadband infrastructure is therefore necessary to bridge the digital divide by ensuring rural communities access to information and e-learning applications. In some remote parts of Europe, such as certain Greek islands, the sparsely-populated Bieszczady mountains in Poland, as well as the northernmost parts of Sweden or Finland, a competitive solution to this problem can be provided by bi-directional satellite internet technology. Consequently, the authorities of the European Union have approved a series of research projects devoted to analyzing needs and finding the best technical and organizational solutions for the deployment of internet satellite technology in rural areas. The first of the series of projects referred to in this

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paper, *Rural Wings* (www.pbf.pl/ruralwings), commenced in 16 countries in January 2006. It was financed by the European Union as an Integrated Project within its 6^{th} Framework Program. Its principal aim was to select, launch and maintain satellite internet pilot stations using bi-directional DVB-RCS (Digital Video Broadcasting - Return Channel via Satellite) technology, cf. e.g. [1,2,4,11], provided by the Eutelsat Atlantic Bird 1B satellite in K_u band. It was intended that broadband internet access should enable local communities to use the web for learning via ground-based WiFi networks. All DVB-RCS learning hubs have been situated in remote rural or mountainous areas, with insufficient or no broadband internet access.

The specific educational goals of the pilot stations were defined and supported first within the “Rural Wings” project then by follow-up projects aimed at exploring the experience gained previously as well as achieving additional goals. Specifically, the pilot stations situated in the three countries involved in “Rural Wings”, namely Greece, Poland and Spain, were given an opportunity to benefit from the Interreg IIIB CADSES project Teleaccess (2006-2008, www.teleaccess.net [8]) and the Lifelong Learning Program project SoRuraLL (2009-2010, www.sorurall.eu). The conclusions drawn from the experience of all the above-mentioned projects were then analysed within an ICT foresight project [3] to determine the feasible development scenarios of the information society in rural areas. The focus areas of the latter study were related to the selection of e-learning and e-government software technologies and the usage scenarios to meet the specific goals of rural learning hubs during the next 10-15 years. Another area of research was oriented towards investigating the social impact of various learning scenarios on local communities.

A multicriteria assessment of a network of satellite internet local learning hubs had not been described before in literature. Therefore, the methodology elaborated for the network of ten sites in Poland was made available to the other institutions involved in the above projects with over a hundred learning hubs.

2 Needs Analysis and Selection of Learning Hubs

In order to select pilot sites for learning hubs, it was necessary to specify a set of *ex-ante* criteria concerning the scope and intensity of usage of bidirectional satellite internet based on DVB-RCS technology in remote areas. Following that, an *ex-post* assessment of the selected sites’ performance was used to nominate the most suitable sites as telecenters and social learning hubs to be supported by subsequent projects. In Section 3, we will compare the ranking resulting from the initial needs assessment with that derived from the final performance evaluation.

While the technical criteria of the needs assessment and performance evaluation could be different, the target goals were unique for all hubs supported by the above project. They were determined according to the priority goals resulting from the earlier Information Society foresight project FISTERA [7] and included:

- the intensity of broadband use, measured as a combination of the number of users, total transmission volume, and its regularity, measured as the standard deviation of daily transmissions (the first goal),

- filling the gaps in broadband coverage (the second goal),
- the number of users willing to use the e-learning applications made available within the project (the third goal).

The values assigned to the above goals were first considered as *ex-ante* expectations at the stage of selecting the pilot sites, then as *ex-post* evaluation results. Both the above were compared with each other and with the initial situation at the assessed pilot sites. To make such a comparison possible, the values of subcriteria that could actually be obtained were transformed as measures of achievement of the above goals. This method allowed us to derive a set of relevant needs assessment criteria from a larger set of criteria considered at the pilot site selection phase of the project. The above approach can be applied to any similar problem involving initial *ex-ante* and *ex-post* rankings, with the latter based on actual performance.

2.1 The Selection of Satellite Internet Pilot Stations: The Case of Poland

As mentioned in the previous section, the outcomes of the 6th FP project Rural Wings should serve as a basis for further development of web-based learning and local information societies in selected rural and remote areas. The aims of the project included the provision of satellite internet access to remote locations and one of the first tasks was the selection of pilot sites.

Taking into account a general project methodology common to all countries (cf. www.ruralwings-project.eu), in order to achieve the above-mentioned targets, we elaborated a selection methodology tailored to specific regional needs. The three main groups of selection criteria are listed below:

- Geographic location of the site – according to the project goals, the more remote and isolated the site, the more eligible for the project, but the diversification of geographical locations and an even distribution of sites over the target areas should be taken into consideration as well.
- Existing internet infrastructure – the pilot stations should be installed in areas without broadband facilities or – at least - internet access provided by third parties should have lower transmission rates or be less reliable than the satellite DVB-RCS system. On the other hand, other existing IT infrastructure, such as school computer labs, LANs etc. could bring added value to the project.
- Availability of potential end-users willing and capable of engaging in the learning activities of the pilot station.

The assessment of each of the above criteria was based on the evaluation of a set of quantitative subcriteria. The latter were calculated from the data gathered in questionnaires assessing community and individual needs at potential pilot sites, and also from interviews. The forms and criteria were enhanced by country-specific additional issues. For instance, in Poland these included the availability of users willing to benefit from web-based learning of e-government issues. Another functionality discovered during the needs analysis was the ability to gather research results in natural parks and supply them via satellite internet to learning establishments. The method used for aggregating the data gathered in the questionnaires is outlined below.

The following 5-step procedure was carried out to select the pilot learning hubs:

Step 1. The needs of regions, sectors and different types of educational institutions in the country covered by the activity of the National Coordinator were assessed in order to choose the most appropriate target groups and areas.

Step 2. Next, online questionnaires were distributed to the selected target groups: schools, national parks, local authorities, research establishments and business support organizations providing adult training.

Step 3. We developed a method for transforming the questionnaire data into the selection criteria, taking into account uncertainty and bias in the data collected. We then used a multicriteria outranking method based on reference sets [5] to establish a preliminary ranking of sites.

Step 4. The selected sites were visited in the order yielded by the outranking procedure, starting with those best ranked. The data gathered so far and the technical feasibility of installing the DVB-RCS equipment at the selected sites was verified.

Step 5. Based on the results of the data verification, the expected support from the local school authorities, as well as the final assessment of the site viability and usability derived from the field visits, the Selection Committee determined the final ranking of sites and the order in which they should be connected to the satellite internet.

After signing the agreements with the local authorities, the installation of DVB-RCS D-Star terminals could then follow.

The above selection process began in early 2006 from a detailed country needs analysis in the areas of web-based learning and other e-services and internet applications. The needs analysis indicated that the only geographical regions in Poland affected by low broadband access as a result of topography and geographical isolation were the Beskidy mountains in the south of the country.

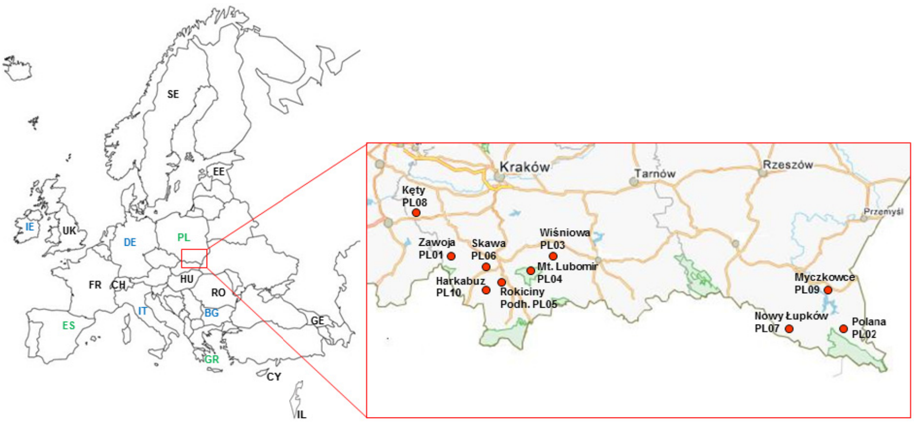

Fig. 1. Satellite internet learning hubs: the ten sites described in this study are shown on the right. The map on the left shows the countries covered by the projects: countries where the first experience was gathered (CH,CY,EE,FR,GE,HU,IL,RO,SE,UK; *black* denotation), countries where these findings have been implemented (BG,DE,IE,IT; *blue* denotation), and countries with both experience gathered and findings implemented (ES,GR,PL; *green* denotation). The shaded areas denote natural parks.

The first two pilot sites selected according to the procedure described above were installed in March 2007. Six schools, one rural school library, one rural telecenter and two research stations were finally selected. All the selected sites are shown in the Fig.1. Their learning goals and basic characteristics are presented in Tab.1 below.

Table 1. The characteristics of the DVB-RCS satellite internet pilot stations selected in Poland [9]

ID	Place, institution	Geographic position	Site type	No. of users	Principal learning goals and e-learning applications
POL 01	ZAWOJA, Babiogórski National Park	longitude: 19°54 latitude: 49°65altitude: 650 m above mean sea level (asl)	remote research station	2000	1. Improved environmental education, enriched science learning and scientific activity in remote rural areas. 2. Learning at work (target group: researchers). 3. Supporting local administration in environmental issues. E-learning applications: producing and disseminating videos with observation of the park wildlife.
POL 02	POLANA, Polana Primary School	longitude: 22°35 latitude: 49°18 altitude: 639 m asl	rural school	80	1. Internet access for learning at school. 2. Internet access for learning at home. E-learning applications: WebTV - schoolchildren record school events then upload them to the web, Moodle
POL 03	WIŚNIOWA Secondary School for Adults	longitude: 20°12 latitude: 49°79 altitude: 380 m asl	rural school	40	1. Internet access for learning at school. 2. Internet access for learning at home. E-learning applications: UNITE platform, Moodle
POL 04	Mt. LUBOMIR, the Astronomical Observatory	longitude: 20°08 latitude: 49°75 altitude: 904 m asl	remote research station	100	1. Internet access for learning at school. 2. Internet access for learning at work. E-learning applications: Discovery Space (D-Space) and similar applications enabling the transmission of astronomical data and joining a network of educational observatories.
POL 05	ROKICINY PODHALAŃSKIE, Raba Wyżna Telecenter	longitude: 19°91, latitude: 49°57, altitude: 550 m asl	rural tele-center	250	1. Intensive e-government-oriented training programs 2. Use of the Raba Wyżna municipal web service 3. Internet access for learning at school 4. Internet access for learning at home 5. Internet access for learning at work. E-learning applications: WebTV, online consultations on local community matters with e-learning support
POL 06	SKAWA, The Municipal Public Library	longitude: 19°90, latitude: 49°62, altitude: 514 m asl	rural library	300	1. Internet access for learning at school 2. Internet access for learning at home 3. Internet access for learning at work E-learning applications supplementing lectures on ecology and biology, and the municipal web service of Raba Wyżna
POL 07	NOWY ŁUPKÓW, Primary School	longitude: 22°05, latitude: 49,15, altitude: 592 m asl	rural school	60	1. Improved education: enriched natural science learning and scientific activity in remote rural areas. 2. Rural school teacher training E-learning applications: WebTV, Moodle
POL 08	KĘTY, Secondary School No.9	longitude: 19°90, latitude: 49°62, altitude: 514 m asl	county-level school	300	1. Improved education: enriched natural science learning and scientific activity in rural areas 2. Rural school teacher training E-learning applications: Teacher IT training seminars, Xplora, UNITE platform, Experinet, Moodle
POL 09	MYCZKOWCE Primary School	longitude: 22°24, latitude: 49°26, altitude: 364 m asl	rural school	120	1. Improved education: enriched science learning and scientific activity in remote rural areas, 2. Rural school teacher training E-learning applications: Cret@quarium, WebTV, e-govt-oriented training
POL 10	HARKABUZ Primary School	longitude: 19°50, latitude: 49°32, altitude: 809 m asl	rural school	75	1. Improved education: enriched natural science learning and scientific activity in remote rural areas, 2. Rural school teacher training. E-learning applications: Cret@quarium, WebTV, the municipal web service of Raba Wyżna, Moodle

2.2 Learning Scenarios for the Satellite Internet Hubs

The development of e-learning had been one of the top priorities of the „ePoland" [7] program, whose first phase was completed prior to launching the pilot learning hubs. This created a background for establishing advanced learning scenarios, referring to the experiences gathered in other regions of the country. Besides learning at school, other forms of education, such as SME training, training of teachers, and other forms of adult learning, creating multimedia information centers, educational content and content servers, in particular in local national parks, could be taken into account.

The National Coordinator's team reviewed the learning scenarios available in the Rural Wings project in order to plan for a more effective project implementation. A new learning package "*Improving internet access to public services and e-government related learning*" was defined and included in the scenario portfolio. This was expected to be one of the most relevant issues in rural areas in Poland at the time when the project was carried out. Following that, the recommended learning scenarios for each pilot site were chosen. The initial assignment of learning scenarios to the learning hubs in Poland is presented in Tab. 2 below [cf. 9].

Table 2. Ex-ante review of the learning scenario implementation in satellite Internet hubs

No.	Scenario description	Satellite Internet learning hubs									
		POL 01	POL 02	POL 03	POL 04	POL 05	POL 06	POL 07	POL 08	POL 09	POL 10
S-1.	Entrepreneurship education: A rural e-shop run by students	N	P	P	N	P	P	N	XP	P	P
S-2.	Access to education: A virtual music school for rural students	N	P	XP	N	P	XP	N	P	P	P
S-3.	Students broadcasting their school affairs through their own WebTV program	XP	P	XP	XP	XP	XP	XP	XP	XP	XP
S-4.	Better education: Enriching science learning and scientific activity in remote rural areas	XP	P	XP	XP	XP	XP	XP	XP	XP	XP
S-5.	Rural school teacher training	P	XP	XP	XP	XP	XP	XP	XP	XP	XP
S-6.	In-the-field personalized communication and training services for farmers	P	P	P	N	XP	P	P	N	P	P
S-7.	Health emergency training	P	P	D	N	P	D	P	P	P	P
S-8.	Addressing change and innovation skills in rural communities	XP	P	P	XP	XP	P	XP	XP	P	P
S-9.	Individual learning (5 scenarios for different social groups in the local community)	XP	XP	P	P	XP	XP	P	P	P	P
S-10.	Improving internet access to public services and the electronic office (e-government)	P	P	P	P	XP	P	P	XP	P	XP
Ex-ante expectation of the dominant users' scenario		R	IAP	TEL	R	E-G	IAP	TEL	TEL	TEL	TEL

The numbering of sites (POL01-POL10) in Tab. 2 is the same as in Tab. 1. The additional symbols used in Tab.2 are explained below:

XP - e**X**tensive use during the pilot phase highly **P**robable
P - **P**otential or Planned use at a later date
D - to be **D**etermined, depending on a possible expansion of the target user group
N – **N**o use expected during the duration of the project
R - **R**esearch
IAP- **I**nternet **A**ccess **P**oint
TEL- on site **T**eaching and **E**-**L**earning platform access
E-G – learning related to **E**-**G**overnment applications

The *ex-ante* expectation concerning the use of satellite internet shown in Tab.2 served as a basis for an *ex-post* assessment of the operation of learning hubs and project goals achieved. This is discussed in the next section.

3 Operation and Evaluation of the DVB-RCS Pilot Sites in Poland

The technical and training support activities provided by the National Coordinator were supplemented by monitoring the operation of the pilot sites and collecting data for final evaluation. They included on-site consultancy and training, measuring transfer rates and monitoring the use of e-learning applications. A further needs analysis concerning software and hardware was also conducted.

The evaluation of the learning hub performance consisted of two components:

- a user-centered one, based on evaluation forms completed by end users at training seminars and other project events (these forms could also be completed online),
- a component related to the technical and organizational aspects of the operation of pilot sites.

The latter included data on transmission rates (down- and uplink), information about the use of the applications, the number and social structure of end-users, time at use, technical problems encountered, etc. The functionality of applications used and their responsiveness to the needs of different target groups was also evaluated.

According the above scheme, the data characterizing the performance of the individual pilot stations, which consisted of 12 indicators, was collected. The indicators were grouped into three categories: technical, intensity-of-learning-related, and qualitative. The criteria groups were then aggregated to three synthetic objectives: technical objectives, based on transmission quality, objectives related to intensity of learning, and objectives describing the quality of fulfilling the e-learning goals. The latter were based on qualitative assessment and interviews. The final ranking was derived by comparing the values of synthetic objectives with the corresponding values for reference sets [5] containing the model and satisfactory objects.

While multicriteria outranking approaches based on weighting individual criteria are commonly prevalent in deriving rankings from individual scores [5], we have discovered that a similarity measure to the most desired and satisfactory objects (i.e. model learning hubs) defined at the selection phase would better correspond to the ideas underlying the functioning of the pilot learning hubs.

The results of the *ex-post* evaluation are presented in Tab.3 below. For reference, in cols. 8 and 9 we have included a comparison with the results of the *ex-ante* assessment and learning scenario expectations presented in Tab.2.

Table 3. Results of *ex-post* technical [9] and learning scenario evaluation [3,8] of the satellite internet learning hubs. The site codes (POL01-POL10) are the same as in Tab. 1 and 2.

Site code	**Mean downlink rate *dl*(kb)**	**Standard deviation of *dl* (kb)**	**Mean uplink rate *ul* (kb)**	**Standard deviation of uplink (kb)**	**Overall technical assessment score [0…10]**	**Learning scenario implemen-tation score**	**Deviation from *ex-ante* scenario assignment**	**Difference between *ex-post* and *ex-ante* ranks**
1	2	3	4	5	6	7	8	9
POL 01	1031,795	486,723	68,375	38,715	5	7	none	-1
POL 02	902,946	538,364	N/A	N/A	4	8	none	0
POL 03	1133,273	508,9445	44,300	7,328	5	6	none	-1
POL 04	720,581	562,458	347,413	304,282	3	6	later launch	-1
POL 05	1417,943	1525,783	58,661	49,041	5	8	additional S-10	1
POL 06	1344,20	741,87	49,37	16,88	6	7	none	0
POL 07	1552,985	350,599	112,845	31,502	8	7	none	1
POL 08	1323,77	665,22	88,01	47,22	7	8	none	1
POL 09	823,546	467,881	58,091	71,147	4	7	later launch	-1
POL 10	922,07	479,05	N/A	N/A	3	8	later launch	1

The overall technical assessment criterion (col. 6 in Tab.3) was a result of rounding and normalizing to a scale [0…10] of the linear combination of the absolute transfer rates (positive weights) with the unreliability of the link expressed by the standard deviation of down- and uplink rates (with negative weights). Observe that the highest mean downlink values obtained in site POL05 were accompanied by the highest connection risk, which reduced the technical score. The principle reason for lower-than-expected use of e-learning applications was lower-than-expected (uplink) transmission rates, which hindered the use of certain applications.

It is to be noted that the operators of the learning hubs had an influence on the technical criteria presented in cols. 3-6 in Tab. 4. The transmission rate values assumed in the project were 4 Mbaud for downlink and 2 Mbaud for uplink, so the values achieved actually differ substantially from those initially assumed.

The intensity of using the e-learning applications was measured in terms of access time to the specific web pages and supplied by the project partner responsible for these measurements. This data was normalized for all sites, taking into account transmission rates at the satellite terminal and the assumed number of potential users. *Ex-post* interviews conducted within the project [3] have been taken into account as well. It is to be noted that the ranking in Tab.3 concerns only the aspects specified in this table, and it might not reflect the assessment of the overall learning hub operation. Therefore, the differences between the *ex-ante* (selection stage) and *ex-post* evaluation ranks in Col.9 of Tab.3 may serve exclusively as an illustration of the evaluation method and not as the final assessment. On the other hand, the values obtained show good compliance between expectations and actual results.

4 Conclusions and Future Prospects of Satellite-Internet-Based Learning

Based on the studies conducted during the above projects, and on the data hitherto gathered at the rural learning hubs, we can conclude that bidirectional satellite internet access is a key element in fostering the expansion of a common intellectual sphere in local societies and eliminating the digital divide in remote and rural regions. The final results of the project [3] confirm that the selected rural areas in Poland will benefit from DVB-RCS or similar bi-directional satellite technologies providing internet access for local schools at least until 2025. A similar conclusion can be drawn for the majority of the countries taking part in the projects presented in [8,9]. In the 'most probable' Polish Information Society development scenario, this will be provided by the dominating telecom operator and by crisis management services, specifically by local fire brigades. The growing transfer rates in the K_a band, increasing reliability and stability of satellite communication as well as the decreesing unit transmission cost are salient trends that could ensure the satisfaction of economic and technical feasibility criteria for the period until 2025. A reverse trend, namely the development of ground-based high-speed broadband will simultaneously limit the deployment of DVB-RCS technology to the most sparsely populated and isolated areas.

Recommendations to e-learning providers resulting from the implementation and evaluation of satellite internet can be summarized as follows:

- The new generations of satellites with high throughput [1,11] can provide reliable, affordable, and geographically unrestricted internet access for e-learning and m-learning. This will require the development of content suitable for mobile and autonomous learning and assistance services to learners in remote areas.
- The successful operation of the satellite internet access points in public schools depends on the availability of qualified and engaged teachers as well as comprehensible e-learning platforms, content, and support services tailored to local needs.
- Wherever satellite internet access is provided to schools in remote areas, the local society also expects it to be available to ensure internet access for e-government and e-health purposes as well as, occasionally, for private usage.

- Until 2020, a number of m-health and telemedicine applications [6] will emerge, which will rely heavily on DVB-RCS or similar technology in remote areas. Thus the relation of m-health applications to web-based learning must be taken into account when designing future satellite internet technology deployment plans.
- Satellite internet access can ensure more reliable communication in rural regions endangered by natural disasters, specifically by floods and earthquakes. DVB-RCS communication infrastructure should therefore be developed taking into account the specificity of the crisis management services in the countries involved.
- It is necessary to monitor the negative aspects of information technology (ab)use in rural schools, such as privacy violation in social networks, personal alienation through e-gaming, social networking and internet surfing addictions, etc. Addiction and cyber-criminality can endanger web newcomers in particular, cf. [10].

The observations made during the operation of the satellite internet-based learning hubs have shown that web-based learning is a relevant driver fostering the development of local information societies in remote rural areas. Improved access to information on the internet will encourage a transition from a traditional rural economy to innovative, sustainable, and animal-friendly agriculture. Other branches of the rural economy, such as tourism, may benefit from satellite broadband access as well.

Finally, it should be mentioned that according to ICT foresight [3] and other forecasts [8,11], after infrastructural IT satiation, including ubiquitous broadband access, the demand for comprehensible e-learning e-economy, e-government and e-health applications will grow rapidly. This would create a new trend in learning content development, with a growing intensity in Poland after 2016.

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Formal Evaluation Methodology of Educational Scenario in Distance Learning

Manel BenSassi[1] and Mona Laroussi[2]

[1] Laboratoire RIADI GDL, ENSI, Campus de la Manouba, Tunisia
[2] Laboratoire Noce - LIFL Universit des Sciences et Technologies de Lille, Lille, France

Abstract. Educational scenarios and learning objects are growing in scale and functionality. Because of this increase in complexity, the likelihood of subtle errors is much greater. One-way to achieving this proposed goal is by evaluation of these course-wares. In this paper, we propose a formal method which is mathematically based languages, techniques and tools for specifying and verifying. Using the automata theory do not a priori guarantee correctness and success. However, they can greatly increase our understanding of the learner's behaviour with the existing scenario by revealing inconsistencies, ambiguities and incompleteness that might otherwise go undetected. Our goal, in this study, is to prove how this formal definition helps designer in his evaluation's task.

1 Introduction

The evaluation of educational scenario is important to educators. It is one of the more challenging tasks that an educational designer is faced with. In fact, the higher cost of the implementation of educational scenarios in distance learning and the complexity of their context and functionalities emphasize the need to evaluate and to simulate them in order to detect potential errors and then to provide valuable feedback and recommendation to designers.

Much research on this area has focused on exploring the dimensions of evaluation and applies it to evaluate the quality of the educational scenario [1] [2]. Other works focus on evaluating the workflow in the course-ware [3] [4]. In these methods, functionalities of the online course are scored on both their effectiveness and importance for the activities they support. The activities themselves are also scored on their importance to the organization. The important scores acts as weight for the effectiveness scores. These methods, although useful in theory and in practice, could be applied only after the execution of the educational scenario. Designer couldn't anticipate and predict learners' difficulties.

For the above mentioned reasons, we propose, in this paper, an early formal evaluation method able to model educational scenarios based on timed automata and tracks simulation.

The rest of paper is organized as follows: Firstly, we will introduce some methods which will enable us to evaluate an educational scenario. Next we will prepare a detailed description of our approach and explain the steps for its design and building. Finally, we will briefly summarize our experience and outline future work.

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2 Evaluation Methods of Educational Scenario

Evaluation is the collection of, analysis and interpretation of information about any aspect of a programme of education or training as part of a recognised process of judging its effectiveness, its efficiency and any other outcomes it may have" [5]. Designers evaluate educational scenario using different methods and techniques. They should draw their criteria and specify different dimensions of evaluation. We explain in the following section some of them.

Dimensions of Evaluation. The diversity in types of educational scenario's evaluation is especially indicated by these properties (shown in figure 1):

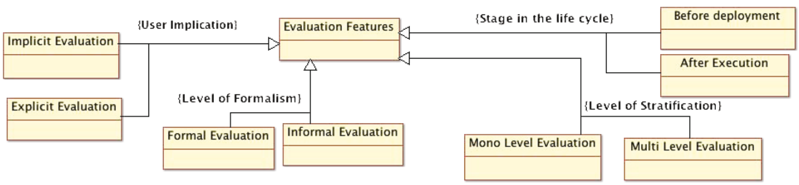


Fig. 1. Features of Evaluation's process

- **Level of Stratification:** We define a stratified evaluation (a hierarchical evaluation) as a layered structure formed by ranked criteria. The criteria composition allow designer to analyse educational scenario from different point of views. Figure 1 shows that depending on the level of stratification, two types of evaluation are possible: Mono-level evaluation and multi-level Evaluation.
- **Degree of Formalism:** This criteria describes the nature of the evaluation method: formal or informal. According to [6], a method is qualified formal if it has a sound mathematical basis, typically given by a formal specification language.
- **User Implication:** This criteria shows whether the learning scenarios related actors (designers, teachers, learners or coaches) are explicitly or implicitly implied in the evaluation process.
- **Stage of Evaluation:** Laurillard [7] states the evaluation process as an iterative one and should take place at every stage in the design, implementation and deployment of the educational scenario.

Comparative Study. Several methods are generally used in educational scenario such as questionnaires, interviews, observations, checklist and tracks' analysis. These methods have different characteristics. Then, we can get different forms of content detailed in the evaluation results from different angles and dimensions of evaluation. We summarize in this table 1 our comparative study between these methods. These methods, although useful in theory and in

Table 1. A comparative study of Evaluation's techniques

Methods	**Stage of Evaluation**	**Degree of Formalism**	**User Implication**	**Level of stratification**
Tracks' analysis and indicators calculating	After	formal or semi formal	Implicit	Mono / multilevel
Questionnaires	After	Informal	Explicit	Mono / multilevel
Interviews	After	Informal	Explicit	Mono / multilevel
Observations	During	formal	Implicit	Mono / multilevel
Checklist	After	Informal	Explicit	Mono / multilevel

practice, could be applied only **after the deployment and the execution** of the educational scenario. Designer couldn't anticipate and predict learners' difficulties. In other hand, methods previously presented are not mathematically based techniques for describing the evaluation process. Then, they don't provide frameworks within which designers can specify, develop, and verify conceived scenarios in a systematic, rather than ad hoc manner. For these reasons, we propose to lean to automata theory in order to model and evaluate the educational scenario. We present in the following section our formal approach.

3 Formal Evaluation Methodology Based on Timed Automata for Educational Scenario

3.1 Specification of Evaluation Dimensions

- **Evaluation Purpose.** Our main goal is to help designer in the re-engineering process so as to improve the structure of his scenario and make it more easier to understand. The cost of future system maintenance should therefore be reduced [8].
- **Evaluation Stage.** Evaluation is of great importance in all aspects and stage of teaching and learning. There are two possible stages for educational scenario evaluation (see figure2): before and after the implementation and the deployment of the educational scenario. We propose that the evaluation of the educational scenario takes place at early stage in the life cycle. This will tend to detect learner's difficulties. It will allow us to focus inwardly on various constraints and factors (such as activities' timing, learners' interaction, the setting of the educational scenario, implementation's strategies..).
- **Evaluation Steps.** Formal evaluation of educational scenario is based essentially on three stages:
  1. *Initial Stage: Educational scenario design* Instructor introduces the content in term of activities, their sequencing, their description and their explanation. He also should draw his constraints of deployment and monitoring requirements.
  2. *Second Stage: Formal Modelling of Educational Scenario* In this stage, the description of educational scenario is translated in Automata Model based on transformation rules described in [9]. We extend the obtained

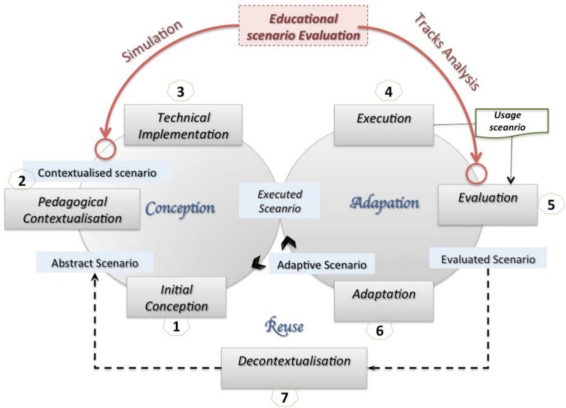


Fig. 2. The position of Evaluation process in the life cycle of educational scenario

automaton with global and local clocks. We also define constraints and correlation between different activities. By creating a formal specification of the educational scenario, the designers are forced to make and to define a detailed scenario analysis at early stage before its deployment into the TEL system.

3. *Final Stage: Simulation and interpretation* Using automata theory as a method of specification, it is possible to use the formal verification techniques to demonstrate that a system design is correct with respect to its specification. The main objective of formal specification and verification is to minimize the creation of functional errors and limits. This analysis will usually reveal errors or consistencies through simulations. In our context, formal specification methods can solve many problems (track's collecting, monitoring problems, behaviour study of learners..), guaranteeing non-ambiguity and supporting powerful analysis capabilities.

We summarize in this figure 3 the main stages of the evaluation methodology.

3.2 Timed Automata for Educational Scenario

Timed Automata Formal Definition. Automata theory is the study of mathematical objects also called *automata* (that means self-acting in Greek dictionary) and the computational problems that can be solved using them [10]. The automata modelling consists of drawing states (represented by circles), and transitions (represented by arrows). An automaton contains a finite set of states. At each instant in time of some run, the automaton is in one of its states. At each time step, when the automaton reads a symbol, it jumps or transits to a next state that is decided by a function that takes current state and the symbol currently read as parameters. This function is called transition function. Formal verification is the process of checking whether a design, satisfies some

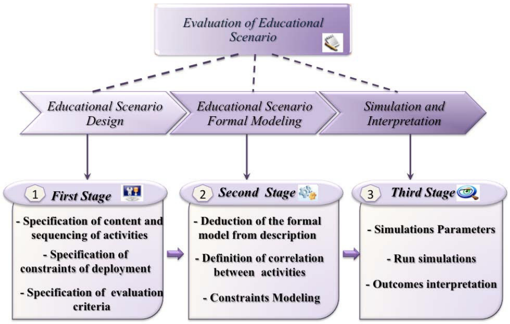


Fig. 3. Sequential Stages of Evaluation

requirements (also called "properties")[11]. It is a systematic process that uses mathematical reasoning to verify that the given specification is preserved in implementation. We also check whether this specification contains some problems and errors.

Let us recall the automata definition. An educational scenario timed automaton is a tuple $SP = (A, \Sigma, V, C, I, F, T, Inv)$[12], where:

– A is a finite set of states (activities),
– Σ is a finite alphabet of actions,
  - P!m : output action, the learner sends a message or he requests access to an activity.
  - P?m : input action, the learner could receive a message.
– V is a finite set of data variables where $\overrightarrow{v} = (v_1, v_2, ..., v_m)$.
– C is a finite set of clocks where $\overrightarrow{c} = (c_1, c_2, ..., c_m)$,
– $I \subseteq A$ initial states,
– $F \subseteq A$ is the subset of final states,
– $T \subseteq A \times A \times 2^A$ transition relation that, L is a set of transition actions $\Sigma \times P(V) \wedge \Phi(C) \times \omega \times 2^C$ where:
  - $P(\overrightarrow{v}) \wedge \Phi(\overrightarrow{c})$: Guard condition is logical formula on data variables and clocks;
  - $\omega(\overrightarrow{v})$: Data variables updates function;
  - 2^C: is a set of clocks to be reset
– Inv: $A \rightarrow \Phi(C)$ assigns a set of time invariants (logical formulas) to the states.

In the following section, we are going to show how we can apply this formalism at the educational scenario and use it to predict student's difficulties.

Motivation of Our Proposal. Several features of timed automata make it suitable to model learning scenario:

– A timed automata formalism supports hierarchical modelling. In fact, states in automata formalism are arranged in a tree structure, useful for decomposing the educational scenario into smaller parts and activities.

- The graphical syntax of timed automata formalism can make modelling more practical because it can be easier to interpret and to edit than a text-based syntax.
- Among timed automata formalism, temporal operators are important to model timing concept. In fact, time definition is an important factor in learning process.

3.3 Timed Automata Implementation and Case Study

We want to show that automata formalism can describe the different learning activities and all the paths to follow in order to evaluate and to monitor the educational scenario through simulation and tests generation. To illustrate feasibility, we select the following educational scenario described by the activity diagram (see figure 4). This scenario has got some conditions to satisfy for going from a sequence to the next one. In fact, the learner progresses the planned scenario on his testing result. According to his score level, the learner has three possibilities. If his score is less than 10, then he should review again his lesson. If his score is between 10 and 15, then he had to move forward another upgrade sequence. Finally, if his score is more than 15, the learner progress to the second lesson. The figure 5 represents the educational scenario automaton. The edges are labelled by scoring values, and clocks constraints (the duration of session and lesson 's deadline). Each activity is modelled and corresponds to the automaton's state. Time correlation between activities in distance learning is shown to be an important factor to evaluate learning process. Then, we propose to synchronize these modelled activities. The table 2 shows how we can correlate two learning activities and the generation of test cases through simulations. Consequently, we can represent the whole scenario by automata network to obtain the educational scenario model.

Case Study. The planned scenario (Figure 4) has been deployed and tested on a distance training through Claroline platform. It's an e-learning environment used by our university in collaboration with other institutes (USTL, University of Carthage Tunisia, University of Saint Joseph in Beirut and University of Notre Dame De la Paix in Namur) to ensure *"XML Lessons"*. The learner had to submit his work individually in a session of three hours. Each tutor coaches a group of 40 students. Different resources are deployed in the learning management system and the educational designer would like to plan a synchronous activity weekly. The training's administrator prepares a study of learner's localisation and the quality of the internet connectivity infrastructure (Table 3). He wants to evaluate the reachability of the learning session. We present the graph of chat room activity (see figure 6) enriched with these constraints (bandwidth) and pedagogical indicators (collaboration rate). The bandwidth is a random variable that simulate the quality of connectivity. The collaboration rate is a variable describing the number of messages written per student divided by the total number of message during the session of chat. We simulate the classroom and generate counter examples with Uppaal simulator tool[14]. This study show that

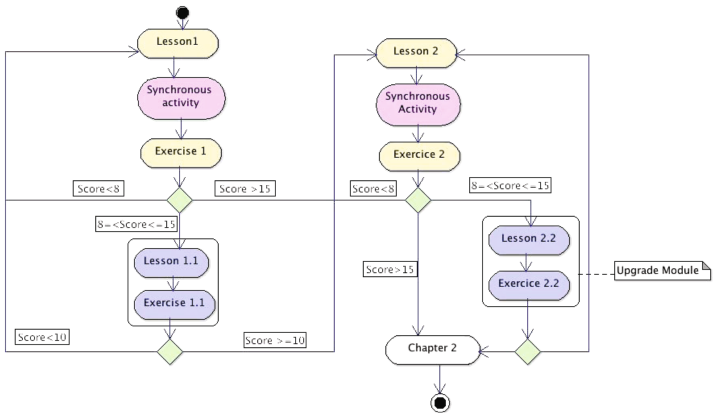


Fig. 4. Initial Educational Scenario

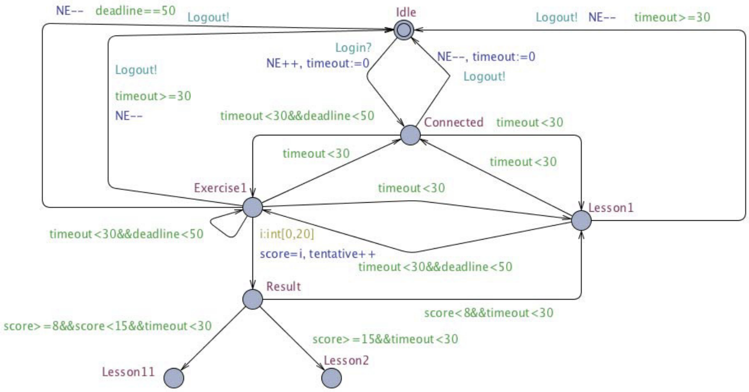


Fig. 5. Planned Educational Scenario

African students couldn't reach a collaboration's rate greater than 30% during one hour of discussion. The following figure 7 resume our experiment's criteria (geo-localisation and the length of the synchronous activity) and our outcomes. This experiment shows that designer had to schedule 2 hours for the synchronous activity to reach the desired rate. Following this experiment, the designer makes his decision to remedy the proposed educational scenario and to substitute the synchronous activity by the *forum activity* following the best practise proposed by [15]. We illustrate the remedied scenario in the following figure 8.

Table 2. Activities' Temporal Modeling

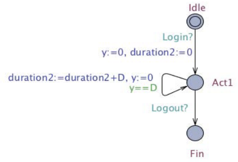
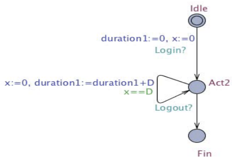
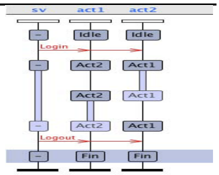
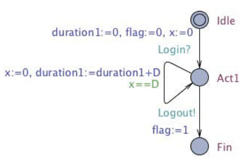
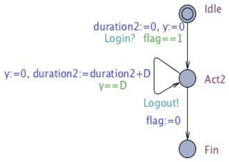
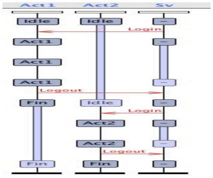
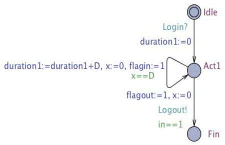
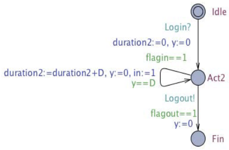
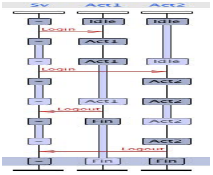
Description	The 1^{st} Activity 's Model	The 2^{nd} Activity 's Model	Simulation 's traces
Simultaneous' activities			
Act1 before Act2			
Act1 overlaps Act2			

Table 3. Distribution of the participants and the quality of the Internet Connectivity Infrastructure [13]

Geolocalisation	Nation	ICT infrastructure quality	Participants' number	Rate per ICT quality
Africa	Cameoon	poor	$(8 \div 40) = 20\%$	40%
Africa	Burkina Faso	poor	$(8 \div 40) = 20\%$	
Africa	Tunisia	medium	$(8 \div 40) = 20\%$	47,5%
Africa	Morocco	medium	$(4 \div 40) = 10\%$	
Asia	Lebanon	medium	$(7 \div 40) = 17,5\%$	
Europe	Belgium	good	$(5 \div 40) = 12,5\%$	12,5%

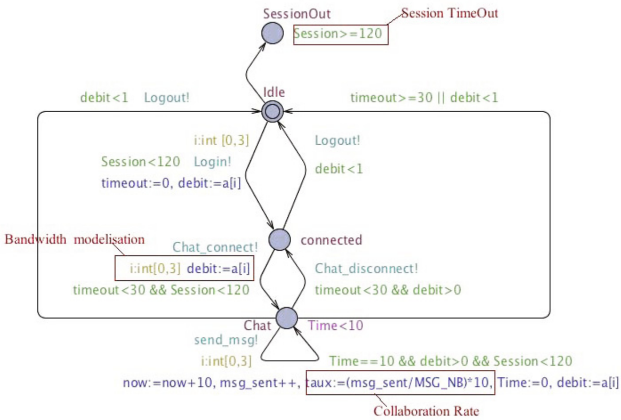


Fig. 6. Chat Room automata Model

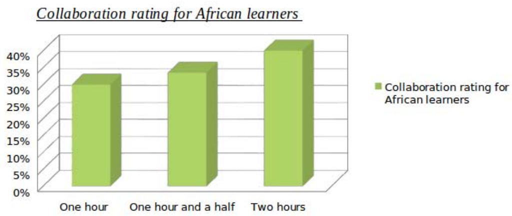


Fig. 7. Oucomes of our experiment

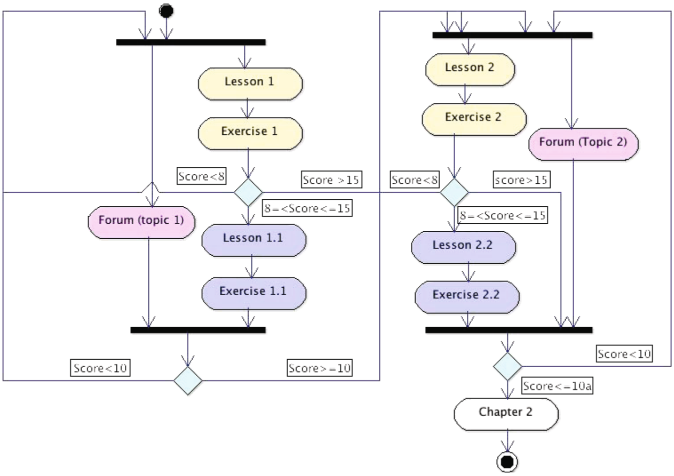


Fig. 8. Remedied Educational Scenario

4 Conclusion

We tried in this paper, to use automata formalism in order to model fractal educational scenarios.We, also, based on this theory to predict learners' behaviour by integrating pedagogical indicators so as to monitor different activities. The advantage of this study is the use of a rigorous formalism to describe a model of deployment that allows a better and more precise understanding of the planned scenario. It provides the designer with an analytical model that helps him to detect errors and learner's difficulties through test case generation and deductive verification. Finally, it creates an environment that simulates an external reality and learner's behavior. For going farther this first result, we are currently working on two direction: Firstly we want to analyse learners' tracks, extract from web log files, their corresponding automata and verify it with tutor's intention expressed in temporal logical formulas. Secondly, in order to assist tutor in coaching, we had to include to this interaction's model a higher level of indicators.

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Comparison of Students' Perception of Moodle in a Taiwan University against Students in a Portuguese University

Yao-Hua Wang[1,2,*], Yuen-Hsien Tseng[1], and Chi-Cheng Chang[2]

[1] Information Technology Center, National Taiwan Normal University, Taipei, Taiwan
[2] Dept of Technology Application and Human Resource Development, National Taiwan Normal University, Taipei, Taiwan
{wang,samtseng,samchang}@ntnu.edu.tw

Abstract. National Taiwan Normal University (NTNU) has implemented Moodle as the official, campus-wide Learning Management Systems (LMS) since 2009. In order to understand and investigate the level of acceptance of Moodle by students, we conducted surveys across the campus in January of 2012. This research will analyze the relationships between the students perceived of Moodle as well as the relationships in regard to its frequency of use. Data on the frequently used functions of the system by the students will also be analyzed. In order to explore further factors such as teaching method, department, and school policies that may influence the students' sense of utilization on the system, a case analyzing a contrasting student body from University of Minho, Portugal (UM), will be utilized to compare with NTNU's case. The results could act as a reference point for universities around the world that are trying to assess and promote LMS.

Keywords: E-Learning Platforms, Moodle, University, Distance education, Web-based Learning, Learning Management Systems.

1 Introduction

Learning Management System (LMS) has been developed and deployed for more than a decade. Some schools have taken costs into consideration, and therefore, they have looked into open-source LMS such as Moodle [1, 3].

In the recent research, the University of Minho (UM) in Portugal, explored in the perceptions and experiences of students in their use of LMS. In the UM, about 20% of students major in Management and Economics programs, and Engineering (36%), Law (14%), and Social Science (11.7%). A questionnaire was conducted by UM during the school year 2008-09 (around 876 questionnaires returned). The proportion of undergraduate students in the sample was 72%, the larger groups were in Management or Economics (40%), Engineering (31%), and Engineering (36%), Law

* Corresponding author.

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and Social Science (14%). On the contrary, fewer groups were in Science (6%), Arts and Humanities (2%), Education (3%), and Health Care (3%).

In Taiwan, National Taiwan Normal University (NTNU) used Moodle as their official platform since 2009. The majority of students from NTNU were in: Arts and Humanities (61%), in Science (19%), and in Technology (13%) [12]. NTNU has no business school, nor engineering school. Therefore NTNU has a different background from UM.

This continued study of blended education includes an in-depth comparison of the differences in setting up, and utilization of this program, in two universities from two completely different backgrounds (Taiwan and Portugal). The purpose of this paper is to (1) investigate NTNU's situation during the implementation of Moodle; (2) analyze the similarities and differences of utilizing Moodle by students of different backgrounds in NTNU and UM; (3) provide an in-depth discussion of the relationship between student's usage of Moodle and engagement by teachers. The research results could be used as a reference for universities to promote the Moodle LMS.

2 Literature Review

2.1 Blended Distance Education Model

In recent years, an increasing number of universities have set up various e-learning platforms. LMS is one of the most-used platforms to assist blended teaching model [9]. Studies have shown that distance education cannot be a complete substitution for traditional face-to-face teaching model [10]. The lack of face-to-face interaction between the teachers and students will most likely reduce the motivation of the students to learn. The blended learning model has been launched in university campuses to ensure students have the best of both worlds [9, 10, 14]; this model allows students to self-teach, without the restrictions of time and distance, and at the same time students enjoy the benefits of face-to-face teaching.

An effective way of learning is through communication in web-based learning environment. Communication and learning between peers help in critical-thinking and innovation. However, different types of teaching and learning methods exist in different courses in each department [8, 11]. Taiwanese students with low relative academic ability seem to benefit from a pedagogy that provides more structure and clear content delivery. On the other hand, individual learning is more highly valued in a Western culture [6]. Therefore, instructors in Taiwan are required to understand and be concerned about providing timely feedbacks and organizing in-class learning activities, taking into account potential social-cultural and learning theories. Pedagogical practices and operation measures such as education material compilation and class management should also be coordinated [9].

Technology Acceptance Model mainly investigates two factors: perceived usefulness and perceived ease of use, which most influence users' acceptance towards a new information technology. These two factors are the evaluations of people's beliefs towards performance and efforts. Understanding of the uses' perception is helpful to the university's evaluation of the implementation [4, 5, 13].

3 Research Questions

Based on the research objective described above, the following questions are to be investigated:

1. What are the most-used Moodle functions by the students and why?
2. What factors influences the students' perceived ease-of-use of various Moodle LMS features?
3. What is the students' perceived usefulness of the different features of Moodle LMS and why?
4. What is the relationship between the teachers' perceived usefulness towards LMS and the students' usage frequency?

4 Research Method

This research compiles a questionnaire based on Technology Acceptance Model (TAM) and a survey by UM [2]. A simple version of the questionnaire is listed in the appendix. On January 2012, the survey via email is conducted on students that have attended classes utilizing Moodle LMS in the semester . A total of 10,350 questionnaires are sent and 2073 (around 20%) responses are received. Using the SPSS statistics software, participation frequency and relationship between perceived ease-of-use and perceived usefulness are analyzed. The analysis is then compared with UM's result.

5 Results and Discussion

5.1 The Most Used Moodle Functions by the Students

Options answered with "Very often (weekly use)" for more than 50% of the sample includes "Download course materials" (62.0% very often and 27.1% sometimes), followed by "submit assignments" (58.2% very often and 28.5% sometimes) and lastly "check course announcements" (50.7% very often and 34.0% sometimes). These three options have over 80% with at least "sometimes" usage. It can be shown that students have a high usage of Moodle for downloading teaching materials, checking course announcements on a regular basis, and submitting assignments. Other options that are regularly used include "check course grades" and "check course syllabus and schedule".

The factor related to instructor is the efficient teaching method and course management. In order to improve student engagement, instructors must have good course management and pedagogical practices [9, 11]. Taiwanese students seem to benefit from a pedagogy that provides more structure and clear content delivery [6].

Our result shows that the NTNU students are frequently using Moodle to download teaching materials, assignment submission and checking course announcements. Therefore, it can be inferred that the instructors are actively uploading teaching materials, making course announcements, and posting assignments via Moodle. Moreover, the students are frequently checking their course grades and outlines. This may imply that instructors are actively providing feedbacks about the coursework and scheduling course outlines.

The students use “sharing files with colleague” (17.5% very often and 26.4% sometimes) and “Participating in forum discussions” (17% very often and 26.3% sometimes) with a total of more than 43% on “sometimes” usage. This shows that education is emphasizing on exchanging ideas with the colleagues, which benefits students’ critical-thinking skills and innovation [11]. Communication between students is the most effective way of achieving higher level of intellectual teaching method [8].

The frequency of the students using Moodle to “take quiz tests” (24.6% rarely and 38.6% never) or “Take course surveys” (35.4% rarely and 23.3% never) is low. Nearly half of the students never use Moodle to “participating in course chat room or virtual classroom” (57.7%) or “taking an online appointment with faculty” (51.8%). This shows that blended learning model allow students to self-teach, and at the same time cannot be a complete substitution for traditional face-to-face teaching model.

Frequency of using the different functionalities of Moodle is compared between the NTNU and UM’s students. Similarly for both schools, “download course materials” is the most frequently used functionality and the least used are “taking an online appointment with faculty” and “Participating in course chat room or virtual classroom”. The most significant differences between the two schools in terms of function usage are “sharing files with colleagues” and “participating in forum discussions”. NTNU has 43.9% with “often or sometime” but UM has 71.66% with “never” for “sharing files with colleagues”. For “participating in forum discussions”, NTNU has 43.3% with “often or sometime” but UM has 59.71% with never.

Comparing the data above, it is found that students from both universities give a good evaluation towards blended teaching but blended teaching is still unable to replace face-to-face interaction between students and teachers. The biggest difference in blended teaching of the two universities is NTNU students have been actively participating in forums and file sharing while UM students seldom utilize the two features. The frequency of NTNU students participating and utilizing Moodle is significantly higher than UM students, showing the teaching atmosphere and culture as the influencing factors. Moreover, there is official support for NTNU’s Moodle LMS, affecting the teachers’ willingness to use and students’ convenience to use.

5.2 Students’ Perceived Ease-of-Use

Investigation of perceived ease-of-use ranges across 5 levels, from 5 (best) to 1 (worst). All the questions are responded with acceptable satisfaction. The 3 highest mean values are “Ease in logging in” (mean = 4.47), “Ease in assignment submission” (mean = 4.40), and “Ease of access to materials” (mean = 4.02), followed by “Time required to learn the system” (mean = 3.78). The lowest mean value of the response is 3, corresponding to the ease in learning to use Moodle. This suggested that Moodle is a relatively easy to use system [7].

Comparison of NTNU and UM students' perceived ease-of-use satisfaction level, with both universities having "Ease in logging in", "Ease in assignment submission" and "Ease of access to materials" being their top 3 satisfied items, NTNU is most satisfied in "Ease in logging in" while UM LMS has "Ease in logging in" coming in third. However, UM's official LMS, Blackboard, has "Ease in logging in" rated first. It can be seen that the ratings are affected by the school's management, such as NTNU's policy of combining LMS with school information system, using a single sign on account.

NTNU has "Time required to learn the system" (satisfied level 75.6%) ranked at number 4 whereas UM has that item ranked at 7th. NTNU's ranked 7th item "Participation in forums" (satisfaction level 71%) is ranked 9th for UM. This has shown a relationship with the frequency of use for "Participation in forums". The perceived ease-of-use for "Participation in forums" of students from NTNU is higher than UM and relatively the frequency of use in forums is higher in NTNU than UM, thus proving the Technology Acceptance Model, perception of less effort to use raises the willingness to use the system.

5.3 Students' Perceived Usefulness

The three highest mean values in the analysis of perceived usefulness are "helps me find the information I need" (mean = 4.17), "serves mainly to download class Power Points" (mean = 4.14) and "has a positive impact on my learning" (mean = 3.99). Questions with lower mean values of agreement are "takes up a lot of my time" (mean = 2.64) and "allows me not to attend classes" (mean = 1.84).

Research shows that students prefer face-to-face teaching method and distance web-based learning provides convenience in obtaining teaching materials and assists learning. This corresponds to the conclusion that distance education cannot be a good substitution for classroom education [9, 10, 14].

The most frequently used functions are "download course materials"; "submit assignments" and "check course announcements". Perceived usefulness has the highest recognition for "helps me find the information I need" and "serves mainly to download class Power Points". Students agree that Moodle is an effective tool in assisting teaching and it allows convenience in acquiring information for personal usage, thus having a positive effect on learning. Research results have found that the more experienced the students are, the higher the satisfaction towards the ease-of-use, therefore the freshmen have the lowest satisfaction towards ease-of-use.

Comparison of the perceived usefulness agreement between NTNU and UM, has shown that for the item "serves mainly to download class Power Points" is ranked 2nd for NTNU (82.8% agreement) but ranked 6th for UM (70.4% agreement). Moreover, agreement for "is not enough to pass the course" is ranked 7th for NTNU (67.5% agreement) but ranked 3rd for UM (81.6% agreement). From these data, it can be shown that most NTNU instructors provide course materials on the LMS and guides students to download the course materials, allowing students to obtain adequate information. However, this is not enough to replace classroom teaching. Both schools has the least agreement in "takes up a lot of my time" and "allows me not to attend classes", especially "allows me not to attend classes". Results have shown that face-to-face on-site teaching still plays an important role in education.

5.4 Relationship between LMS Perceived Usefulness and Students' Usage Frequency

Reviewing a report in 2010 by NTNU investigating the satisfaction of teachers using Moodle, survey results have shown that 91% of the teachers use Moodle to place teaching materials, 77.2% hands out assignments, 74.7% post course announcements, and 47% uses the forum. This statistics corresponds closely to the distribution seen in College of Education and College of Liberal Arts. It can be deduced that teaching activities for humanities and social science courses utilizes the forum more.

The situation of students using Moodle is closely related to the teachers' participation and utilization of Moodle. Teachers from NTNU has a higher satisfaction about LMS than the students in organizing teaching materials, allowing courses to be more organized, convenience in teaching and increased student-teacher interaction. Most teachers will upload course materials, hand out assignments, post course announcements to improve the students' desire to learn and participate more actively [9, 10], thus creating a beneficial cycle of teaching and learning.

6 Conclusion

The research results have shown that Moodle is a suitable tool for universities performing blended teaching. The paper shows the case of NTNU's implementation of Moodle LMS to investigate the features most frequently used by students of different colleges. This comparison highlights the school's resources and support, teachers' willingness to participate, and recognition of LMS as the main factors triggering the students' willingness to use the system. Therefore, it can be inferred that the there exists positive relationship between the teachers' perceived usefulness towards LMS and the students' usage frequency.

Moreover, comparison with UM Portugal has shown that the major difference is the "communication" mechanism in teaching. This difference is due to the difference in culture and student background of both schools. NTNU utilizes more of the forum feature, sharing feature, and evaluation opportunity provided. Both schools have a significant difference in their usage of the online platform when it comes to blended teaching. The cause of the difference can be further investigated to be either cultural difference or teaching influence.

Finally, this investigation was limited by the motivation of students' learning. A number of possible future studies using the same structure to implement and promote LMS are apparent. In addition to the investigation of the tool's convenience, teaching strategy, user satisfaction, and teaching efficiency, the difference in cultural background and school environment between the West and East is another topic to be further explored.

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Appendix A

The following questions are to be investigated:

- Q1: My frequency of using functionalities in Moodle: 1. Very often (weekly use); 2. Sometimes (monthly use); 3. Rarely (below 5 times); 4. Never.

1) Download course materials (texts, activities, handouts); 2) Check course announcements; 3) Check course grades; 4) Check the course syllabus and schedule; 5) Submit assignments; 6) Check faculty and colleagues' contacts; 7) Take quiz tests; 8) Send emails to faculty or colleagues; 9) Take course surveys; 10) Taking an online

appointment with faculty; 11) Participating in forum discussions; 12) Sharing files with colleagues; 13) Participating in course chat rooms.

- Q2: I think the usability of Moodle are: (scale of 1 for ”worst” to 5 for “Best”)

1) Ease in logging in; 2) Ease in assignment submission; 3) Ease of access to materials; 4) Time required to learn the system; 5) Organization of materials; 6) Intuitive navigation; 7) Participation in forums; 8) Visual appearance; 9) Search tool; 10) Internal help tool.

- Q3: Student agreement with using Moodle: (scale of 1 for ”worst” to 5 for “Best”)

1) helps me find the information I need; 2) serves mainly to download class Power Points; 3) has a positive impact on my learning; 4) helps me keep up with the course work; 5) helps me organize my study; 6) helps me keep up when I miss a class; 7) is not enough to pass the course; 8) helps communicating with faculty; 9) helps with group work; 10) should be preceded by training sessions for students; 11) takes up a lot of my time; 12) allows me not to attend classes.

Igniting Students' Passion for Knowledge by Incorporating a Discovery Enriched Curriculum

Howard Leung[1], Zhifei Li[2], and Jianmin Zhao[2]

[1] Department of Computer Science, City University of Hong Kong, Hong Kong S.A.R.
howard@cityu.edu.hk
[2] College of Mathematics, Physics and Information Engineering,
Zhejiang Normal University, China
{lzf,zjm}@zjnu.cn

Abstract. One of the major challenges in tertiary education is to design the lectures such that students will be motivated to attend and get really interested which will ignite their passion for knowledge. For this regard, City University of Hong Kong has proposed to apply a discovery enriched curriculum (DEC) in developing teaching and learning activities to encourage students discover knowledge that is new to the students themselves. In this paper, we shared our experience about how the DEC was adopted in an introductory course on webpage programming to some freshmen students who had diverse technical backgrounds. Some webpage examples made by the instructor were used to stimulate students' interest. These examples were designed so that they were related to students' daily life to illustrate how things around them could be implemented in practice. The class has recorded a relative high attendance rate of around 75%. The relation between the average quiz marks and the number of lectures attended by the students was examined and the result indicated that the students who attended more lectures tended to obtain higher average quiz marks.

Keywords: discovery enriched curriculum, passion for knowledge, lecture attendance, experience sharing.

1 Introduction

In [1], Goldberg and Nagurka summarized from the literature about student centered learning methods: active learning, cooperative learning and inductive learning. The term discovery learning falls into inductive learning and there are various definitions in the literature. In general, discovery learning can be considered as a form of student-centered learning instead of the traditional way of focusing on the teacher side. Since 2012, our university has proposed a similar theme called discovery enriched learning with which students are encouraged to discover knowledge that is new to the students.

In order to carry out discovery enriched learning, one important factor to consider is how to increase the students' motivation to learn as echoed by the studies in [2] that "a major factor influencing academic success is about each student's motivation and

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willingness to engage in the learning activities". In this paper, we shared our experience in working towards this goal for a course that aims to teach freshmen students webpage programming. Various e-learning strategies have been proposed for teaching programming courses with different focuses. In [3], Watson *et al.* proposed to combine several forms of corrective feedback with concept visualization similar to games. In [4], Hwang *et al.* designed a web-based system to facilitate students' collaborative learning of programming. Vesin *et al.* built a learner model for a programming tutor system [5]. Regueras *et al.* studied the aspect of students' motivation in learning programming through a competitive learning scenario [6]. In our case, we designed a number of interesting demonstrating webpages to be shown to the students in the lectures to ignite students' passion for knowledge.

This paper is organized as follows. In Section 2, we will introduce the discovery enriched curriculum proposed by City University of Hong Kong as well as its supporting facilities. In Section 3, we share our experience of applying discovery enriched curriculum in an undergraduate course by specifically targeting ways to increase students' motivations to attend lectures by showing interesting and interactive example webpages during the lectures. We will also show our high lecture attendance statistics and its relationship to the average quiz marks indicating that students who attended more lectures tended to get higher average quiz marks. The conclusion and future work are described in Section 4.

2 Discovery Enriched Curriculum (DEC)

2.1 Discover&Innovate@CityU®

City University of Hong Kong has proposed to apply a discovery enriched curriculum (DEC) in developing teaching and learning activities since 2012. The goal of DEC is to let students make original discovery while they are studying in our university. Our university has a slogan Discover&Innovate@CityU® and a number of core competencies that we would like to nurture our students are listed in our university website (http://www.cityu.edu.hk/provost/dec/index.htm):

- experiencing what it means to create new knowledge;
- communicating, curating and cultivating new knowledge to benefit society;
- recognizing and protecting intellectual property that can be the basis for bringing new ideas to the marketplace;
- thinking from a global and collaborative perspective;
- capitalizing on technology and social networks;
- embracing a strong sense of social responsibility, sustainability, and ethics; and
- becoming life-long learners

2.2 Supporting Facilities

To support DEC, the Department of Computer Science and the Chief Information Officer at City University of Hong Kong has set up a few special designed classrooms called DEC labs. One of our DEC labs is shown in Fig. 1. In a DEC lab, the chairs are equipped with wheels that facilitate students moving them around to form groups quickly. Writing surfaces are mounted on the walls so that students can brain storm, take notes and communicate effectively. The DEC lab is also equipped with many notebooks and tablets so that each student can use them during the class to stimulate their learning. There are multiple TVs that can be connected to notebooks or tablets so that each group can visualize and share their work.

Fig. 1. DEC lab

3 Experience Sharing

3.1 Course Delivery

The first author taught an undergraduate course about webpage programming during the 2nd semester of the academic year 2012/2013. The students were year one freshmen who had quite a diverse technical background as some students may have taken some courses on information communication technology during their secondary school, while other students may have no technical background at all. As a result, it is quite a challenge to design the course materials to cater for students with such diverse background. At City University of Hong Kong, there are 13 weeks of classes in one semester. For this course, lectures were provided in the first 10 weeks to cover the course materials. Students took a quiz at Week 11 and gave their project presentations during the last 2 weeks of classes. The pedagogy activities during this period were summarized in Fig. 2. In the class taught by the first author, there were 133 students, with about 26% male and 74% female. Among the students, about 88% were local students and 12% non-local students who came from different countries.

For the technical components of the course, it is important for students to attend the lectures in order to learn the fundamental concepts especially for students who did not have any technical background. However, this is a university course so we do not make lecture attendance compulsory because we want our students to have self-discipline. As a result, it is important to maintain students' motivation to come to the lecture. In this course, the instructor showed the students some interesting demonstration webpages made by the instructor himself so that students would feel fun and be convinced that they could implement something by themselves. The interaction between the teacher and the students is illustrated in Fig. 3.

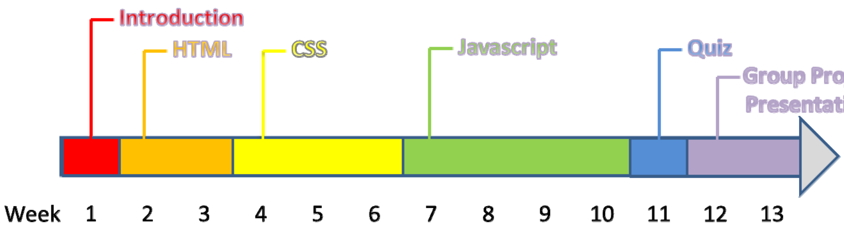

Fig. 2. Pedagogy activities during the 13 weeks of classes

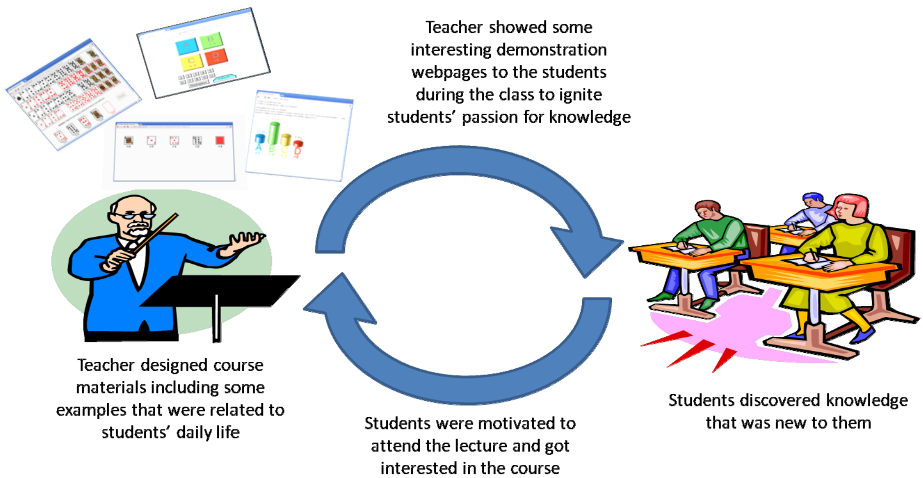

Fig. 3. Interaction between teacher and students

Magic Trick. During the first lecture, the instructor who is the first author of this paper performed a magic trick to stimulate the interest of the class. In selecting the magic trick, the instructor had made some considerations because he did not want to show a common trick that students most likely had seen it before. Rather, the magic trick to be shown should make students feel that it is non-trivial. Besides, it should be related to the course. As a result, the instructor had created a webpage that helped the magic performance. During the magic performance, the instructor first asked 6 volunteers to come out to the front. 5 of the volunteers were asked to randomly draw one card from a deck and were told not to reveal it to the instructor. The 6th volunteer was instructed to mute/unmute the projector. After each of the 5 volunteers drew a card, the instructor went up at the audience stage and then asked the 6th volunteer to mute the projector so that the audience cannot see the output of the computer. At this time, each of the 5 volunteers who drew a card was asked to input their card on the webpage shown on the computer by dragging-and-dropping the corresponding image to the target rectangle as shown in Fig. 4. After all the 5 cards had been input by the volunteers, the webpage was updated by showing the cards with face down (thus hidden) in a different order. The 6th volunteer was asked to unmute the projector so that the audience including the instructor could see the webpage. The instructor asked 4 of the volunteers to reveal the cards according to the order shown at the webpage as shown in Fig. 5. At this point, the instructor declared that he knew the 5th card and spoke out loud to the class that it was ♥6. The last card on the webpage was revealed which was exactly what the instructor had predicted. The audience was pretty amazed by the performance and it certainly caught their attention. In fact, this trick was Fitch Cheney's 5 card trick but very few people had seen it before. This magic performance helped demonstrate some of the webpage programming concepts such as array, displaying image, drag-and-drop etc.

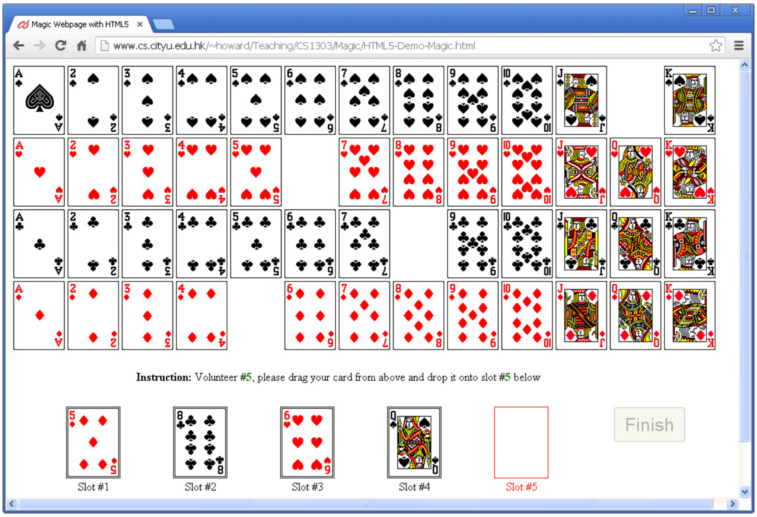

Fig. 4. Initial webpage of the magic trick demonstration

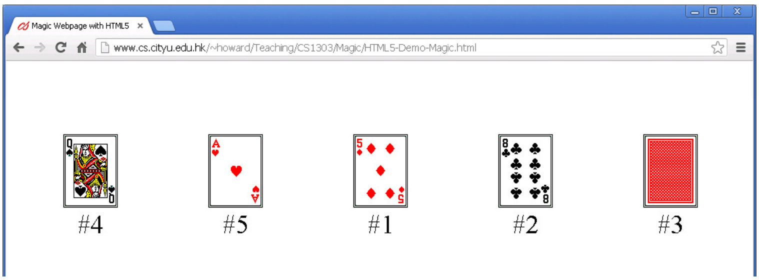

Fig. 5. Final webpage of the magic trick demonstration

Survey Webpage. When the instructor introduced the parameter passing between webpages and canvas elements in HTML5, he created a survey webpage to illustrate these concepts. The demonstration of the survey webpage is shown in Fig. 6. The students were given the link of the webpage and were encouraged to complete it with their own mobile devices. On the survey webpage, the students were asked about how many hours per week they would spend for this course. There were 4 choices with which students needed to click on the corresponding areas to make a choice. Afterwards, students needed to enter the last 5 digits of their student ID which was used to check whether duplicate entry had been previously entered. The webpage would then be updated to show the survey statistics in the form of a 3D chart as shown in Fig. 7. In fact, local television programmes often asked the audience different questions and asked them to provide their choice via their mobile phone. The resulting statistics were revealed towards the end of the television programme. As a result, the instructor mimicked this action so that 1) students would feel that it is more related to their daily life as they had seen it often; and 2) the instructor could demonstrate that visual artifacts seen by students during their daily life could be implemented using the techniques learnt in the class.

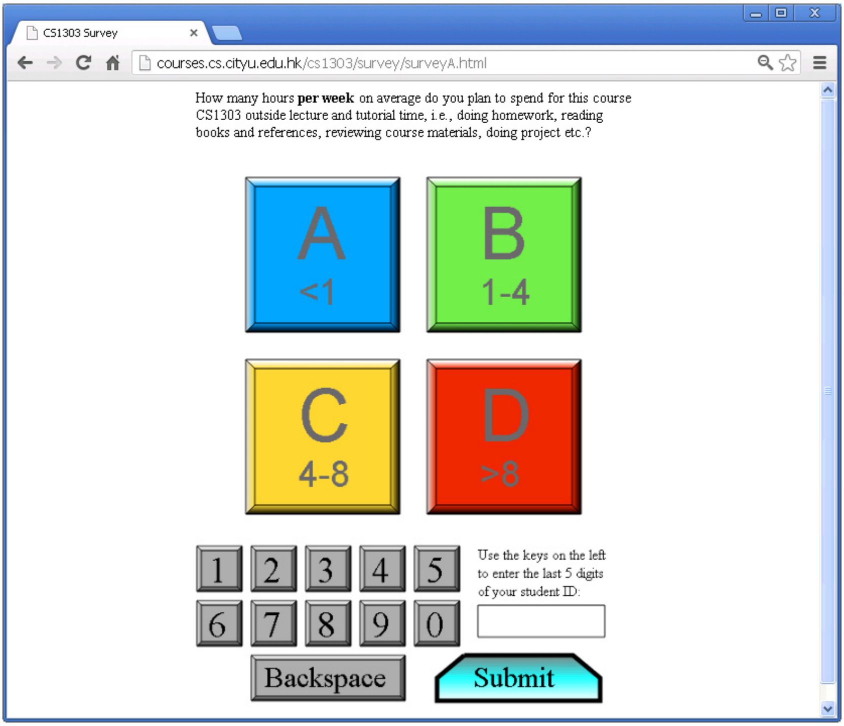

Fig. 6. Initial webpage of the survey webpage demonstration

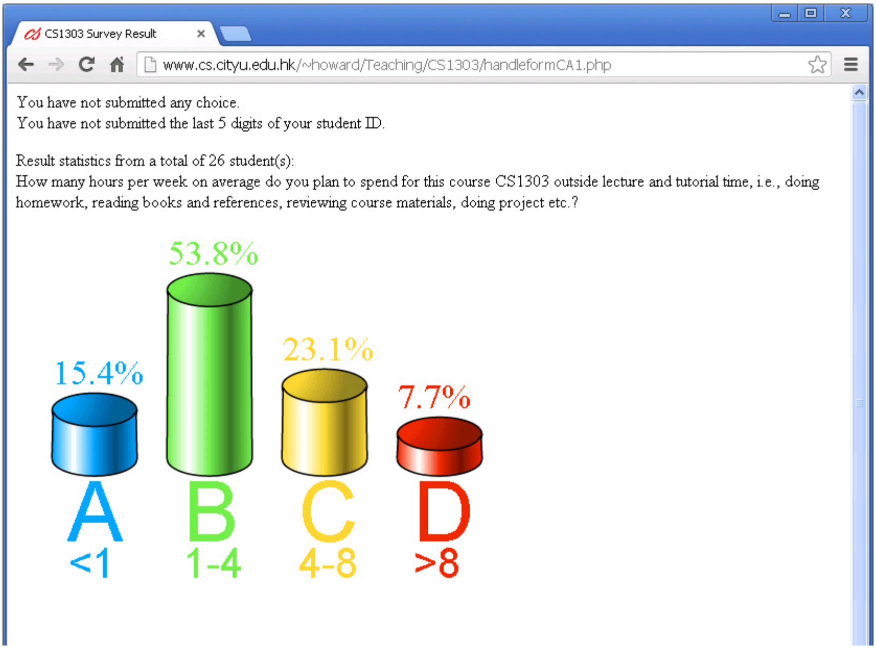

Fig. 7. Final webpage of the survey webpage demonstration

Photo Viewer Webpage. After the instructor introduced all technical parts on HTML, CSS and Javascript, he made a photo viewer webpage and used it to demonstrate the related concepts. A snapshot of the photo viewer webpage is shown in Fig. 8. Upon loading, the main photo is shown in the center which will be updated to show the next page in every 2 seconds. The control buttons are placed at the bottom of the main photo with which the user can go to previous photo, next photo, first photo, last photo as well as enable/disable autoplay feature. Some thumbnails of the photos are shown below the control buttons. When there are many photos, the user would know that there are many pages of thumbnails and can be accessed by clicking the corresponding buttons to go the previous/next page. When the webpage is resized, the content is also resized to make sure that the user can view the whole main photo. Using this example, the layout techniques with CSS about the photo and thumbnail placements were demonstrated. Besides, the buttons and the event handling by Javascript were also applied. Nowadays students spent quite a lot of their time viewing photos due to the availability of the mobile devices and this photo viewer webpage demonstrated how such application can be implemented in practice.

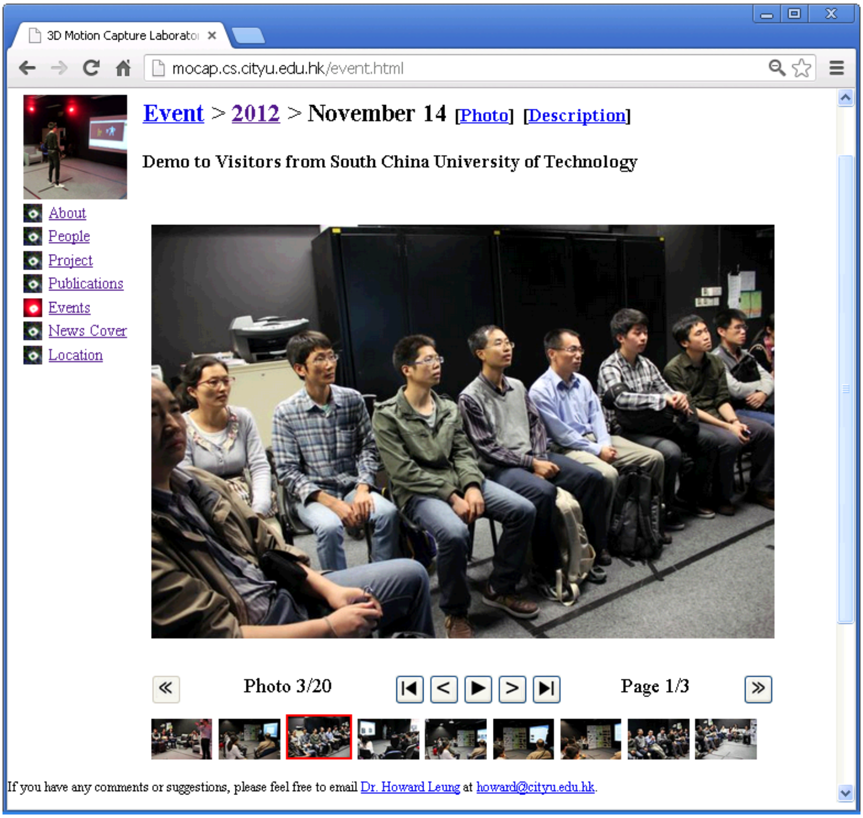

Fig. 8. Demonstration of photo viewer webpage

3.2 Students' Lecture Attendance

As mentioned in Section 4.1, there are 13 weeks of classes in a semester at City University of Hong Kong. Every week a two-hour lecture was given to the students from Week 1 to Week 10 to teach about the course materials. Students had a 10-minute break for every hour of lecture. For the course materials, a brief introduction on the internet was first given, followed by 3 main technical parts: HTML, CSS and Javascript. The attendance of the students was taken during each lecture. The statistics of the students' lecture attendance were collected and shown in Table 1. It can be seen that around 31% of the students attended all 10 lectures and about 17% of the students attended 9 lectures. These two groups constituted the largest two percentages of students among all groups. From the statistics, the average number of lectures that students attended was found to be 7.44 (thus an attendance rate of around 75%). This is considered as a high attendance rate since this is an undergraduate course in which attendance is not compulsory.

Table 1. Students' lecture attendance statistics

Number of lectures attended	Percentage of students
0	1.50%
1	1.50%
2	1.50%
3	6.02%
4	6.02%
5	6.02%
6	10.53%
7	9.02%
8	10.53%
9	16.54%
10	30.83%

3.3 Relation with Students' Quiz Marks

A quiz was conducted at Week 11 to assess students' knowledge about the course materials. The quiz consisted of 30 multiple choice questions in which students need to select the best choice out of 4 options. The students were given one hour to complete the quiz. Students will get one mark for each correct answer and no marks will be deducted for wrong answers. After grading, the average mark of the quiz was found to be 15.44 (out of 30). We analyzed the relationship between the average marks among students attending different number of lectures which is shown in Fig. 9. As shown in Section 3.2, the percentage of students attending 0-3 lectures is relatively small so they were grouped into one category when the average quiz marks was calculated. The average quiz marks for other categories, i.e., for students attending 4-10 lectures, was calculated separately. It can be seen in Fig. 9 that there was a positive trend for the quiz marks when students attended more lectures. The trend became stabilized when the students attended at least 8 lectures.

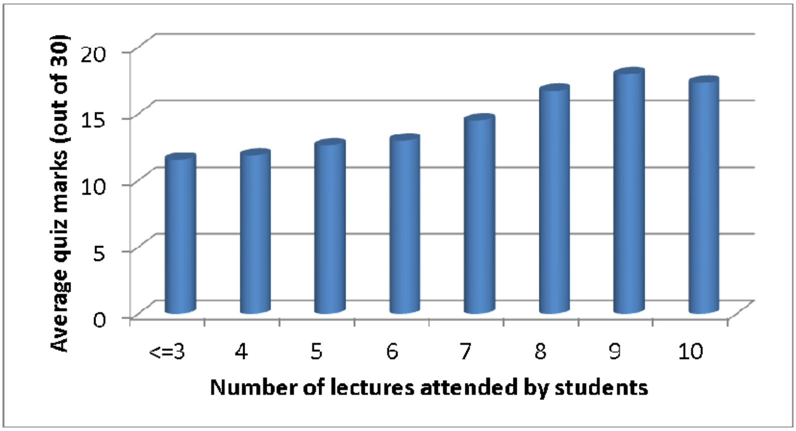

Fig. 9. Average quiz marks versus number of lectures attended by students

4 Conclusion and Future Work

Since 2012, City University of Hong Kong has proposed to apply a discovery enriched curriculum (DEC) in developing teaching and learning activities to encourage students discover knowledge that is new to the students themselves. The DEC was adopted in an introductory course on webpage programming to some freshmen students who had diverse technical backgrounds. In this paper, we shared our experience in using some webpage examples made by the instructor to stimulate students' interest. These examples were designed so that they were related to students' daily life to make them feel more attached. This would ignite their passion for knowledge and motivate them to come to the lectures. The class has recorded a relative high attendance rate of around 75%. In addition, the relation between the average quiz marks and the number of lectures attended by the students was examined. The result indicated that the students who attended more lectures tended to obtain higher average quiz marks.

In the future, we will design some questionnaires to be completed by the students to investigate the effectiveness of DEC from the students' subjective evaluation. In addition, other strategies for applying DEC to make teaching and learning more effective will be explored. For example, we will figure out ways for making full use of all the available resources in the DEC labs. Besides, we will study how the experience can be applied in teaching other courses.

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Initial Design Principles for an Educational, On-line Information Security Laboratory

Sarfraz Iqbal and Devinder Thapa

Department of Computer Science, Electrical and Space Engineering
Luleå Tekniska Universitet, Luleå, Sweden
{sarfraz.iqbal,devinder.thapa}@ltu.se

Abstract. E-Learning systems should be based on systematic pedagogical approaches and well-designed procedures and techniques. However, current literature on several areas of technology-enhanced learning environments, such as online information security (InfoSec) laboratories still lack well-specified pedagogical approaches and concrete design principles. In information security education, hands-on lab exercises play a major role in learning. Distance education brings in new challenges as the hands-on exercises require now virtual labs, which need to be accessible anywhere and often also anytime. This creates technological and pedagogical challenges, which are not fully understood in terms of explicit design principles that would enhance implementation and use of on-line educational labs. To contribute to this knowledge gap the paper describes five initial design principles: *contextualization, collaboration, flexibility, cost-effectiveness, and scalability*. The principles are based on a literature review, contextual interviews and observations at a European University. The initial concretization of the principles adopts the pedagogical approach of Personalized System of Instruction (PSI), which is deemed to represent a good fit to the contextual goals for developing on-line security labs in the context of the target university. Further research for actual design of virtual InfoSec labs, adopting the action design-based research tradition to develop learning environments, is needed in order to concretize, to test and to elaborate these design principles.

Keywords: Design Science Research (DSR), Online Information Security Lab, Design Principles, E-learning platform.

1 Introduction

To match the benefits with traditional learning environments, a successful e-learning system must be designed and constructed carefully, based on well-grounded pedagogical principles and robust design guidelines [1]. In the field of information security many courses provide little hands-on practice that can be applied to thoroughly securing real world applications from various threats that exist today [2]. Similarly, the lab experiments are often not available to distance students that represent a critical challenge in offering an online information security program which is considered to include plenty of hands-on practices in addition to theoretical lectures [3].

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E-learning must be rooted in systematic pedagogical approaches in order to make it effective [4]. Furthermore, the importance of creating a link between theory and practice in order to design and develop an instructional system is also emphasized [4, 5]. However, effective design is possible only if the developer has a reflexive awareness of the theoretical basis underlying the design [6, 7]. To contribute to the similar research strand, the paper proposes initial design principles to design, develop, implement, and test e-Learning platform for information security. The example of information security laboratory is used to explain the systematic process; however the actual installation of the lab will be reported in the future papers.

The rest of the paper is arranged as follows. The next section provides overview of theoretical framework based on Action Design Research (ADR) method. Section 3 summarizes background and problem formulation. Section 3.1 briefly describes the selected pedagogical approach. Furthermore, we discuss the contribution of the research work in section 4. Finally, Section 5 concludes the paper with future research agenda.

2 Design Research for Developing an e-Learning Platform for Information Security Labs

Existing literature shows that most of the literature is focused on the technical implementations of labs, whereas, ignored the pedagogical elements of the curriculum and rationale behind them [8]. It leads to improper guidance about how the instructor and the learner can make use of the platform. There are a few examples of using design science in developing e-learning platforms, such as Cybernetic e-Learning management model applied to a (case study of BMW group) [9], Business Process Management e-learning program [10], user defined and controlled virtual learning environment [11], and Synchronous e-learning [12]. In addition, a didactical framework for the design of blended learning arrangements is proposed with a focus on identifying the right blend for the communication component in the context of a distance education program considering expenditures [13].

However, these frameworks cannot be generalized based on the fact that different stakeholders evaluate communication tools and scenarios differently. Tel and Thomas [14], analyzed technology as a process and as a value-laden system arguing that design-based research can address some of the deficiencies of other research methods in investigating the role of tools and techniques in the classroom to impact educational practice. Our research adheres to the similar stance where general absence of methodically designed online InfoSec labs is evident.

Keeping in view the strategic objectives and practical demands of the future related to provision of hands-on exercises in different courses in InfoSec program a road map in the form of initial design principles to develop a security lab is proposed. The paper will use an example of InfoSec lab to describe the laboratory building, intervention, and evaluation process.

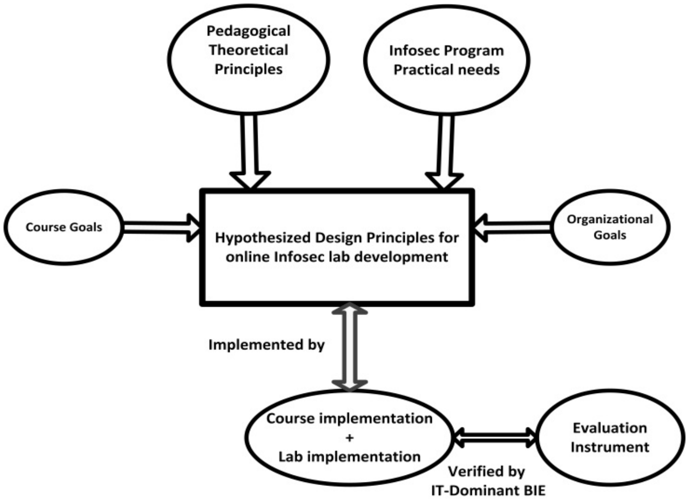

Fig. 1. DSR based Framework for development of e-Learning platform

As shown in the figure-1, the technological, pedagogical, and organizational goals interact during design of e-learning platform (online InfoSec lab). The platform in this context is conceptualized as an ensemble IT artifact [15], because the design outcome is a result of emergent perspective on design, use, and refinement in the actual context. As suggested by [16] and looking at the emergent nature of the platform, the framework suggests employing Action Design Research (ADR) method for laying the roadmap. ADR is a typical design research method representing the view of continuous stakeholder participation in the research project [17]. At the same time, different stakeholders examine the propositions iteratively together with researchers to define and redefine options for the design.

ADR is defined as a research method which generates prescriptive knowledge through building and evaluating ensemble IT artifacts by addressing a problem situation encountered in a specific organizational setting through intervention and evaluation. Moreover, ADR method emphasizes on the development, intervention and evaluation of an IT artifact which also imitates theoretical grounds. Contrary to the traditional design research methods, ADR promotes design and development of IT artifacts based on the organizational context. For example, this research is motivated by an ongoing initiative to design and develop an online InfoSec lab at the University to address the contextual needs of the Msc Information security program.

After clarifying the contextual issues, the hypothesized design principles will guide the initial development of online InfoSec lab based on problem framing and theoretical premises adopted in stage one e.g. InfoSec program's practical needs, course goals, organizational goals and the pedagogical principles laid down based on a kernel theory will inform the initial design theoretically.

Going along the ADR process, the next stage starts with the BIE (Building, Intervention and Evaluation). Two different types of BIE processes are identified in ADR (1) IT-dominant BIE, (2) Organization dominant BIE [17]. The IT-Dominant BIE process supports the continuous instantiation and testing of emerging artifact as well as the theories ingrained in it via organizational intervention subject to the assumptions, expectations and knowledge of the participating members. The organization dominant BIE deploys the artifact early in the organization in the design iterations where ADR team challenges organizational participant's existing ideas and assumptions regarding artifact's specific use context to improve the design.

In this context, the framework suggests the IT-Dominant BIE process [17] for online information security lab development. The lab will be implemented in different courses for some specific exercises which could be based on a variety of pedagogical approaches in order to achieve pre-defined course objectives via testable propositions (cf. Gregor &jones, [18]). The testable propositions will be guided by hypothesized design principles.

Thereafter, an evaluation instrument will be designed in order to have authentic and concurrent evaluation of the implemented design (evaluation details will be reported in the future work). Evaluation is a crucial [19] and significant activity [20] which plays central role in conducting rigorous Design science research. Evaluation puts [21] the science in Design Science by examining its research productions because without evaluation there is no surety that the designed artifacts will work in a useful manner to solve some problems. A research stream [9, 19, 21, 22, 23, 24] suggests that Design Science Research projects should establish a clear evaluation strategy through an evaluation constituent of their Design science research which will explain the questions of what to evaluate, when to evaluate and how to evaluate. The evaluation methods will unfold the rigor hidden in the utility, quality and efficacy of a designed artifact [19].

The evaluation strategy in aforementioned project should be based on the following two purposes in order to evaluate product artifact (online InfoSec lab) and relevant process artifact (methods, procedure to accomplish some tasks) [21]:

- Evaluate a designed artifact formatively to identify weaknesses and areas of improvement for an artifact under development.
- Evaluate an instantiation of a designed artifact to establish its utility and efficacy (or lack thereof) for achieving its stated purpose.

3 Background and Problem Formulation

To illustrate the systematic process of building and implementing InfoSec lab, we present a case of a European University. The Luleå Tekniska University lately noticed an increase in the number of distance students who want to study Msc in Information Security. Most of the distance students are professionals who also want to work and practice their study individually at times and in places which suit them. As the university stated in its vision and strategy of 2020, "Our programs are conducted on the campus and as distance courses, and we work for flexible learning that makes use of modern technologies. Independent, active learning that challenges every individual's capacity to meet the future." Likewise, the interviews with the management personnel and perusal of the strategic planning documents of University helped to obtain a clear organizational perspective regarding research and education at Computer and systems science department. In addition to the above mentioned strategic objectives and visions the management is also interested in finding ways to address the following issues:

- How to increase the student throughput in different courses of the program?
- How to facilitate flexible learning?

As a process of program improvement in the department of computer and systems science, we planned interviews with all the staff members (teachers) involved in teaching different courses in Msc Information Security program and the program management (to obtain the organizational perspective). One of the authors of this article conducted interviews (semi-structured open ended) with the teachers and the management to gather details about their teaching experience in the field of information security as well as focusing on the practical needs of the degree program. The interviews included discussions on issues such as:

- Instructional strategy, or tactics for teaching
- Need of any specific pedagogical approaches for teaching InfoSec courses
- Major challenges related to teaching courses in InfoSec education program
- Use of any lab for hands on education in information security
- Practical demands of the Information security degree program
- Challenges related to practical needs of the program
- Suggestions for the program improvement

The results of the interviews with the teachers showed that most of them don't follow any specific pedagogical approach or instructional strategy. They are not using any InfoSec lab for practical work in different courses of graduate program, although they assign students different exercises to conduct at their own computers. The students were unable to practice their security skills practically due to the fact that an InfoSec lab is not available at the moment. This fact was also highlighted by the comments given by some of the participants where they stated that there was a gap between the theoretical and practical aspects of the program as the program focused more on the theoretical aspects while not focusing on practical skills at large. The focus of the program has been on management related theoretical issues in the past but now there are plans to address the technical aspects of information security through changes in different course structures. Almost every participant showed interest in the development of an online InfoSec lab to facilitate students regarding practical work in different courses.

The interviews revealed that the university in general and the systems science department in particular, want to improve the graduate program of information security in a systematic manner. To achieve the objectives, the following action plan is set forth:

- To develop an effective and meaningful E-learning program for the distance as well as campus students.
- To introduce an online InfoSec lab for the students where they can practice their security skills flexibly from distance according to the practical demands of the course.

The interviews with teachers as well as program committee suggests that an online InfoSec lab based on explicit pedagogical principles should be developed in order to facilitate students to practice their security skills and also to maintain a balanced situation between the theoretical and practical aspects of the degree program in information security. To address this issue, a literature review is conducted in order to understand the design principles related to online InfoSec labs and how the knowledge regarding design and development of such labs has been communicated to the community (see table-1 and ref[8]). The sample of articles mentioned in table-1 was further scrutinized in order to answer the questions; such as does the existing literature provide any explicit design principles for online InfoSec lab development? What type of pedagogical model, learning theory or scientific method has been used for the development of online InfoSec lab to conduct hands-on education?

Table 1. Literatur review for Design Principles, Pedagogy, Learning theory and Scientific method

Ref No.	Design Principles		Pedagogy	Learning Theory	Scientific Method
	Implicit Focus	Explicit			
[26]	Provision of hands-on practice for security mechanisms	-	-	-	-
[27]	Provision of hands-on practice for computer security and system administration.	-	-	-	-
[28]	A platform to experiment in a networked environment.	-	-	-	-
[29]	Remotely accessible Laboratory teaching environment.	-	-	-	-
[30]	Providing hands-on practice to students	-	-	-	-
[31]	Logical isolation of networks for experimentation	-	-	-	-
[32]	Improve student's access to University resources	-	-	-	-
[33]	Virtual computer lab for teaching online IA classes	-	-	-	-
[34]	Providing remote user access to computing resources	-	-	-	-
[35]	Feasibility of Virtual security lab for distance education	-	-	-	-
[36]	Centralized remote lab services	-	-	-	-
[3]	Remote lab for IDS/IPS education programs	-	-	-	-
[2]	Building a research application that mimics fully functional online bookstore	-	-	-	-
[25]	Developing a portable virtual laboratory	-	CLS	-	-

The review shows that there is a lack of systematic approach in design, development, implementation, and evaluation of InfoSec lab. Likewise, none of the articles studied provides any details of lab development that is based on design science principles [8, 18]. The review shows the gap of knowledge in the field of design and development of online InfoSec labs. None of the articles studied for review purpose (table-1) demonstrated any explicitly described design principles based on a specific design research method. The review also shows the lack of any pedagogical model, learning theory and scientific method trailed for the design and development of online InfoSec laboratories. Only one article [25] adhered to an explicit pedagogical idea, the cooperative learning strategy. The general absence of scientific methods shows that the systematic development has not been adopted leaving a gap between theory and practice related to the development of e-learning platform for hands-on education of information security. To contribute to this gap we propose that the lab design and development should be based on the design principles in order to truly communicate, justify and accumulate knowledge in the field of hands-on education of information security.

3.1 Pedagogical Approach to Support Problem Formulation

Based on the problem formulation stage the second stage of ADR leads to building, intervention and evaluation (BIE) of InfoSec lab as described in section-2. As we argued that the InfoSec lab should be based on pedagogical approach; in this context, looking at the course goal and students' requirement, such as individualized flexibility, personalized system of Instruction (PSI) [37] can be utilized as pedagogical approach. PSI is considered a pedagogical approach which can help to develop individual and flexible learning environments. The PSI approach enhances individualized learning by facilitating the students to learn and advance in their studies at their own pace. The distinct features of PSI are:

- Division of course content into smaller modules / units
- Flexibility (study at your own pace)
- Mastery of the course unit / module
- Use of Teacher, Assistant / Proctor

The objective of the InfoSec lab is to provide students with individual and flexible learning environment for hands-on practices in a course of "Information Security". The pedagogical approach however can be varied in various situations. In this paper, the approach is suggested in light of the contextual factors such as organizational goals, course goals, practical needs of the InfoSec program obtained through perusal of organizational policy documents, observation and interviews with program management and teachers.

4 Design Principles

The paper explains how the research regarding the actual design, development, implementation and maintenance of e-learning platform in general and InfoSec labs in particular should be conducted; as we want that the research should be based on a systematic process. The researchers in the field of design research should be responsible to create standards that make design experiments recognizable and accessible to other researchers [38]. The research approach selected here is coherent with [4] that e-learning in information security should be based on a theory-into-practice framework that characterizes the instructional implications of situated cognition and guides the design of e-learning. Developing such a model for e-learning purposes emphasizes on the interaction between pedagogical models, instructional strategies and learning technologies to facilitate meaningful learning and knowledge building. We concur. To contribute to this argument we conducted interviews, observations, literature reviews, and reflected on the pedagogical approach i.e. PSI. Consequently, we derived five design principles (see table 2), in which, principle 1 and 2 along-with ADR principles provide guidelines for the design and development (research process) of the InfoSec lab, whereas, principle 3, 4 and 5 are the principles of InfoSec lab itself that help to derive attributes for the lab. The design principles are discussed as follows.

Table 2. Initial Design principles for Online-lab development

Design Principles	Impact
Contextualization	Organizational Goals, course goals, Teacher goals, constraints, requirements
Collaboration	Researcher (acts as Instructional designer), Practitioners (Developer, IT staff) End users (Teachers, proctor, Students)
Flexibility	Remote access to lab resources Lab Should be accessible to students 24x7.
Cost-effectiveness	Optimal resource allocation
Scalability	Lab can be upgraded and easily modified based on practical requirements of different courses.

Design Principle #1: Contextualization

The principle #1 refers to the contextual factors that we need to consider while building and implementing InfoSec lab based on PSI principles, such as organizational goals (To implement hands-on exercises for distance students, flexible learning), course goals (To improve student's practical knowledge level, provide students individual hands-on exercises) teachers' goals (Efficiency in terms of consuming less time than traditional teaching method with the help of an Assistant / Proctor), resource constraints (available funding) and practical requirements. Contextualization provides meaning to goals and communicates the means for interpreting the environment where the activity takes place [39].

Design Principle #2: Collaboration

The principle #2 refers to the collaboration among researcher, practitioner, and end users to design and develop effective artifact. This principle also contributes to principle #1 in defining the context. By applying ADR collaboration among the community (e.g. researchers, developers, administrative staff, teachers and students) can be promoted. The ensemble artifact in this way will emerge through an interdisciplinary and collaborative effort of experts from different fields [40].

Design Principle #3: Flexibility

The principle #3 based on PSI approach refers to the remote access to lab resources, for instance lab should be accessible for experiments from everywhere any time in order to facilitate the students who are professional, want to work individually and cannot work under a strict schedule (go at your own pace). Most of the literature reviewed (see table-1) implicitly focused on provision of flexibility such as remote access to students. Technologies like virtualization can be applied to provide remote access to multiple single-user & multi-user computer systems and multiple virtual machines [35]. The flexibility principle in this case also refers to the configuration of the information security lab based on the particular context. As we can see the context can be understood through applying principle #1 and #2.

Design Principle #4: Cost-effectiveness

The principles #4 refer to the availability of resources, such as fund, technology, and human skills. Existing literature on InfoSec labs demonstrates that virtualization technologies such as VNC Server, VNC client, VMware workstation, VMware server, Vlab Manager, VPN Concentrator, Virtual center, Apache Virtual Computing lab, Microsoft HyperV, Xen, and VMLogix Lab Manager [27,33,34,36] are considered an important element of InfoSec labs which provide such benefits as lower hardware cost, increased deployment flexibility, simplified configuration management, customization of software & hardware resources, increased accessibility of computing resources, system administration and ease of isolating the virtual networks [28,30,32,34]. The existing solutions, such as virtualization technologies can be utilized to make the lab more cost-effective. Existing researches support this principle by stating that the configuration costs of Virtual labs are far less expensive compared to physical labs [35].

Design Principle #5: Scalability

The principles #5 refers to the scalability, which depends on factors such as need to extend the lab resources if more students than expected appear in a course, lab upgradation based on introduction of a new and better technology etc. As the observation shows that the information security graduate program is getting popular and the number of students is increasing. To accommodate this influx of the student, scalability of the lab facility should be considered while building, intervention and evaluation of the lab. For example, If there are 30 students in a class and they will work with exercises individually (based on PSI approach), the setting of lab resources will be different from a situation when they are working in groups of 2 or 3 students. Virtualization technologies help to make virtual lab easily scalable compared to physical lab [35].

5 Conclusion

The main objective of this paper is to promote research based hands-on teaching in the field of information security which will not only benefit the university to have an experienced research based group of teaching staff members but also will help the academic community by continuously adding new information based on educational experiments and experiences with online InfoSec labs. In a longer run, attempting to achieve a full fledge design theory in the field of hands-on education through online InfoSec labs should be the goal as design theories also helps to provide prescriptions for the development of specific applications. It is generally accepted that "Ultimately a full design theory is often seen as the goal of design research and the key exemplars develop full theories" [41].

In this paper the review of the prior research and preliminary interviews with teachers and program management on the development of online InfoSec labs lead us to formalize five design principles: *contextualization, collaboration, flexibility, cost-effectiveness, and scalability*. These initial design principles will guide the research process which will ultimately help us to achieve a refined set of emergent design principles.

The paper intended to implement online InfoSec labs for hands-on education in information security. While implementing the lab hypothesized design principles will be tested through testable proposition that will help to validate instructional applications in different perspectives. The lab will be designed and developed in Luleå University that offers an MSc Program in Information Security to both on campus and distance students since 2007. This is our agenda for future research.

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An Interactive and Personalized Cloud-Based Virtual Learning System to Teach Computer Science

Jing Zhao and Babak Forouraghi

Computer Science Department, Saint Joseph's University, Philadelphia, PA 19131
{jz570129,bforoura}@sju.edu

Abstract. Virtual learning environments (VLE) provide up-to-date education and training for individuals, and in some cases they can generate personalized feedback based on the learner's performance. Unlike other VLE's available to-date, the learning system developed in this work extends the basic instructional and assessment capabilities of a typical VLE by dynamically creating a cloud-based computer laboratory that is needed by Computer Science students. Specifically, the basic capabilities of Moodle are enhanced by developing two new modules: a virtual lab module (VLM) and a study progress module (SPM). VLM utilizes Amazon's EC2 cloud-based web services technology in order to create a personalized experimental environment especially suited for Computer Science students although the same concept can easily be applied to other disciplines. SPM, on the other hand, evaluates student progress in terms of specific learning objectives and offers personalized guidance using the Apriori data mining technique. An implemented cloud-based Internet Application Development laboratory highlights the advantages of the proposed approach.

Keywords: Apriori data mining, Amazon AWS, Moodle, Virtual Learning System, Cloud-Based Learning.

1 Introduction

Online learning management systems (LMS) have been rapidly developing over the recent decades and are widely used in academia as well as in industry [1-4]. LMS is not limited only to organization and delivery of course content via tools such as lectures, videos, exams, and assignments, but it can also be designed to interact with the learners and provide personalized tutoring and guidance based on the learner's performance [2, 7, 9, 11].

Virtual learning systems are subject of much active research in the area of online education, but an interesting phenomenon that only recently has begun to influence these systems is the exponential growth of cloud computing [6, 8, 12]. Specifically, cloud computing refers to a type of web service that allows users to share computing resources, be it hardware or software, over a network. The fundamental type of service supported by a cloud can roughly be categorized as platform as a service (PaaS), software as a service (SaaS), or infrastructure as a service (IaaS) [10]. In the PaaS and

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SaaS models, the cloud environment offers computing platforms or software systems as service, respectively, whereas in the more complex IaaS model (e.g. Amazon EC2) the cloud providers actual virtual machines in addition to all other resources available in other models [12]. The success of cloud computing in distance learning relies on the fact that it can free the designers and administrators of learning systems from challenges and limitations associated with IT infrastructures in traditional brick-and-mortar institutions such as the setup and maintenance of reliable networks, web and database servers, and storage services [8].

Although applications of cloud computing in distance learning are increasing at a rapid pace, the cloud itself is mostly under-utilized as a simple PaaS or SaaS host in the learning environment. For example, an e-learning ecosystem has been proposed that attaches itself to a cloud; however, the cloud is essentially used as a passive device for storing course and assessment materials [6]. In another approach, benefits of using all three cloud models (PaaS, SaaS, IaaS) in distance learning are fully acknowledged and discussed [15], and some experiments are conducted to compare and contrast the effectiveness of using IaaS and PaaS for an advanced computer science course [13], but no specific system implementation has been attempted or suggested.

This paper introduces a novel approach that allows computer science students to take full advantage of the IaaS model of cloud computing in distance learning by having access to an interactive and intelligent experimental laboratory environment. For instance, students who study operating systems need access to Linux machines while students in a typical web design or database course need access to virtual machines with web and database servers. In general, technical advances in the field occur rather quickly so it is imperative that students stay abreast recent hardware and software developments. To accommodate these needs, the implemented virtual environment in this work contains two modules: the Virtual Lab (VL) module and the Student Progress (SP) module. VL utilizes Amazon Elastic Compute Cloud (EC2) to provide students with the state-of-the-art technical environment, called the virtual machine (VM). All required software tools are pre-installed by the system administrator, and an Amazon machine image (AMI) is created based on VM. Subsequently, students can perform the assigned work on their personalized VM and Elastic Block System (EBS), which is used to store students' persistent data. The module SP, on the other hand, monitors student progress and provides personalized guidance based on the learner's performance using the Apriori data mining algorithm [5, 12, 14].

The remainder of the paper is organized as follows. Section 2 provides background information on the Amazon EC2, the Apriori data mining algorithm, and the Moodle [4] course platform. Sections 3 and 4 present the Virtual Lab and Study Progress modules, respectively. And finally, Section 5 is the summary and conclusions.

2 Background

This section is a brief introduction to Amazon's cloud computing, data mining and the Moodle online course management system.

2.1 Amazon Cloud

Cloud computing is a type of web service that allows users to share computing resources, be it hardware or software, over a network. The fundamental type of service supported by a cloud can roughly be categorized as infrastructure as a service (IaaS), platform as a service (PaaS), or software as a service (SaaS) [10]. The main advantage of cloud computing is that it frees the designers and administrators of learning systems from challenges associated with IT infrastructures of traditional brick-and-mortar institutions such as the setup of reliable and accessible networks, web and database servers, and storage services [8].

Amazon Web Services (AWS) is a widely used cloud computing platform which enables users to virtually run everything in the cloud. Elastic Compute Cloud (EC2) and Simple Storage Service (S3) are the most well-known services in AWS. EC2 offers computing resources as a service while S3 is a scalable storage service in the cloud. By using EC2, users can almost instantaneously launch a remote virtual machine (VM) in the cloud, which is also called an EC2 instance. A set of operating system images called Amazon Machine Images (AMI) can be chosen to run instances, for example, of various versions of Windows and Linux. If the existing AMI does not meet the requirements, users can configure images using specific software applications, programming languages and libraries [8, 15]. S3 provides a simple web service interface to store and retrieve data over the Internet. User data files are stored as objects in S3, and in addition, storage volumes can be mounted by an EC2 instance as devices in order to store users' persistent data. Because it is independent from the life of EC2 instances, it is particularly suitable for specific applications that require a database.

2.2 Apriori Data Mining

Apriori is a well-known data mining algorithm, which is extensively used in market basket data analysis [12]. A market basket is a collection of items appearing together in a single transaction. Through analyzing a large market basket database, association rules or relationships between various items can be mined [14].

Let $I = \{i_1, i_2, \dots, i_m\}$ be a set of items, and $T = \{t_1, t_2, \dots, t_n\}$ be a set of transactions. Transaction $T_i \in T$ contains itemset $I_j = \{i_{j1}, i_{j2}, \dots, i_{jk}\} \subseteq I$. The support for itemset I_j is defined as the percentage of the transactions that contains I_j:

$$S_{I_j} = \frac{|T_{I_j}|}{|T|} \tag{1}$$

where $|T_{I_j}|$ is the number of transactions that contain item set I_j. If S_{I_j} is greater than the user-defined minimum support (*minsup*), itemset I_j is called large itemset. The form $X \Rightarrow Y$, such that $X \subseteq I$, $Y \subseteq I$ and $X \cap Y = \Phi$, denotes an association rule. The association rule $X \Rightarrow Y$ is considered a significant rule if $X \cup Y$ is a large itemset and its confidence is greater than the user-defined minimum confidence (*minconf*). The confidence level for rule $X \Rightarrow Y$ is defined as the ratio of the number of transactions that contain $X \cup Y$ to the number of transactions that contain X:

$$\alpha = \frac{|X \cup Y|}{|X|} \tag{2}$$

The goal of the Apriori data mining algorithm is to discover all association rules that satisfy the statistical *minsup* and *minconf* properties for a large set of transactions.

2.3 Moodle Platform

Moodle is an open-source web application that is widely used to manage online courses. It was created using PHP language and can be easily extended by developing and installing additional modules [4]. Basic functionalities are provided in the Standard Moodle Package Version 2.4, which is the latest package at the time of this writing. E-learners can participate in a variety of Moodle activities having access to a number of resources as listed in Table1.

Table 1. Activities in the standard Moodle package

Activity	*Description*
Resources	Resources could be in various format: • File: learning material can be in the formats of plain text, Microsoft PowerPoint, PDF, videos, etc. • URL: instructors can provide a web link as course resource.
Assignment	Assignment activity has the following capacities: • Allows instructor to assign exercise and tasks to learners. • Allows learners to submit their work. • Allows instructors to provide grades and feedback.
Quiz	Quiz can be used to evaluate learners' performance. • Quiz can have various types of questions, including multiple choice, short-answer, true-false, matching, and essay. • Instructors can grade an attempt and provide feedback.
Forum	Forum enables asynchronous discussions by subscribing to a forum to receive forum posts.
Chat	Chat enables a real-time synchronous discussion.

An appealing characteristic of Moodle is its extensibility. Because the code is readily available users can modify it to customize the software. A large number of plug-in modules are available and users can install specific plug-ins in order to customize their Moodle system. If no existing module meets users' requirements, new modules can be developed and contributed as new plug-ins.

3 Virtual Lab

The Virtual Lab Module is especially suitable for disciplines that require students to conduct computer experiments. The Internet Application Development course is used as an example there to highlight the advantages of the cloud-based virtual lab. In order to help students to get through this course, it is essential to engage students in developing deep knowledge of a wide range of computer languages such as HTML, JavaScript, PHP, and SQL. VLM can provide students with the virtual machine that has XAMPP (as web server and database server package) installed and a great deal of sample code resides on EBS so that students can run the sample code as well as write and publish their own web sites.

3.1 Integration with AWS

An important consideration in online programs is that the number of enrolled students is always unpredictable; therefore, it is difficult to plan IT resources. Amazon's pay-as-you-use services provide a cost-efficient solution. The more students enroll in the online program, the more EC2 instances can be created in the cloud.

As shown in Fig.1, the extended Moodle provides the interface for students to operate the remote Amazon EC2 virtual machines. VLM takes advantage of Amazon Web Services APIs to interact with Amazon cloud. Students can do the following operations through the system's user interface:

- Start/Stop the remote virtual machine
- Get the encrypted password and access the remote virtual machine
- Review the total number of hours the virtual machine runs

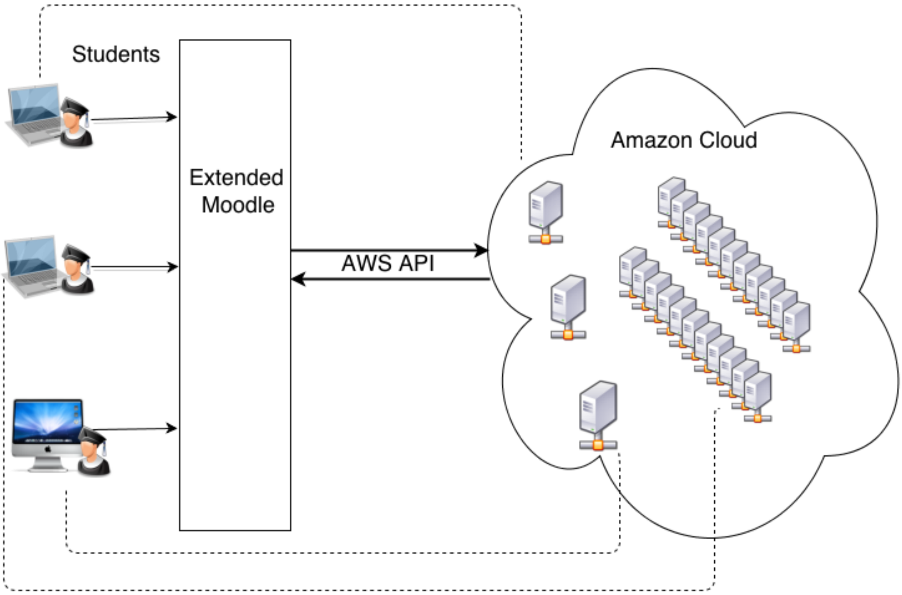

Fig. 1. Cloud-based virtual lab

Once the remote VM is running, the EBS volume will be attached and mounted to the VM automatically. Students can start the Apache web server and MySQL database server residing on EBS and conduct various experiments. The instruction about the experiments could be either stored on EBS as a file or posted on Moodle system as a course resource.

3.2 VLM Workflow

VLM was implemented as a standard Moodle module by following Moodle's recommended module development guidelines. Fig. 2 shows the control flow of the implemented VLM.

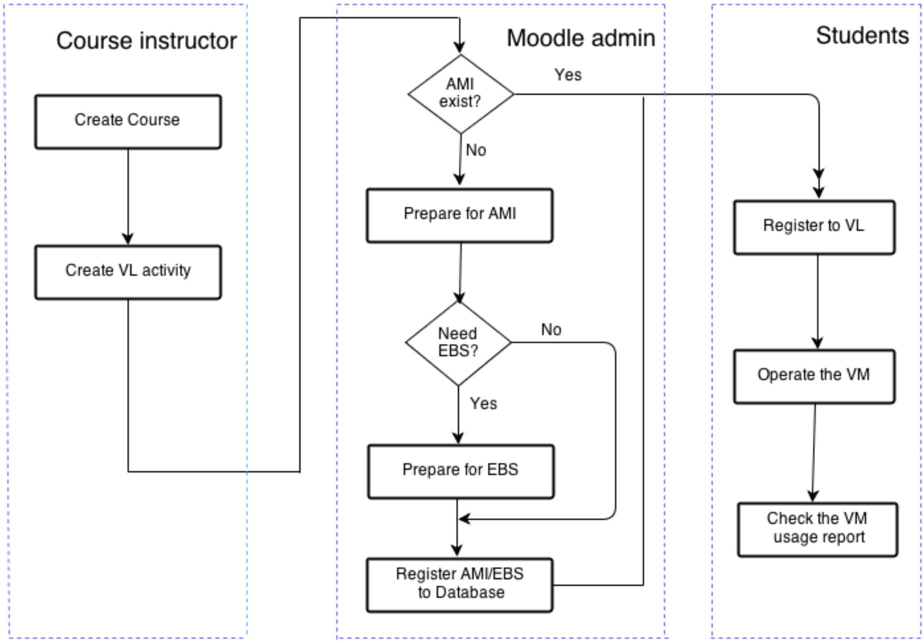

Fig. 2. VLM control flow

Once the course instructor creates a course, specific VL activities can be added to the course. The operating system version and required software are specified during creation of the VL activity. After the Moodle administrator receives the new VL request, the database is searched to determine if any existing AMI meets the request. It is possible that some sample codes and instructions could reside on EBS so students can access the replica images when they start the virtual machine and attach the replicated EBS to their instances. When AMI and EBS are available, the VL is ready for registration. Students register for the VL to get the RSA cryptographic keys, which are used for virtual machine authentication and EBS volume used for persistent data storage. After registration, students can start the virtual machine and commence experiments. Students can also easily view the virtual machine usage report to better plan the time they spend on each experiment.

4 Study Progress

4.1 SPM Architecture

SPM tracks the study progress of each student and generates personalized suggestions based on his/her performance. As seen in Fig. 3, the core component of SPM is the Apriori Data Mining algorithm, which uses students' grades for all gradable activities, such as assignments, quizzes, workshops, etc., and generates association rules.

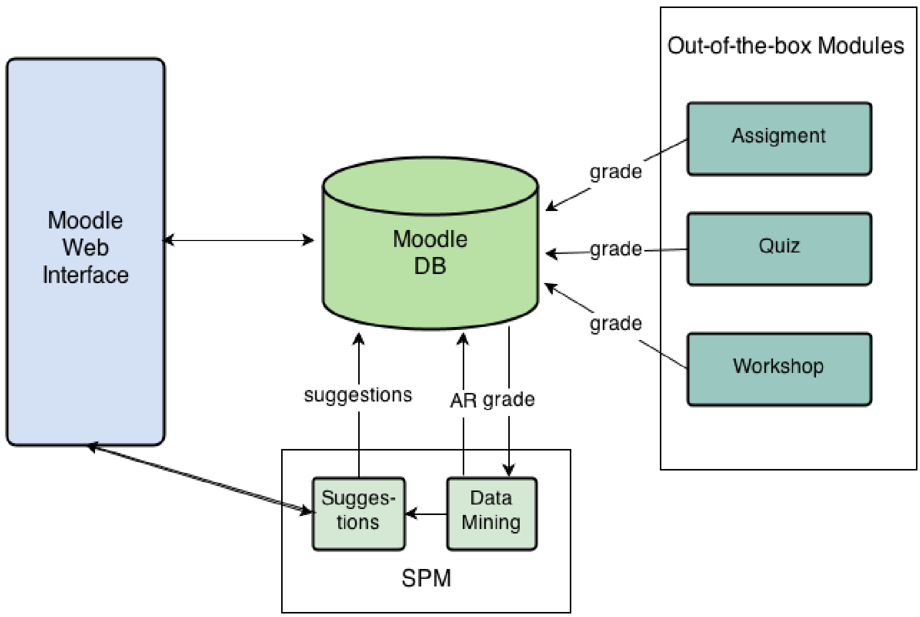

Fig. 3. SPM architecture

The discovered association rules contain important pedagogical information regarding mistakes students make. These rules are fed into the Suggestions component, which is designed to interact with the instructor who reviews the rules and makes proper adjustments in terms of his/her teaching approach. The adjustments could involve changing the order of some specific sections in the course or offering supplementary learning materials for further study. Teachers can also attach suggestions and comments to the actual generated association rules. The suggestions are stored in the database and shown to students who perform poorly in the materials that relate to the association rules. The students are then instructed to revisit some concepts or complete more assignments and/or take more quizzes.

A section can have multiple activities. Some activities are gradable such as assignments and quizzes while others are not. Some activities play a more important role in helping students master the subjects. The mark used in Apriori is the weighted average grade of each section as shown in Eq. 3. Note that $g_1$is the grade of the first gradable activity in the section, and g_{1m} is the maximum grade of the activity. The grade is converted to a percentage and then multiplied by $w_1$which is the weight of the activity. The instructor can configure the weight ranging from 1 to 5 for each activity.

$$G = \frac{100\frac{g_1}{g_{1m}}w_1 + \cdots + 100\frac{g_i}{g_{im}}w_i}{w_1 + \cdots + w_i} + (g_{i+1}w_{i+1} + \cdots + g_n w_n) \tag{3}$$

4.2 Apriori Data Mining in SPM

The set of failed sections for a single student is used as a transaction in Apriori. For example, in the Internet Application Development course there are five sections for JavaScript: JS Basic, JS DOM, JS Objects, JS Libraries, and AJAX. The weighted average grades are stored into the database and shown in Table 2.

Table 2. Students' section grades

Student	*JS Basic*	*JS DOM*	*JS Libraries*	*JS Objects*	*AJAX*
A	76	50	78	80	55
B	85	52	90	59	48
C	85	53	75	78	46
D	43	60	52	76	59

Student A fails JS DOM and AJAX sections. These two sections are treated as a transaction with *TID* (transaction ID) of 1 as shown in Table 3.

Table 3. Transactions in Apriori algorithm

TID	*Items*
1	JS DOM, AJAX
2	JS DOM, JS Object, AJAX
3	JS DOM, AJAX
4	JS Basic, JS Libraries, AJAX

As shown in Table 4, supports of the itemsets are calculated and large itemsets are identified based on a minsup of 0.75. The large itemsets with more than one item are used to generate association rules. The confidences of all rules is computed in order to identify the significant rules. The rule {JS DOM} => {AJAX} becomes the significant rule in this example if minconf is 0.8 (see Table 5). The meaning of this association is that the students who fail JS DOM section are most likely to fail the AJAX section. The instructor can, therefore, assign more appropriate instructional materials or exercises to students who fail JS DOM before they can move on to the AJAX section.

Table 4. Itemset support

Itemset	*Support*	*Large itemset (minsup = 0.75)*
{JS Basic}	0.25	No
{JS DOM}	0.75	Yes
{JS Libraries}	0.25	No
{JS Objects}	0.25	No
{AJAX}	1	Yes
{JS DOM, AJAX}	0.75	Yes

Table 5. Association rules

Association rule	*Confi-dence*	*Significant rule (minconf = 0.8)*
{JS DOM} => {AJAX}	1	Yes
{AJAX} => {JS DOM}	0.75	No

5 Conclusions

The main goal of a virtual learning system is to utilize the Internet as a powerful resource for teaching and learning. Specifically, creation of a virtual environment to teach technical courses in computer science is rather challenging and of particular interest simply because of the rapid pace of technological change in the field. It is becoming more and more difficult for computer science programs to update and upgrade their IT infrastructure in face of a rapidly evolving IT arena. Consequently, only recently many educational institutions have begun to realize the full potential of cloud computing in classroom as well as distance learning.

The virtual system designed and implemented in this work relies heavily on the IaaS model of cloud computing in order to introduce computer science students to the latest hardware and software tools needed in the areas web and database technologies. The main components of the system are the Virtual Lab and the Student Progress modules that were incorporated in the Moodle course management system. It was shown that the Virtual Lab module allows students to have access to a virtual environment built on top of the Amazon EC2 technology using the concept of virtual machine. Furthermore, it was demonstrated how the Student Progress module can monitor the learner's progress using the Apriori data mining approach. This learning and performance guidance module observes the behavior of the learner in the system and automatically generates a set of association rules indicating how the student successes and failures relate to the desired learning objectives specified in the underlying Moodle course management system.

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Towards Open Corpus Adaptive E-learning Systems on the Web

Miloš Kravčík and Jian Wan

RWTH Aachen University, Informatik 5, ACIS Group
Aachen, Germany
{kravcik,jianwan}@dbis.rwth-aachen.de

Abstract. Development of conceptual knowledge is an important part of education. In individualized instruction this aim can be facilitated by concept maps interconnected with learning materials. Traditional adaptive web-based e-learning systems use a closed and static corpus, which is predefined in the design time. But there is plenty of learning resources publicly available on the Web, which provide a huge potential for learners. Obviously, it would be very useful to have an opportunity to choose for a particular context a suitable concept map that could dynamically access selected learning repositories and enable an intuitive navigation in both the concept and document layers, as well as between them. We have attempted to develop a solution that is based on the principles of open corpus adaptive educational hypermedia and at the same time can be part of a personal learning environment. The outcomes show that this may be a promising approach, but its usefulness is highly dependent on the usability and flexibility of the e-learning application.

Keywords: Adaptive E-learning Systems, Open Corpus Adaptive Educational Hypermedia, Concept Map, Ontology, Learning Repository, Reusability, Personal Learning Environment.

1 Introduction

Individualized instruction is a crucial requirement of the modern era and web-based leaning provides many approaches how to address this big challenge. From the pedagogical perspective one of the key learning theories is cognitivism [1], which aims to develop internal cognitive structure that strengthens synapses in the brain. One way how to technically support this approach is by means of interactive concept maps [2], which are graphical tools for organizing knowledge that represent it in graphs, showing the relationships among concepts. Concept mapping has been shown to help in learning, creating new knowledge, writing, and assessment. A concept map enables active acquisition of knowledge and can be also used as a network for navigation, allowing for discovery learning [3], which is a technique of inquiry-based instruction, based on the principles of constructivism. It is also a method of instruction through which students interact with their environment by exploring and manipulating objects.

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Context exploration can be supported by concept based navigation [4], when the learner can easily access a wide spectrum of the relevant concepts. This fosters an inductive way of learning relationships among concepts. Navigation in the semantic space can start from an occurrence of a concept in a learning material. Then the concept map can be accessed, showing correlated concepts as well as materials related to the concept, explaining its meaning. This concept map is an example of opportunities that web instruction provides to enhance learning, because information can be accessed in different ways, choosing always the preferred perspective. Students and teachers appreciate in the web environment what they cannot find in traditional classroom [5]. But going beyond the "no significant difference phenomenon" requires more attention for innovative approaches enabled by online instruction.

The positive outcomes from this approach lead us towards ideas about how to overcome its limitations related to the system closeness and how to generalize it. We see a challenge in exploitation of the huge amount of publicly available resources on the Web and their orchestration towards an open and flexible learning environment providing a new quality of experience. So instead of the traditional adaptive e-learning systems with a closed and static corpus predefined in the design time, the teacher or the learner could have an opportunity to choose an appropriate concept map in the form of an ontology and dynamically interconnect it with selected learning repositories in order to enable a flexible selection of learning resources and navigation on both concept and document layers, as well as between them. This kind of reusability and interoperability is also a main aim of open corpus adaptive educational hypermedia [6]. Here we aimed to integrate this approach with the personal learning environment interface, which is becoming popular.

In the next paragraphs we first introduce a theoretical background for this work. Then our conceptual approach is explained. In the following paragraph we describe the system architecture and its implementation. Afterwards the evaluation outcomes are presented. Finally we conclude the paper, summarizing its main results.

2 Theoretical Background

An adaptive system can react to certain circumstances and adapt accordingly. The process of adaptation is typically based on users' goals and preferences. These and other relevant properties of the user are stored in a user model, which enables the system to tailor its reaction accordingly [7]. In the context of e-learning, adaptive systems are more specialized and focus on the adaptation of learning content and navigation. An adaptive system intervenes at three stages during the process of adaptation – it controls the process of collecting data about the user, the process of building up the user model (user modeling), and during the adaptation process [7]. But traditional adaptive hypermedia systems take into account only a limited set of documents and relations between them that have been chosen at design time, i.e. closed corpus. Therefore a natural challenge is to exploit the huge potential of the available resources on the Web and to enable dynamic updates of the materials considered. An open corpus adaptive hypermedia system has been defined as "an adaptive hypermedia system which operates on an open corpus of documents, e.g., a set of documents that is not known at design time and, moreover, can constantly change and expand" [6]. Such documents can be enriched with annotations and relationships for the learning purposes.

As authoring of adaptive educational applications is quite a demanding task, the Semantic Web has been often leveraged to facilitate this process and to improve the efficiency of authors in this field, taking into account principles of reusability and interoperability [8]. Many solutions have been based on ontologies that integrate various learning standards in their implementation. Ontology can be considered as a network of concepts. Several network-based knowledge representation formalisms have been explored, including Concept Maps [9]. Representation of a domain model as an ontology enables usage of standard representation formats and publicly available inference engines, as well as access to a vast pool of technologies for ontology mapping, queering, learning, etc. The domain ontologies also benefit of such properties as intentionality and explicitness, which allows building unbiased and logically complete domain models.

Semantic annotation uses the Semantic Web technologies for knowledge discovery. In the process of ontology-based text annotation [10] the elements of the ontology are identified in the text and their presence is indicated, showing also the type of the entity. Several recent projects exploit the ontology-based annotation techniques for automatic indexing of textual Web-resources with semantic meta-data. One of them is COHSE (Conceptual Open Hypermedia Service) [11]. COHSE is based on the original idea of distributed link services [12] working as intermediaries between Web clients and Web servers and augmenting Web documents with dynamic links. The COHSE components apply ontology-based annotation technologies to associate automatically the pieces of documents with ontology concepts. Another approach is implemented in Magpie [13], which works on the client side as a browser plug-in. It analyses the content of the HTML document being browsed on-the-fly and automatically annotates it based on a set of categories from an ontology. The resulting semantic markup connects document terms to ontology-based information and navigates the user to the content describing these terms.

3 Conceptual Approach

As we have already explained, our aim is to represent the concepts and their relationships in one layer, the learning materials (documents) in the other, and then to interconnect them semantically in order to offer easy navigation in this open hyperspace for the user. Figure 1 illustrates the conceptual structure of our system. Learning objects are collected from the open corpus and the domain ontology is used to annotate and index these objects. Then user model, domain model (ontology), content model, and adaption model (specifications of adaptation semantics by adaptive rules) are exploited to perform the learning content adaptation. Finally, the adapted results are presented to the user. We aim at developing an adaptive application that applies semantic web technologies to analyze available information from open corpus.

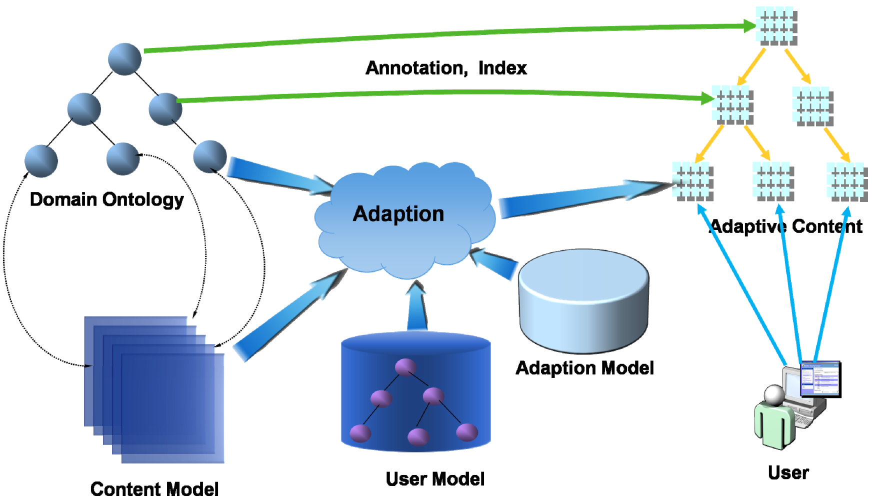

Fig. 1. The Conceptual Structure of System

The functionality of the system includes structuring the concepts network (knowledge space), structuring the hyperdocuments network (hyperspace) and connecting the knowledge space and the hyperspace. In principle, this procedure consists of the following steps [14]: content from open corpus extraction, meta-data generation, adaptive hypertext generation, and result visualization.

Content extraction: It is performed by means of federated search, which is an information retrieval technology that allows the simultaneous search of multiple searchable resources. The system can search multiple databases at once in real time, arrange the results from the various databases into a useful form and then present the results to the user. Federated search has been used to search distributed learning object repositories for e-learning [15].

Meta-data generation: The collected content will be enhanced with additional information through attaching various attributes to documents. Semantic annotation can speed up searching and help users to find relevant and precise information. It enriches the unstructured or semi-structured data with a context that is further linked to the structured knowledge of a domain and enables to find results not explicitly related to the original search.

Adaptive hypertext generation: This process analyses the harvested content and adaptively responds to the learner query. Learners can compose a query by selecting one or more keywords from a set of specific domain concepts. For users' queries, the system first performs concept adaptation using the domain model, the user model, and the adaption model. The result is the selection of concepts and relationships between them. Then content adaptation is performed with the selected concepts. Finally, a complete hypertext is generated for the user query. Figure 2 illustrates the process of adaptive hypertext generation, which includes four steps of concept, content adaption, hypertext generation, and presentation.

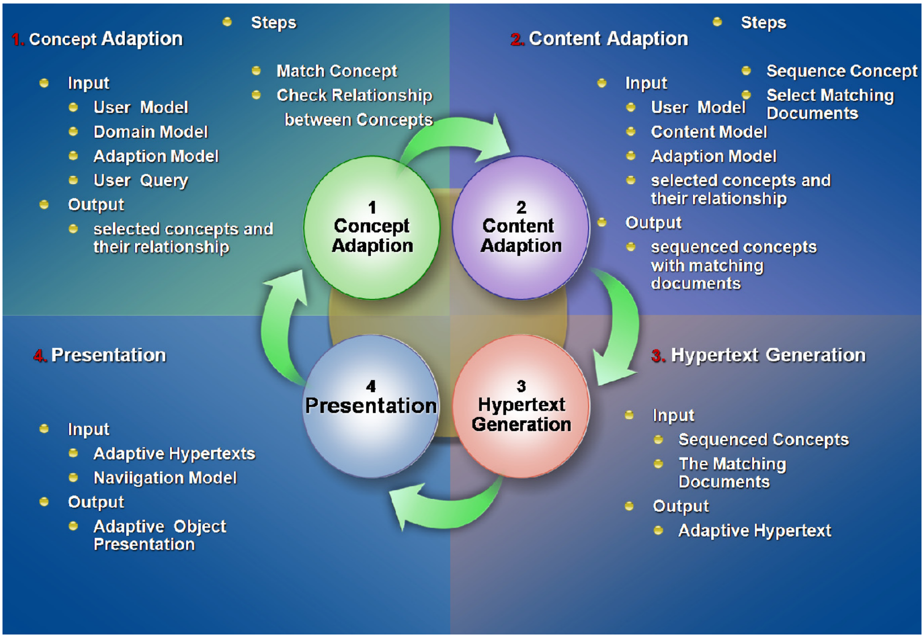

Fig. 2. The process of Adaptive Hypertext Generation

Visualization: This phase includes creation of the navigation part and user interface part. The navigation is based on domain concepts to reflect the relationship among concepts and documents so that learners can be guided in a rich context.

4 System Architecture and Implementation

This system has client-server architecture that consists of three fundamental interconnected layers as shown in Figure 3. The database layer consists of several databases, which store the data on users and collected learning content. The application layer builds up the adaption service logic. It runs on a web server and presents an ontology-based adaptation infrastructure. In this structure, the Data Manager, the User Manager, the Event Manager, and the Context Manager interact with the Adaption Engine, which aggregates their outputs into a single representation. The Session Manager keeps track of users' activities and responds accordingly. The presentation layer runs on the iGoogle gadget platform, which provides the user interface with widgets (small standalone GUI applications) that can be selected and designed by the user into a personal learning environment.

We divided the implementation of adaptation service into three phases: learning content extraction, semantic annotation, and learning object adaption. KIM platform has been used for text analysis and generation of semantic links [10]. We use Apache Tomcat as web server to publish our adaption service. AJAX and RESTful technology are used to realize the communication between client-side and web server-side. User interface and navigation models are implemented in the client layer. According to the navigation models, we use concept map to construct navigation space.

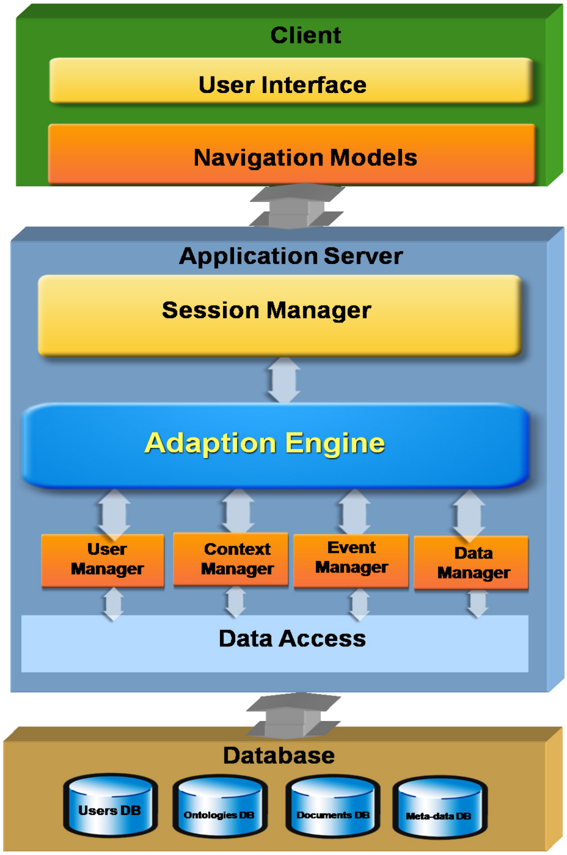

Fig. 3. System Architecture

As already mentioned, we realize the presentation layer in the iGoogle gadgets environment. iGoogle and gadgets can be used as platform to integrate various kinds of services [16]. We can deploy several gadgets in one screen on iGoogle. By setting up own iGoogle interface, the user can use different functionality gadgets collaboratively. It can provide an active learning environment. The user interface includes five widgets:

- User log in and profile data edition
- Keyword search
- Documents list
- Concept map
- Document semantic annotation

The realized gadgets have been published in iGoogle. The keyword search widget, the documents list widget, and the annotated document widget are shown in Figure 4. By query widget, users enter keywords for relevant content. Users can also use concept map to search learning content by choosing directly. The list of adaptive content is shown in second widget. In third widget, users can look through the annotated document, in which the entities are colored differently. The additional information based on domain concept and knowledge space can be seen by mouse over operations.

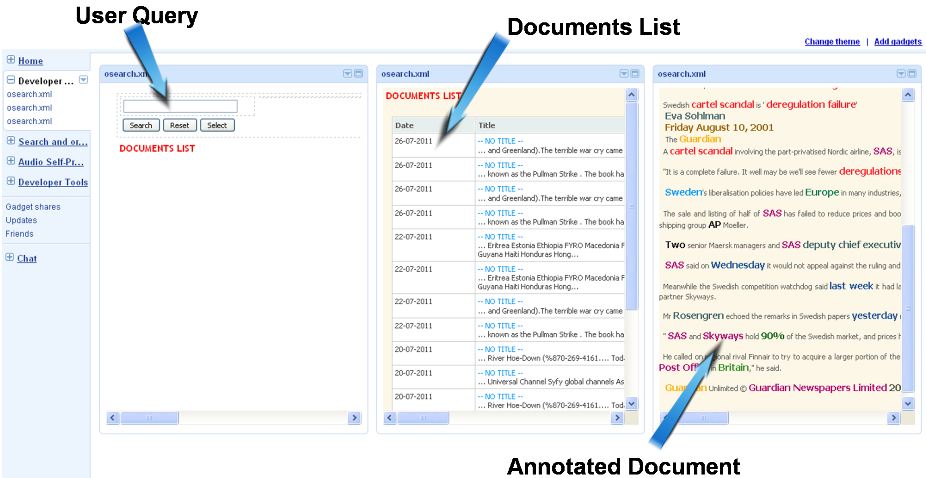

Fig. 4. User Interface Illustration

5 Evaluation

In the evaluation phase, we have surveyed 10 students. The first group consists of 5 experienced users and the second includes 5 non-experienced users. This number is inline with the outcome of usability research [17]: The best results come from testing no more than 5 users and running as many small tests as you can afford.

After a brief introduction of the system, the related knowledge of participants has been surveyed. Afterwards the system usability was tested and participants were asked to perform several tasks, like annotation of documents, searching in the list of relevant documents, or navigation. Most of the users could perform the assigned tasks successfully. Figure 5 shows the result of the usability test. The users could finish most of the tasks in thirty seconds. But several users could not understand the meaning of the ontology-based adaptive navigation correctly.

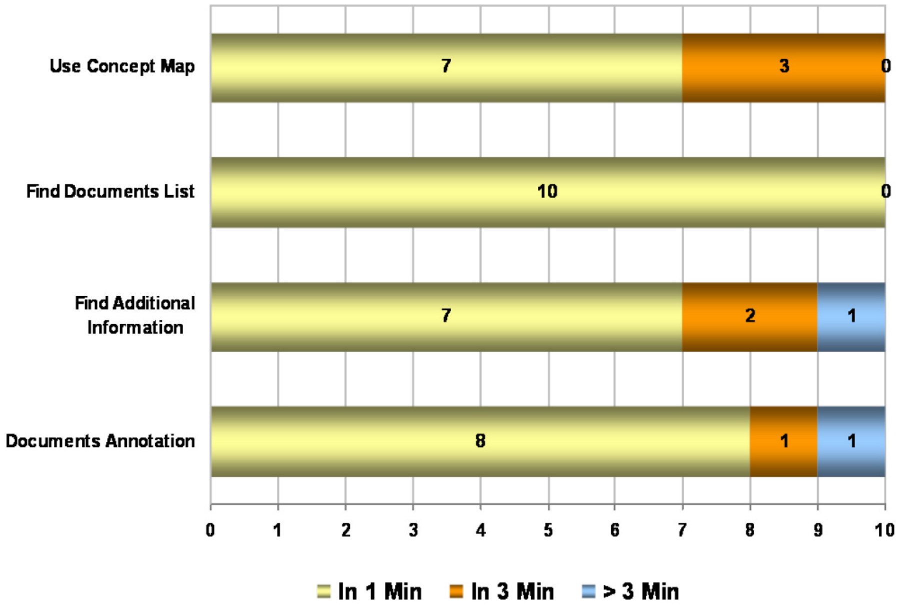

Fig. 5. Results of Usability Tests

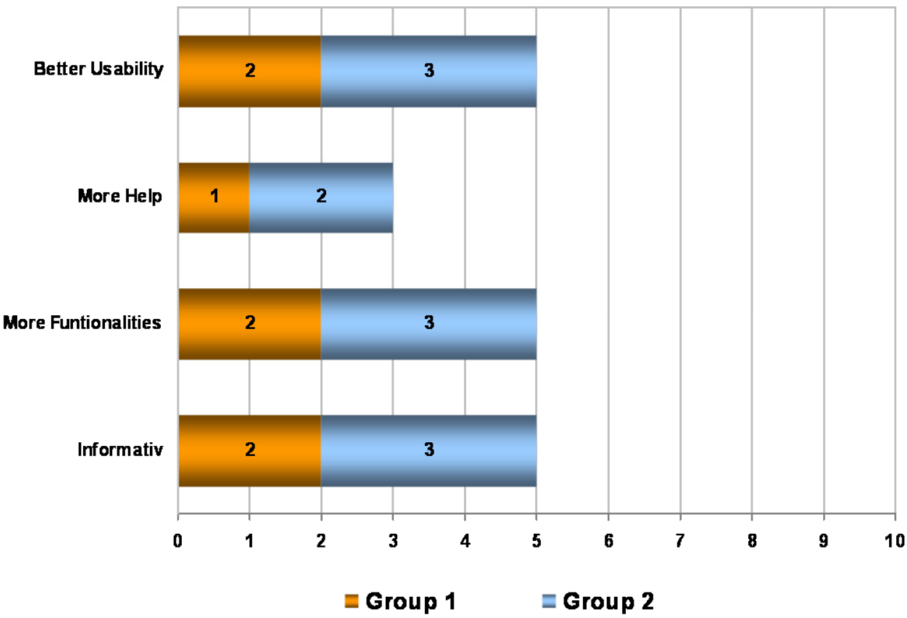

Fig. 6. Further Requirements of Users

When asked to rate the functionalities of the system the users rated the adaptive navigation more positively than the user interface and display style. They also estimated the quality of provided information in average as satisfactory, which is about the average. Regarding knowledge improvement, most students believed that they had extended their knowledge.

The evaluation results have revealed certain benefits and drawbacks of this system. On one side most users were able to perform the required operations successfully, even if some of them were not very experienced in this field. But the ranking of provided information as satisfactory is not very positive and indicates quite some potential for improvements, which was demonstrated also by further requirements of users (Figure 6).

6 Conclusion

The aim of this work was to design and implement an adaptive e-learning application that could exploit open educational resources, including domain ontologies and learning repositories. This idea has been inspired by the principles of interactive concept maps together with open corpus adaptive educational hypermedia. Open corpus adaptation is a challenging problem for modern Web-based systems in order to provide more flexibility for users as well as to improve reusability of available resources and interoperability of existing solutions.

In this experiment we have attempted to design and implement an e-learning system that would enable exploitation of existing domain ontologies as concept models and learning repositories as educational resources. Moreover, in order to enable flexible adaptation of the whole environment, the user interface was implemented in the form of widgets that can compose (a part of) a personal learning environment. The performed evaluation of the system has revealed both positive and negative outcomes, which can be used in the future in similar efforts. Especially the functionality of the system and its usability can be improved.

As interoperability plays an important role also in the area of serious games [18], this approach might inspire new activities also there. On one side serious games represent a special type of adaptive systems, but on the other hand standardization, reusability, and interoperability are rather limited in this area. So a general adoption of open corpus resources is a big challenge for serious games in general. Nevertheless, gamified learning is becoming more and more popular, which implies new opportunities how to stimulate motivation in adaptive educational applications.

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Discovery of Action Patterns in Task-Oriented Learning Processes

Xiaokang Zhou[1], Jian Chen[2], and Qun Jin[1]

[1] Graduate School of Human Sciences, Waseda University, Tokorozawa, Japan
[2] College of Computer Science and Technology, Taiyuan University of Technology, Taiyuan, China
xkzhou@ruri.waseda.jp, jin@waseda.jp, chenjian02@tyut.edu.cn

Abstract. In this study, in order to support and facilitate the web-based learning, we concentrate on user learning behavior pattern discovery in a task-oriented learning process. Based on a hierarchical graph model which can describe relations among learning actions, learning activities, learning sub-tasks and learning tasks, we introduce the formal definitions for Learning Action Pattern and Goal-driven Learning Group to discover and represent users' learning behavior patterns within a learning task process. Two integrated algorithms are developed to calculate and generate the Learning Action Patterns for an individual user and the Goal-driven Learning Groups for a number of users, which can benefit sharing of learning activities and improve learning efficiency in e-learning environments. Finally, the design of a prototype system with experiment results is discussed.

Keywords: Learning Pattern, User Behavior Modeling, Learning Activity, Learning Task.

1 Introduction

Recently, e-learning has been continuously experiencing a change with emerging computing paradigms, which makes it possible for more and more populations to perform the learning activities at any time and any places as long as they can get onto Internet. The traditional e-learning system, in which both instructors and students always have to follow the defined instruction and assessment procedure to conduct the pre-planned curriculum within a fixed knowledge domain, may not be suitable for the personalized learning process. People no longer learn only from instructors or by themselves, but learn through interactions and collaborations in a community or across a social network. Research work [1] conducted within a scale of 100 participants indicates that collaborative work can help improve both motivation and performance in a learning process.

In our previous study, we have proposed dynamic navigation of learning activities, which can provide users with the adaptive learning activities navigation based on a gradual adaption recommendation model for personalized learning support [2].

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Furthermore, we proposed an integrated adaptive framework to support and facilitate individualized recommendation by providing the target users whose information access behavior patterns are similar to the reference users with the optimized information seeking processes [3].

In this study, to better facilitate the learning collaborations in the web-based learning environment, we try to find a way to describe and analyze users' learning behaviors in a task-oriented learning process. In details, after modeling of a task-oriented learning process, we define the Learning Action Pattern (LA-Pattern) to discover users' learning behavior patterns which represent learning actions and learning activities. Based on these, we design the Goal-driven Learning Group for the further analysis of the similarity of users' learning behaviors, in order to share the more related information among users and improve the efficiency in a learning process.

The rest of this paper is organized as follows. We give a brief overview on the related issues and works in Section 2. In Section 3, a learning activity model within a learning task is addressed to demonstrate the relations of the learning task, learning sub-task, learning activity and learning action. Based on these, the Learning Action Pattern is introduced in Section 4, which is proposed to analyze user learning behaviors in a task-oriented learning process. We further introduce the Goal-driven Learning Group to figure out the similarity of learning patterns, in order to share the related learning behaviors among users. The architecture of a prototype system is discussed in Section 5. We conclude this study and give some promising perspectives on future works in Section 6.

2 Related Work

The user behavior modeling and analysis, as well as their applications, have been developed by more and more researchers these years [4-7]. Stolfo et al. [4] employed the EMT (Email Mining Toolkit), which used behavior-modeling techniques to compute behavior profiles or models of user email accounts, to detect the viral propagation problem. Benevenuto et al. [5] presented user behavior analysis of OSN (Online Social Networks) workloads based on a clickstream dataset collected from a social network aggregator. Wang et al. [6] have tried to model the temporal user behavior, in order to satisfy user's current need and further facilitate and simplify the user's future online activities. Considering both user behaviors and collaborative filtering, Liu et al. [7] have proposed a novel semantic relatedness measure between words to retrieve related words and detect new word tasks, which can help user experience enrichment and hidden information discovery.

As for the information and knowledge sharing aspects, [8] has pointed out the fundamental issue of social learning relies on the delivery of right information to appropriate social groups in favor of the stated perspectives. Based on sharing the information of similar users, Wang et al. [9] proposed a user-centric approach to the integration of social data from different social networking sites, which allow users to create personalized social and semantic contexts for their social data. Hamouda et al. [10] proposed a new system in order to make socially personalized tag recommendation for social bookmarking systems by finding similar users and similar bookmarks. Evidences have been revealed in [11] and [12] that the wiki-based forum system can prompt learners to share information and raise their interests in examining the discussions. [13] indicates that the analysis of weblogs can enhance the cognition construction in a specific domain with the statistical results on a 30-participant experiment.

Research works have been also tried on task-oriented study. Benbunan-Fich et al. [14] developed a set of activity-based metrics for computer-based multitasking by measuring multitasking behaviors, which can be used to establish a conceptual and methodological foundation for further multitasking studies. Fetaji et al. [15] used the Task Based Learning model to develop and analyze a mobile software solution in order to enhance learning in university environments. Zhang et al. [16] proposed the so-called Transfer Metric Learning (TML), in which the transfer learning has been viewed as a special case of multi-task learning and the formulation of multi-task metric learning is adapted to the transfer learning setting that uses some related source tasks to help learn the target task. Leen et al. [17] proposed a Gaussian process model for the asymmetric setting in order to improve the performance on the target task in a multi-task learning environment.

3 Modeling of Learning Activity within a Learning Task

3.1 Definitions

A series of definitions shall be introduced and defined in order to describe user information behaviors in a task-oriented learning process.

Learning Action: A learning action is composed of the minimum unit of learning operations. A learning action may consist of a series of learning operations. For example, learning new foreign language words is regarded as a learning action, in which two operations, reciting and writing new language words, can be employed for the learning action of learning new words.

Learning Activity: A learning activity is a set of learning actions, which constitute a purposeful learning process with a certain learning action sequence and time span [1]. It is an educational process or procedure intending to motivate learning through actual experience. For example, in a foreign language lesson, a learning activity consists of learning actions - learning new words, learning new grammars, learning texts, doing exercises and doing quizzes. In this situation, the goal of this action sequence is to finish the final quiz. Besides, the sequence of learning actions for a learning activity can be optimized so as to satisfy different target students.

Learning Sub-task: A learning sub-task is a set of learning activities that complete a certain learning purpose in a specific learning stage. For example, each lesson could be viewed as a learning sub-task in the whole foreign language learning course.

Learning Task: A learning task is a set of learning sub-tasks, which is a learning process to complete the final learning purpose in a learning course.

3.2 A Hierarchical Model for Task-Oriented Learning Process

Following the definitions above, a hierarchical model is proposed to interpret the structure and relations in a task-oriented learning process.

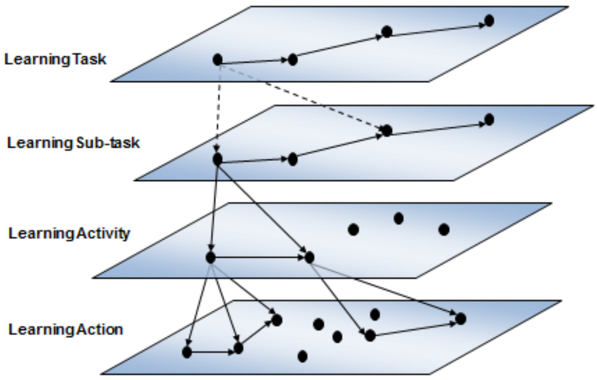

Fig. 1. Model of task-oriented learning process

Generally, as shown in Fig. 1, a learning course may be divided into several learning tasks with a certain sequence to complete the final learning purpose. As for each learning task, it shall contain several sub-tasks in different learning stage with a specific sub-purpose. In turn, in each learning sub-task, a series of learning objectives shall be established in different learning periods for different users, followed by a series of learning activities which are assigned to realize them. Likewise, the learning activity can further be divided into a sequence of learning actions which are composed of the minimum units of the learning operations. In details, they can be recorded as what has been done at what time with the necessary materials for a specific learner. Take a specific English learner for instance, a learning action sequence can be recorded as memorizing new words in early morning, learning English grammar in the morning, and doing exercise in the afternoon.

4 Learning Action Pattern Discovery

4.1 Definition of Learning Action Pattern

The Learning Action Pattern (LA-Pattern) is defined to discover and represent users' information behavior patterns in a task-oriented learning process. Therefore, in order to figure out these patterns, the task-oriented learning shall be formalized as follows:

$act = \{U, O, Lr\}$: a non-empty set to describe the Learning Actions generated in a task-oriented learning process, where U indicates the user that a specific Learning Action belongs to. O indicates the concrete operation of this Learning Action (e.g. submitting a report). Lr indicates the learning resources that the owner U has used to complete a Learning Action.

Act = < act_1, act_2, …, act_n, *G*>: a non-empty sequence of Learning Actions, where Act_i indicates the Learning Action that belongs to this Learning Activity. *G* is a special Learning Action that indicates a goal of this sequence of Learning Actions, For example, if *G* indicates taking a quiz, the < act_1, act_2, …, act_n > indicates the Learning Actions that are performed to prepare for a better outcome of the quiz.

S-Task = < Act_1, Act_2, …, Act_n, *T* >: a non-empty sequence of Learning Activities, where Act_i indicates the Learning Activity that belongs to this Learning Sub-task. *T* indicates a learning stage within the whole learning task, which can also be viewed as the end of time interval. For example, if the whole learning task is an English language learning course, each class can be viewed as a *S-Task*, then T indicates the period during this class, while < Act_1, Act_2, …, Act_n > indicates the Learning Activities that are taken for this class.

Based on these, the LA-Pattern, which is a sub-sequence of learning actions, can be defined as:

$$< act_i >_u^w \rightarrow G \tag{1}$$

where <act_i> denotes the learning action sub-sequence which constitutes a purposeful learning process. *w* denotes the weight of this LA-Pattern, specifically, the value indicates the frequency that this segment of learning actions occurs in a whole learning action sequence (e.g., a sequence generated from a learning sub-task). *u* denotes the user that this learning action sequence belongs to. *G* denotes the learning purpose of this sequence. In this way, the LA-Pattern can be viewed as a set of sequential learning behaviors frequently occurring in a specific user's learning action sequence, by which the user intends to complete a certain learning purpose.

The *trie* [18], an ordered tree-based structure which is used to store a dynamic string-like data set, has been well developed and applied in information storing and retrieving field. For instance, Iglesias et al. [19] have applied the *trie* data structure in behavior profile creation and recognition for a computer user. Inspired by it, we employ this kind of tree-based data structure to find all the related sub-sequences with their frequency in a given learning action sequence, in order to calculate the weight *w* of each LA-Pattern. In particular, a certain learning action sequence with its subsequence suffixes which extend to the end of this sequence shall be inserted into a *trie*, in order to calculate the frequency of each sub-sequence in the tree building process. For example, if the whole sequence is <*A, B, C, D*>, the < *B, C, D*>, < *C, D*> and <*D*> shall also be inserted. In this study, for a specific user, the input set of the learning action sequences shall consist of his/her learning sub-tasks.

Based on these discussed above, two criteria shall be given to generate the LA-Pattern as follows:

Criteria 1 - Basic Criteria: Given a pre-defined purpose set $G = \{G_1, G_2, \ldots, G_m\}$, and a sub-sequence q described as $< Act_1, Act_2, \ldots, Act_j, Act_n >_{u_i}^w$, if it satisfies that n >=2, w>=2, and $Act_n \in G$, then q is a LA-Pattern for user u_i, which can be described as $< act_1, act_2, \ldots, act_j >_{u_i}^w \rightarrow G_k$.

Criteria 2 - Incorporation Criteria: Given two sub-sequences q_1: $< act_1, act_2, \ldots, act_n >_{u_i}^{w_x}$ and q_2: $< act_1, act_2, \ldots, act_m >_{u_i}^{w_y}$ for user u_i, if they satisfy that $w_x = w_y$, and $< act_1, act_2, \ldots, act_n > \subset < act_1, act_2, \ldots, act_m >$, then q_1 can be incorporated into q_2.

The algorithm for the generation of LA-Pattern based on the mentioned two criteria is described in Fig.2.

Input: The Learning action sequence set {< act_1, act_2, …, act_n>}
Output: The LA-Pattern set $\{< act_i >_u^w \rightarrow G\}$

Step 1: For each user u_i, divide the whole learning action sequence < act_1, act_2, …, act_n> into several sub-sequences in each corresponding pre-defined time period *T*, which can be recorded as q_i:
$\{< act_1, act_2, \dots, act_j >_{T_1}, \dots, < act_1, act_2, \dots, act_k >_{T_n}\}_{u_i}$
Step 2: For each q_i, insert each sequence element with their corresponding subsequence suffixes into a *trie*, in order to build a tree-based data structure for each user u_i
Step 3: For each user u_i, traverse the *trie* from the root node to each leaf node in order to acquire all the sub-sequences with their corresponding frequency, which can be recorded as *sq*: $\{\{< act_k >^w\}_{u_i}\}$
Step 4: Filter each element in *sq* according to *Criteria 1*, if $k >= 2$, $w>=2$ and $act_k \in G$, remain the satisfied sequences, which can be recorded as *rsq*: $\{\{< act_j >^w \rightarrow G_n\}_{u_i}\}$
Step 5: For $\forall rsq_i, rsq_j \in rsq$, according to *Criteria 2*, if $w_x = w_y$, and $< act_i > \subset < act_j >$, let $rsq_j = rsq_i \cup rsq_j$
Step 6: Return the *LA-P*: $\{< act_i >_u^w \rightarrow G\}$ for each user u_i

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Fig. 2. Algorithm for LA-Pattern generation

4.2 Goal-Driven Learning Group Based on LA-Patterns

Following the formalization and generation of LA-Patterns, we give the definition of Goal-driven Learning Group, in order to analyze the similarity among users in accordance with the LA-Patterns calculated above, and further share the more related information and knowledge within a certain user group.

Goal-Driven Learning Group: A Goal-driven Learning Group is introduced to model a certain group of users who have the same learning purpose and similar learning behaviors according to the LA-Patterns in a specific time period, which can be formalized as follows.

$$\{[< act_k >_{u_1,u_2,\dots,u_i}^{w_1,w_2,\dots,w_i}][G_j, T]\} \tag{2}$$

where, <act_k> denotes the learning action sequence in a specific LA-Pattern, u_i denotes the owner of this LA-Pattern, while w_i denotes the corresponding weight. G_j denotes the learning purpose for this user learning group, and *T* denotes the specific time period.

The Goal-driven Learning Group primarily refers to two portions: users' learning behaviors and the corresponding learning purpose. The former one represents the similarity of learning behaviors among users based on the LA-Patterns, while the latter one indicates the same learning purpose that these users try to complete within a specific learning period. That is, users will be grouped according to the same learning purpose and similar learning behaviors. Note that, this process is not a division, which means one user can be assigned into several Goal-driven Learning Groups. The algorithm to compute the Goal-driven Learning Group is described in Fig. 3.

Input: The LA-Pattern set $\{< Act_i >_u^w \rightarrow G\}$
The learning purpose set $\{G_n\}$
Output: The Goal-driven Learning Group set $\{\{[< Act_k >_{u_1,u_2,\ldots,u_i}^{w_1,w_2,\ldots,w_i}][G_j, T]\}\}$

Step 1: For each user u_i, according to the learning purpose set $\{G_n\}$, divide the LA-Pattern set $\{< act_i >_u^w \rightarrow G\}$ into several sub-sets, which can be recorded as $\{[< act_j >_u^w, \ldots, < act_k >_u^w] \rightarrow G_n\}_{u_i}$
Step 2: group the Learning Action Pattern set $\{[< act_j >_u^w, \ldots, < act_k >_u^w] \rightarrow G_n\}_{u_i}$ by selecting the learning action sequence $[< act_j >_u^w, \ldots, < act_k >_u^w]$ with the same learning purpose G in a specific time period T
Step 3: In each group, incorporate each $< Act_j >_u^w$ which may have the same learning action sequence, and record as $[< Act_k >_{u_1,u_2,\ldots,u_i}^{w_1,w_2,\ldots,w_i}]$
Step 4: Return the $\{\{[< Act_k >_{u_1,u_2,\ldots,u_i}^{w_1,w_2,\ldots,w_i}][G_j, T]\}\}$ as the final the Goal-driven Learning Group set

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Fig. 3. Algorithm for Goal-driven Learning Group generation

Based on these discussed above, it can be viewed as that users in the same learning group may have the most similar learning behaviors when they pursue the same learning purpose within a task-oriented learning process. Thus, in order to facilitate their collaboration works to reach better learning efficiency, in our system, we try to share the information and knowledge among them by recommending a target user with the selected suitable learning action as the further learning guide.

5 Moodle-Based Prototype System

The architecture of a prototype system for the individualized learning activity recommendation is shown in Fig.4.

This prototype system consists of four major components: Learning Action Extractor, Learning Action Pattern Analyzer, Goal-driven Learning Group Generator and Individualized Action Recommender.

The Learning Action Extractor is employed to extract the learning actions generated by users in a specific learning course from Access Logs. The Learning Action Pattern Analyzer is used to calculate the LA-Patterns according to the analysis of learning behaviors from learning actions. By Goal-driven Learning Group Generator, users will be divided into several Goal-driven Learning Groups based on

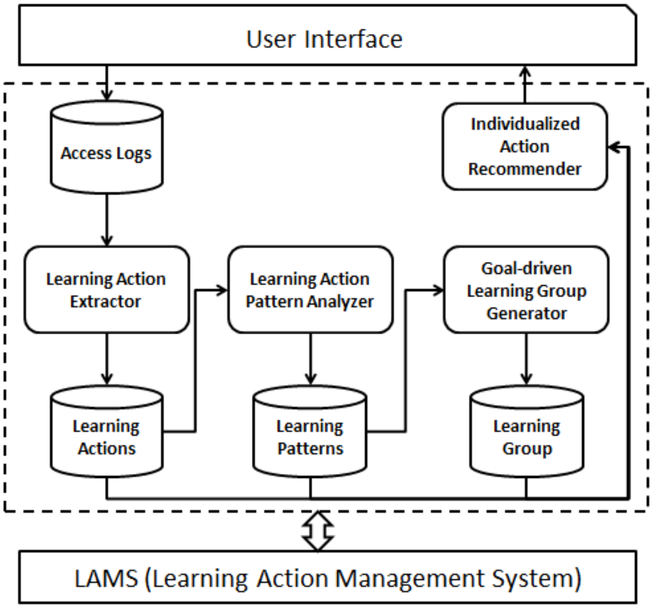

Fig. 4. Architecture of the Task-oriented prototype system

the LA-Pattern analysis. The Individualized Action Recommender is responsible for sharing the possible learning activity among the similar users. Finally, the LAMS (Learning Action Management System) concentrate on managing all the learning actions and controlling the whole recommendation process in this system.

In order to analyze users' learning behavior patterns and their similarities, a prototype system for experimental evaluation has been built within the Moodle system, a learning content management system. We designed an activity course that consists of 15 learning activities corresponding to 15 weeks. Every learning activity begins on Monday, and ends on Sunday. A quiz is prepared at the end of each learning activity. Learning process logs of more than 34 students' were used to infer the successful learning activity.

As shown in Fig.5, in this Moodle based recommendation system, a standard learning process is introduced in a list first for all the users in this learning course to follow by. When a target user logs into the system next time, the last learning action will be shown. Based on these, the recommendation based on the calculation of the similarity of the LA-Patterns will be provided thereafter. For instance, in this case, Step 6, showing in Fig. 5, may be the most recommended learning action as the next learning step in accordance with those learning actions from users in the same Goal-driven Learning Group.

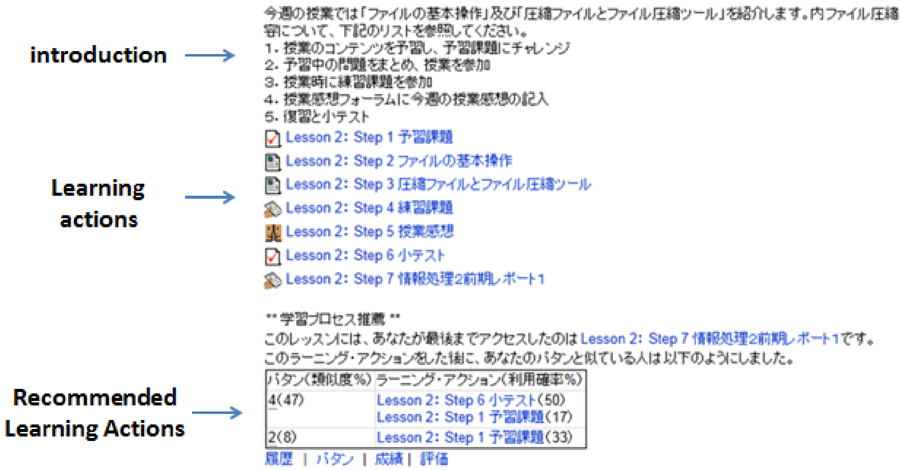

Fig. 5. A snapshot of using the prototype system

6 Conclusion

In this study, we have proposed an approach to modeling and analyzing users' learning behaviors which are described by learning actions and learning activities in a task-oriented learning process, in order to support the learning collaborations in the web-based environment.

We first introduced a hierarchical model to describe the relationships among learning actions, learning activities, learning sub-tasks and learning tasks in an abstract level. After that, the LA-Pattern was proposed to discover and represent the user learning behavior pattern described by the sequence of learning actions, and the Goal-driven Learning Group was introduced to analyze the similarity of users' learning behaviors according to the LA-Patterns. Based on these, two algorithms have been developed to calculate and generate the LA-Pattern and Goal-driven Learning Group respectively. Finally, the design of the prototype system and application example have been described.

As for the future work, we will improve the user learning behavior model and further try to employ the proposed learning patterns to support the recommendation in the task-oriented learning processes. In addition, we will fully implement the system with the developed algorithms, and evaluate our proposed approach.

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Automated Evaluation of Student Comments on Their Learning Behavior

Kazumasa Goda[1], Sachio Hirokawa[2], and Tsunenori Mine[3]

[1] Kyushu Institute of Information Science, Dazaifu, Fukuoka 818-0117, Japan
gouda@kiis.ac.jp
[2] Kyushu University, Hakozaki, Fukuoka 812-8581, Japan
hirokawa@cc.kyushu-u.ac.jp
[3] Kyushu University, Motooka, Fukuoka 819-0395, Japan
mine@ait.kyushu-u.ac.jp

Abstract. Learning comments are valuable sources of interpreting student status of understanding. The PCN method introduced in [Gouda2011] analyzes the attitudes of a student from a view point of time series. Each sentence of a comment is manually classified as one of P,C,N or O sentence. P(previous) indicates learning activities before the classtime, C(current) represents understanding or achievements during the classtime, and N(next) means a learning activity plan or goal until next class. The present paper applies SVM(Support Vecotor Machine) to predict the category to which a given sentence belongs. Empirical evaluation using 4,086 sentences was conducted. By selecting feature words of each category, the prediction performance was satisfactory with F-measures 0.8203, 0.7352, 0.8416 and 0.8612 for P,C,N and O respectively.

1 Introduction

To grasp a student's learning situation is indispensable for providing a good education. Teachers want to estimate their students' learning situations at an early stage of their class. They want to teach more advanced contents to high-achieving student or others whose results are being improved. Average students have to be analyzed so that teachers can figure out problems or difficulties they have. Poor-achieving students or others who are likely to fail in their final examination need much care. Students' comments are good resources to predict their learning situation. However, the description of comments should be appropriate for estimating the real situation. We need some kind of measurement to evaluate how a student comment is useful to estimate their learning situation.

It is becoming easy to collect the data about study by digitization of learning environment. Analysis of those collected study data has also prospered in connection with it. The term EDM (Educational Data Mining) also gains popularity. The data about study can be divided roughly into the two categories depending on whether they are directly related to results or not. A periodic exam, a quiz, and a report and an attendance situation are directly related to

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results. The use record of an assessment-of-students-by-their-teachers questionnaire, comment and students' log in a learning system, or learning environment, and self-study evaluation are not directly related to results.

The analysis of data directly related to results leads to increased efficiency of work of grading or evaluation. Therefore, many researches have been engaged on automation or reductions of grading costs. Not only multiple exclusive selective form, or fill-in-the-blank questions, which are easy to carry out, but also description froms grading of the paper and the essay are targets of automatic evaluation and put in practical use [2,6].

On the other hand, careful analysis of students behavior is crucial even if they are not directly related to their final results. However, teachers do not have enough time to analyze those data. As a result, those data are collected in the gross at the end of a term in many cases. Therefore, the time particle size tends to become large. In analysis of the questionnaire used for assessment of students by teachers, a subjective evaluation is made based on teachers impression or free description is just shown. In the use of information on a learning system or learning environment, the time particle size of a concrete target, such as access logs of an e-learning system is too small to interpret anything from a line of log. Combination with other data is necessary to interpret them.

The time particle size of comment is small and useful. They are used for the lesson improvement and the study improvement as feedback toward the individual reply from the teacher to each student, and to the whole students. There is much room for improvement of analytical skills and method for student comments.

The PCN method is proposed in [4,5] for estimating a lesson participating attitude quantitatively from the student's free description sentences. The PCN method analyzes students' description from the four view points: P(Previous behavior to a class), C(Current situation in a class), N(Next learning schedule) and O(others). In [4,5], the PCN scores are determined to each sentence by teachers who read them in detail. Students are asked to describe their behavior in three forms that correspond to the three view points of P,C and N. However, there is a wide range of distribution on level of appropriateness. Some students describe properly with respect to the three viewpoints. However, there are some comments in which different viewpoints are mixed. The score is based on the level of how the comment is described appropriately for the three view points P, C and N. The total score of student's lesson participating attitude was calculated as the sum of those scores of sentences. This PCN score and the subjective evaluation of each student are in well agreement with each other. A strong relation between the PCN score and the final evaluation with respect to each student was reported in [4,5].

A difficulty in [4,5] is that analyzing and determining PCN scores of sentences takes long time and hard work. The present paper applies SVM(Support Vector Machine) to estimate PCN scores.

The high accuracy of prediction performance will be a basis of understanding and grasping the student learning efforts and status. The time series analysis of the PCN-score will provide clues to interpret the scores obtained by small tests in each lesson. Not only the score of the lesson, but the attitude of student to the class will be useful to discover the students with some difficulties. The writing style of their response will reflect their problem. They could not focus on what they are supposed to write even they are asked for their comments on P, C or N. If they respond properly to each of P, C and N, we would be able to figure out their difficulties. If their response omits details, the teacher should ask and follow them to find their problem before the final examination.

2 Related Work

Development of the research on analysis of study data is remarkable. The research is called EDM(Educational Data Mining) and is becoming one field. The international conference on the theme is held from 2008 every year [1]. Not only the numerical value and character of the answer of the test of fill-in-the-blank questions but text data like an essay and the server log of an e-learning system in the data are used as the candidate for analysis. The previous studies mainly consider the data about students' learning behavior logs recorded unconsciously such as server log of an e-learning system. However, the time particle size of those data is too fine. So, it is necessary to interpret in combination with other data, and analysis is not easy. The study data used by our research is a comment text which a student describes by natural language immediately after a lesson at each time. A student writes looking back upon his learned behavior and situation. Similar approach is taken also in self-control study (Self-Regulated Learning [15]) that the student itself evaluates. Since it is a registered form, correspondence with a student and a document is clear and contrast with the last results is easy. Since they are collected at each classtime, it is easy to grasp not only a whole tendency but the change for every time, and a student individual's change.

Many researches considerd the early detection of dropout of students based on the objective data such as server log and attributes of a student [3,11,12,9]. They presume a student's action and behavior focusing on the time of the data for analysis being created. However, as compared with each time of a lesson, the time particle size of such analysis is too small. The analysis result obtained is too concrete and tends to become fragmentary.

On the other hand, the PCN method, proposed in [4,5], used student comments as subjectivity data to presume the student's learning situation. They classify the data into four items of school hours (Current), prior learned behavior (Previous), an ex post facto learning scheme (Next), and others (Other). Since the analysis and response are performed right after the lesson, feed backs are in good timing and intelligible for students.

SVM is a machine learning technique widely used for the text classification of the reputation information about a company or goods. In order to apply SVM, it is necessary to classify the target document into positive examples and negative examples according to prepared training data. Next, a discernment model is built and a concrete document group is classified according to the hyperplane which separates positive examples and negative examples. The present paper applied SVM to generate models to distinguish four classes P,C,N and O of sentences of student comments.

3 Feature Words of Student Comment

3.1 Basic Analysis of Data

The first author of the present paper gave lectures on programming for two classes where 123 students attended. The class lasted 15 weeks. The student comments werecollected last half 9 lessons, i.e. from 7 to 15 lessons. They were asked to fill in the four simple quiestionnaires on their learning behavior. They answered how they prepared to attend the class (Previous), how they engaged in the class (Current) and what they thought for the next class (Next). Student can write other comments (Other) as well. So, a response of a student at a classtime consits of four small documents each of which is categorized in P,C,N or O. The total number of documents we analyse is 4086, which is almost equal to 4*9*123 = 4428. Most of the documents consit of single sentence. We constructed a search engine using GETA [1].

3.2 Feature Words by TF*IDF and SMART

In this section, we firstly extracted the feature words of each sentence of PCNO according to TF*IDF and SMART measurement. Remembe that each sentence is categorized into P,C,N or O. We used the functions provided in GETA search engine. TF*IDF is a measure widely used as importance of the word which appears in the document of search results. The TF*IDF score of a term is high score when the term appears often in the search result and does in a few documents. The SMART measure is introduced in [13] and is a default measure in GETA. Table 1 and 2 show the top 5 feature words by TF*IDF and by SMART with respect to each category P,C,N and O. The target documents of the present paper are short sentences. Most of terms appear at most once or twice in a sentence. As a result, TF*IDF does not give appropriate words that characterize P, C and N. On the other hand, feature words by SMART seem meaningful.

Table 1. Feature Words by TF*IDF

class	words
p	talk, category, handful, about, break down
c	norm, get off, overcome, number, dark blue
n	left, around, perfect, repeat, drive
o	month, air conditioning, collection, abbreviation, byte

[1] http://geta.ex.nii.ac.jp/

Table 2. Feature Words by SMART

class	words
p	slides, material, read, through, beforehand
c	problem, can, somehow, middle, catch
n	next time, review, firmly, report, think
o	become, care, notice, *no(Japanese), think

4 Prediction Performance of PCNO Sentences by SVM

We applied SVM to 4086 sentences which are classified into four classes P,C,N and O. Each sentence was expressed as a vector of 1 and 0 depending on whether the word appear in the sentence or not. Table 3 displays the performance of prediction by SVM based on 10 fold cross validation. The scores are not perfect ones. But they are useful compared to laborious labeling by human. The category P has the best performance and the category O has the worst, as we expected.

Table 3. Prediction Performance

category	precision	recall	F-measure	Accuracy
P	0.5995	0.8827	0.7136	0.8220
C	0.5088	0.8993	0.6492	0.7565
N	0.5073	0.8875	0.6438	0.7551
O	0.6477	0.5833	0.6130	0.8184

4.1 Score of Words with Respect to SVM

The value of F-measure and accuracy are satisfactory to some extent. Next, we considered if the model obtained by SVM is appropriate or not, by calculating the importance of each word. There is no standard way to estimate the importance of a word for SVM. So, we evaluated the importance of a word by identifying a word with an imaginary sentence that only contains the word. We consider the score of the document, obtained by the SVM model, as the score of the word. The score represents the distance from the word to the hyper plane that separate positive and negative data. Table 4 displays the top 5 positive and negative features of each category. The lists of positive features are similar to the ones by SMART. The crucial differences between Table 4 and Table 1,2 are in the negative list of words.

Table 4. Positive and Negative Features

class	Positive Words	Negative Words
p	previous, read, preparation, through, slides	next, already, think, get used, catch up
c	catch up, training, follow, able, problem	through, next, review, confirm, do best
n	next, review, rest, once again, make use	previous, nice, very much, pre, easy
o	notice, improve, important, get to know, realize	time, make use, slides, learn, review

5 Feature Selection for PCN Sentences

In the previous section, the score of each word is calculated by applying the SVM model for the imaginary document that contain only the word. If we draw the graph of distribution of score of words, we observe that almost all words have the score zero, which implies that they are not related to discernment of PCNO. Only few words have non-zero scores. These words are considered to be effective in discernment of PCNO. We use top potitive words and bottom netative words with respect to the score for feature selction to vectorize the sentences.

The strength of SVM is that we can apply it even when the number of features is quite large, since SVM extracts the support vectors which usually have a small number. However, it is pointed out that an appropriate feature selection improves the performance, particularly when the target data are short sentences [14]. It is reported that the prediction performance is attained by appropriate number of top words with respect to SVM score[14]. The data we analyze in the present paper are sentences, for which the feature selection will improve the prediction performance.

Table 5 shows the performance evaluation based on feature seletion. The last column of "optimal size" describes the optimal number of feature words.

Table 5. Prediction Performance with Optimal Feature Selection

category	precision	recall	F-measure	Accuracy	optimal size
p	0.7959	0.8491	0.8203	0.8706	10
c	0.7227	0.7521	0.7352	0.8629	20
n	0.8032	0.9229	0.8416	0.8427	1
o	0.8824	0.8540	0.8612	0.9263	1

5.1 Feature Selection for P Sentence

Figure 1 display precision, recall, F-measure and accuracy of prediction performance of P sentence using top N feature words. We chose top N positive words and top N negative words to vectorize sentences. The performance is obtained by 10 fold cross validation. The horizontal axis represents the number N of feature words. The horizontal straight line represents the F-measure of the base line where all words are used. The F-measure drops at the point $N = 3$ and increased to reach the maximal score 0.8203 at $N = 10$. This score is better

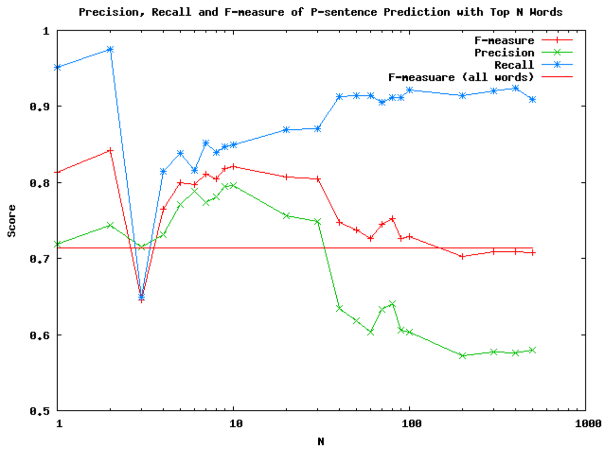

Fig. 1. Prediction Performance of Feature Selection of Top words (P-sentence)

than F-measure 0.7136 of the base line. Thus, the feature selection improves the performance in predicting P sentence.

Table 6 shows the top 10 positive and negative feature words of P sentence. The number following a word shows the number of sentences that contain the word. From the table, we can read, for example, that most top positive words occur often in P sentence. However, the second negative word “already(0)” does not occur in P sentence. The third negative word “think(69)” occurs in 69 P sentences among all of 1023 P sentences. This word does not seem to be a feature word of P sentence. The deterioration of F-measure at $N = 3$, i.e., with the word “think” might be caused by the property of SVM. The model of SVM is determined by the support vectors which may represent many sentences. The number of sentences does not matter when evaluating the distance from the separating hyper plane. The support vector gives a good separation of positive and negative samples, as long as we do not count the number of samples with the same vector values. We think that parameter adjustment will be required to gain much better performance, though the current score is quite good.

Table 6. Top 10 Feature Words of P sentence

	1	2	3	4	5
+	previous(152)	read(211)	preparation(355)	through(99)	slides(446)
-	next(8)	already(0)	think(69)	get used(4)	catch up(14)
	6	7	8	9	10
+	in advance(90)	stage(15)	confirm(81)	single reading(8)	internet(9)
-	firmly(25)	all(3)	teacher(2)	more(2)	somehow(0)

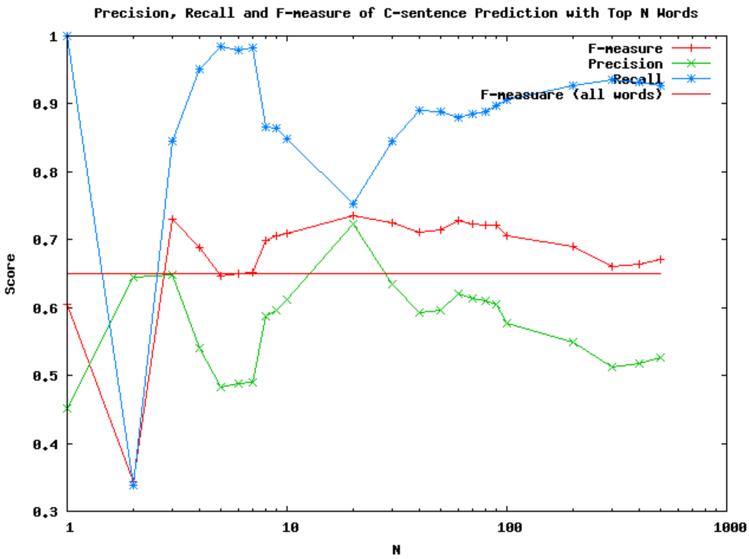

Fig. 2. Prediction Performance of Feature Selection of Top words (C-sentence)

Table 7. Top 20 Feature Words of C sentence

	1	2	3	4	5
+	catch up(62)	training(18)	follow(61)	able(503)	problem(303)
-	through(0)	next(3)	review(22)	confirm(7)	do best(6)
	6	7	8	9	10
+	middle(48)	learn(60)	somehow(60)	listen(11)	able(22)
-	rest(0)	notice(2)	think(112)	put(5)	presentation(0)
	11	12	13	14	15
+	receive(16)	teacher(60)	question(46)	two(28)	proceed(19)
-	loop(1)	preparation(60)	firmly(21)	read(6)	like(85)
	16	17	18	19	20
+	concentration(15)	nice(44)	listen(51)	root(27)	almost(16)
-	report(19)	slides(40)	power(2)	come(0)	bring forward(0)

5.2 Feature Selection for C Sentence

Figure 2 displays precision, recall, F-measure and accuracy of prediction performance of C sentence using top N feature words. The best F-measure 0.7352 is obtained at $N = 20$. This F-measure is better than 0.6492 of the base line. Top 20 feature words are shown in Table 7 where meaningful words can be seen.

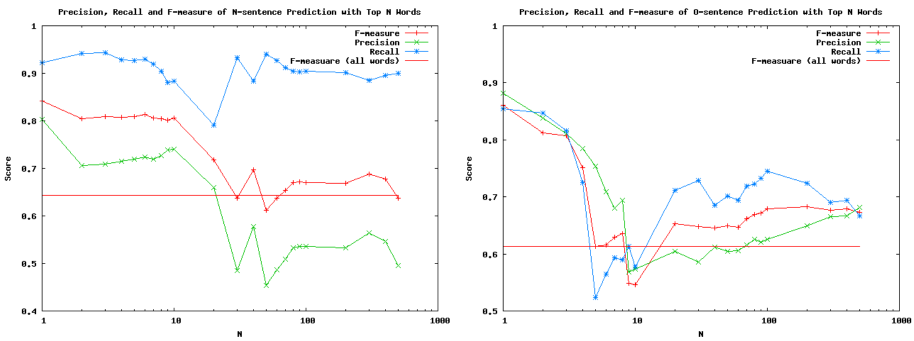

Fig. 3. Prediction Performance with top words (N and O sentence)

5.3 Feature Selection for N Sentence and O Sentence

The effect of feature selection for N and O sentences are quite different to that for P and C sentences, as we can see in Figure 3. The best F-measures are obtained at $N = 1$ for N sentence as well as for O sentence.

6 Conclusion and Further Work

Careful observation of students behavior is very effective to guess the difficulty they have and to improve education. The PCN method introduced in [4,5] is a quantitative method to interpret student's behavior before, during and after a class. The PCN score is a measurement for evaluating how the sentence is described properly for the aspect of P (previous), C (current), N (next) and O (other). The present paper applied machine learning method SVM to categorize students' comments into P, C, N and O. By empirical evaluation, it is confirmed that prediction performances as F-measures are 0.7136, 0.6492, 0.6438 and 0.6130 for P,C,N and O respectively. Moreover, the better performance was obtained applying feature selection with top 10, 20, 1 and 1 feature words for P, C, N and O respectively. These top feature words are confirmed meaningful to interpret the sentences of each category. Extraction of typical expression from proper PCN sentences, which is useful for results prediction, is the next subject for further work.

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Support for Non IT Savvy Teachers to Incorporate Games

Cat Kutay[1], Moira Sim[2], and Toni Wain[2]

[1] CSE The University of New South Walesn
[2] SIRCH Edith Cowan University
ckutay@cse.unsw.edu.au, {m.sim,t.wain}@ecu.edu.au

Abstract. This research is to provide the tools for novice IT users to develop immersive games for teaching. The tools were developed in the context of a project in which Aboriginal Australian people, who are members of university or general communities, describe and explain their culture to non-Aboriginal students. Learning from Aboriginal cultural ways of teaching, these tools can be applied to other domains.

The teaching environment includes recorded narratives in an interactive cross-cultural training game which is to be used as part of the professional preparation of students working in health.

The paper focuses on the tools used to generate learning environment from the stories. This includes authoring the rules for the agent's emergent narrative in the teaching games, learning paths to link individual contribution into a coherent story, and scenarios generated using visual tools to support contributors.

The tools have been used to generate prototypes from a previously collected set of stories stories, constructing scenarios by compiling them from simpler interactions and this process will be used in future story collection workshops to provide story providers with better control of how they will contribute to the teaching framework.

Keywords: Indigenous storytelling, authoring tools.

1 Introduction

This work is in the area of Culturally-Aware Teaching and describes tools that combine resources from many different contributors to describe an environment that is remote from the learner either in time or place. The context we work with is Aboriginal history and culture which is not well understood by the majority of people in Australia. Ignorance has in the past led to actions which have had devastating impact on Aboriginal peoples and negative attitudes which perpetuate myths and prejudices.

The main learning content of the game worlds developed in this project is narratives provided by the Aboriginal Australian people whose knowledge sharing techniques suggest an alternative way of organising knowledge for teaching, such as linking these separate narratives through themes, location and the story

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context (Kutay & Ho, 2009) to form a conversation. Using immersive games in education can elucidate and change attitudes and improve the social context for creating a safer culture for all. Furthermore, this approach to teaching can be used a variety of courses.

Engaging students in education in any reflective course can be a challenge. We live in a society where we have grown up with biases and when provided with information that is contrary to our beliefs, we resist this new view. However learning environments such as immersive narratives and games have the potential to break down the barriers, allowing new information in a less threatening way, and creating interaction or discussion between students.

In this research we combine the gaming technology with resources that can change views, and aim to develop a tool which teachers can use to modify content and context, so that they can develop relevant material and generate interactive games that simultaneously challenge the students to think differently.

This tool has been now been used to develop games for two learning scenarios on different topics. We use a simulation format that allows non-IT savvy teachers to review and approve the various scenarios generated before running in the game environment. This first evaluation is based on the creation of educational games from a repository of community narratives, and scenarios that are enacted by virtual human agents to provide authentic emergent narratives.

2 Teaching Culture through Collaborative Narratives

There are different approaches to teaching culture, and in this project we use the Aboriginal method of teaching through narratives, as well as immersion in cultural processes through interactive narratives generated by virtual humans. We are using an online repository to gather stories from remote and urban Western Australia as learning content. However, to use a collection of stories in teaching we need to link them into a coherent whole, to provide a containing narrative in which the stories will be used. To do this we are taking the approach Aboriginal people use in teaching their children about the environment. The teaching process is holistic, in that it involves many aspects and approaches in the one story. However each teaching session or game will focus on a single theme or a location.

For this we are developing a system that involves generating a website around the main theme of the story, such as health or kinship relations, and then supporting community people to record and submit stories related to the theme. The teacher's role is to elect relevant stores to their students and place these in the game. To increase immersion and interaction we have added the ability to create simple scenarios around sub themes.

The course material developed at Edith Cowan University is used to teach Aboriginal health issues using online multimedia, which include four scripted scenarios performed by actors and a collection of individual stories on video. The project was developed with an OLT grant and included the generation of scripted scenarios as videos on themes selected by the Aboriginal Reference

Group: Communication, Stolen, Stereotyping and Passing On. These have been done as the scripted scenarios, but more scenarios can now be generated from game avatars, as discussed below. A final stage of the lending environment is to add automated interaction with the users by avatars, where they react in culture to the user to provide feedback in a role-play environment.

2.1 Related Work

Research into teaching cultural competencies has emphasised the value of story telling by those from the culture being taught (Search, 2007) & (Murphy-Shigematsu, 2009), and immersive role-plays for those learning the culture (Pepe & Santarelli, 2009). These have been developed for face-to-face courses that have been shared around the world, such as 'Brown Eyes versus Blue Eyes' developed by Jane Elliot, and the same concepts used in game design.

Games have also been used in cross-cultural learning (Gee, 2003), and have been shown to be valuable, partly through their immersive nature and the role playing aspects. However given the nature of the course and the variety of learning material, the problem we are dealing with is how to assist the teachers and Aboriginal storytellers to combine their contributions and create the games which our non-Aboriginal students can use to gain the cultural competency required in their professional work in Australia.

The authoring tools are to allow teachers to author these games, or create games from previously authored parts, as a series of scenarios to provide a context for the stories and to provide the agent rules for the auto-generation of short interactions in the games. The visual interface and simulation of the model allows teachers to check the concepts are being taught correctly and to demonstrate their concepts to more novice users. This is important as the virtual agent interactions are to provide vignettes between viewing the recorded stories, so that the students are immersed in situations that emulate aspects of Aboriginal culture, or various forms of this culture, as well as listening to relevant stories.

Similar existing tools such as the Alelo system developed by (Johnson, 2008) help teachers develop role-playing games where text and audio instructions are linked to virtual human behaviour. Alelo uses a graphical editor to generate dialogues and build up more complex systems from previously generated ones. Other authoring tools such as TutTalk (Jordan et al., 2007) and StoryTec (Memh et al., 2011) provide a sophisticated tool for editing dialogue interactions and options. These allow the collaboration of learning domain experts with technical and gaming experts. Also simple storytelling tools exist for scripting online scenarios, such as Xtranormal (Xtranormal , 2013). The authoring tool developed in this work is used for more complex games, not simply scripted scenarios.

3 Learning Design

The prototype teaching system based on face-to-face use of the videos and scenarios has been evaluated and we discuss this in developing the implementation of these courses with the developed authoring tools and how to provide a relationship between the 'modern' online games and the traditional knowledge sharing process we are trying to emulate. There are four areas of interest:

Authority to Speak. A significant feature of traditional storytelling is only those with authority to speak are able to present a story. Authority comes from 'being there' in person or through a close relation, being part of the group involved in the story or having some personal connection to the story (Povinelli, 1993).

Deferral to Others. When Aboriginal storytellers are speaking, they will often include or invite other speakers, singers and performers into the story, either to vary the story detail based on who is present; to emphasise the main points by getting corroboration; or to allow alternative view points to be expressed (Povinelli, 1993; Langton, 1997).

Stories Fit within a Larger Theme. Aboriginal stories relate back to other stories. In particular the 'Dreamtime' stories are presented to children as simple moral stores, that grow with the child, to provide context for information on where to hunt and how to care for animals and the environment (Kutay & Ho, 2009).

Knowledge is Given not Requested. When using a holistic, narrative teaching approach information is given within the story. While the teller of the story may start at any point in the narrative, it is their decision where to start. To elicit information a learner must give their understanding first as a statement of understanding, rather than a question, so the teller knows where to start and how to direct their story.

We deal with the first aspect by allowing people to speak for themselves and of their own story. However that makes the second aspect harder to manage. In fact we are finding that when we record people after workshops they like to talk together, combining their stories, in a more traditional format than the European style of solo interviews. This will provide support for learners as they hear the Aboriginal storytellers explain their experience of history to each other. On the third point we are using introductory material to provide a context, both for collecting the stories and for intro ducting the students to the game. We hope this will prove a generic introduction to many such games, which will allow students to play more than once and gain more each time. The fourth point relates to the evaluation of the authoring tool and how we elicit feedback.

We show here how the authoring tools allow the teachers to provide a learning environment for their students that incorporates these features.

4 Teaching with Narratives in Games

In the overall project we are providing a story telling system to present a group narrative, through a process where different contributors can provide stories through online submission. The teachers then select from these stories and design scenarios and learning paths that assist students in the desired knowledge acquisition, and comprehension of specific cultural rules, patterns or historical processes. Virtual human agents provide enactment of various scenarios and take roles tailored to the students professional needs.

While the system is being designed around a specific learning domain of culture-awareness of the Aboriginal experience in Australia, the design is flexible to allow for future adaption. Feedback on the cultural relevancy of the first games is being gathered using workshops or teaching face to face in courses. The authoring tools enable teachers to change the learning environment such as location, theme and scenario scripts, and to incorporate a continually updated repository of stories. We discuss below the support for authoring the games, but first we describe in a little detail the system they are authoring.

4.1 Teaching Components

The game system has been built using the Unity game engine and its scripting interface. This involves a combined approach to support the following learning formats:

Locate Stories. The game environment will vary across disciplines, for instance a hospital for health students, school for education students, etc. Hence we need a relatively cheap and easy interface to create scenes from components available from other game creators, and to place the video viewing panels within the game.

Teaching Framework. The teachers add learning paths that are relevant to their teaching goals, and track the student's progress through videos or interacting with scenes and use these as a record of their learning and guide their next move in the game.

Generate Role-Play Scenarios from Audio Scripts. We offer short scenarios with agents acting to audio scripts. The scrips have been developed from previous work in creating role-plays and the in game scenario is developed on a time line.

Generated Emergent Narratives from Agents. Using the kinship rules of Aboriginal culture and a culturally aware agent modelling system we can create in game narratives that emerge from the interaction with the student and between agents.

The authoring requirements differ for each of these components. To locate stories we use the database to handle the different media formats and allow commenting of video segments. The learning paths are created by writing rules that will be applied to the student as they navigate the system. The scripted role-play scenes are edited on a timeline, in a Machinima style editor. To provide scenarios where the student can interact more freely within the culture, we use an event based modelling system (Kutay et al., 2012b) to define cultural norms.

The generation of games is therefore a complex and non-intuitive task, which need creative tools to enable teachers to develop their own resources and create gaming environments.

4.2 Authoring Scenarios and Learning Paths

The authoring tools for creating the interactions for the students incorporate features for implementing the learning paths and agent interaction rules. These tools provide visual definition of the rules as the teacher writes them, and can be run as a simulation of the final rules. There are three types of authoring.

4.3 Scripted Role-Play

Using existing material developed for the course, we have used the actor's scripts to develop short role-plays showing typical issues in cultural misunderstandings in Australia. The Machinima timeline shown in Fig:1 is used to add timed events and link to agents that are configured to work with Unity animator system. This tool allows the teacher to run the edited scene through to view their edits in action. Also the scenes can be saved using the front-end XML description language and re-used in different games where relevant. At present we are using Machinima to recreate existing films, using the extracted audio, but the tool is able to support the creation of any animated scene if dialogue is provided.

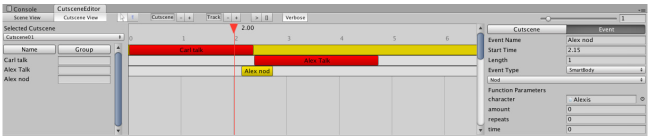

Fig. 1. Machinima tool interface

4.4 Creating Teaching Framework

The teacher selects the story videos related to the agent scenarios and place these in a "room". These rooms are pre-designed Unity scenes, and are created with locations for videos. The videos are linked according to their tags. So if the teacher specifies that a location in the game is to deal with the communication theme, the video having that tag are shown. When the student select the videos a record is kept of the range of contexts, etc. they have covered as these attributes are used in the state charts to generate a learning path between videos, or to select the next appropriate video. The teacher must also select the Unity scene and the location within the scene each group of videos will be placed in for that scenario.

4.5 Interactions and Agent Modelling

When story providers and teachers design the agent modelling they develop the learning format and guide the students' interactions. We prefer some sections to be written in collaboration with Aboriginal people as this relates closely to the cultural teaching rather than general educational knowledge. Hence the visual modelling tools will enable a more open design process for the rules for agent interaction, and some aspects of the scenarios rules, These incorporate the teaching guidelines, as questions for reflection or text material to guide students which are provided by storytellers and can be edited by teachers.

5 Evaluation Methodology

We have been using Activity Theory to evaluation the initial online workshop videos and prototype games (Kutay et al. , 2012b). While the storytellers have some familiarity with recording and sharing online, we need to respect the contributors methods of expressing their interest or otherwise in using the tool, and what other tools or functions they might like to have. We work with cultural reference groups for each project, run focus groups at community workshops to prepare contributors and gain a better understanding of what they wish to teach, and run surveys for teachers who use the website. We are preparing one for those who first use the authoring tools.

5.1 Prototype

The first implementation of the course at Edith Cowan University (ECU) teaches Aboriginal health issues using online material that is incorporated into face-to-face teaching. The four scripted scenarios discussed above were linked to teaching notes and were viewed nearly twice as much as the individual stories. We suspect this may be due to two reasons:

1. The scenarios are a combination of many individual stories, providing an easy to digest summary
2. The teaching guidelines provided more assistance to non-Aboriginal teachers for guiding and accessing learning.

Hence we are:

1. Providing tools for teachers to edit new scenarios from scripts which they can author themselves, and
2. Asking story tellers to add reflective questions when they submit story, and teachers can link these to the videos in the game.

A further item that arose in evaluation of this project was how to deal with non-Aboriginal students who are antagonised by the alternative view of Aboriginal culture. The most successful method reported by lecturers in the ECU evaluation was to continue the class ignoring the derogatory comments. By placing the learning in a game we will remove the opportunity for other class mates to be upset, or to react, allowing the student to work out the issues in their own way.

We are also running workshops in New South Wales to collect the stories under the theme of Kinship for another version of the teaching system. The workshops provide time for people to discuss what they wish to contribute to the topic of Kinship, and the stories they would like to publicly share with university students. The stories are of people's experience, to show that the sum of these form an experience that is well beyond the experience of non-Aboriginal Australians.

The first authored game scenarios are to show the contributors how those stories will be used, the context, so they will be confident that their story will not be misused or misinterpreted. While the risk is that the non-Aboriginal students will not understand or appreciate the significance of such stories, or just not believe them, some Aboriginal people have expressed their belief that by locating them in a group of stories and allowing them to reinforce each other, will provide material for a variety of learners to construct their understanding of the history and culture.

5.2 Case Studies

We developed the first prototype games to analyse suitable interface and learning paths to guide the students between video sites. These were developed by hand to provide the template for the type of interactions that can be used in the scenarios. Similarly the placement of videos and the rules for guiding the student between videos were tested in the first prototype then had to be generalised to a scene with six video locations.

The second game uses the role-play scenario authoring component tools described above and has a focus on the health aspect of doctor-patient communication. The parts of the game are run as separate levels, so do not interact yet, although data can be recorded of the student's progress through all levels. For the teachers creating the scenarios, each of the components are complete in itself and can be re-used in another game. We use short scripted role-plays where actors have provided the audio script and the Machinima timeline tool is used to edit the agents actions.

In the second level the game displays the recorded video stories, guides the student between stories, and allows the student to select stories. We create new learning environments by specifying the stories available for the students to listen to, and the learning path between the stories, such as providing thematic sequences.

The final part of the game is a short emergent narrative generated by the virtual humans following cultural rules. When these games are played by students, the student can then step through a selection of options as to how they deal with the problem, and receive the response that is appropriate to the cultural rules plus feedback from the mood of the agents, or they can ask for assistance and watch the agents step through the same process with the student as observer.

6 Evaluation

The authoring tool provides an interface for teachers to develop and simulate their designs of the learning environment and the cultural rules. However the feedback has lead to the inclusion of further actions for the scenario, to provide more interesting acting by the agents. Feedback from teachers as they use the tools in game generation, and as our experience of their needs improves will expand the scripted components. The generic event scripting classes provide the format to incorporate further agent action into the timeline.

Feedback has also suggested we are add an interactive component to the scripted scenarios that includes pauses for reflective questions and student response. These response will be collected and emailed to the students (with an option to submit to the teacher).

For the integration of videos into Unity scenes we have web interface where teachers select the videos they will use. The videos are also allocated to locations in the "game room" and can have more than one video per location. The rules to determine which video will be seen by a student have been developed using the tags that authors use to describe the videos. However this will change for the domain, so we will need to develop a generic way of classifying tags and using those to describe the learner model and suitable videos to display during any session in the game, and incorporate this into the learning path scripting tool.

When running the first Unity games from the generated code we found that the teachers needed tools to provide more guidance for negotiating the system. To improve the system we have provided support which can now be integrated into the authoring tool:

Speech Balloons used instead of text lines as provide a more natural perception of the interchange.

Visual Tag for agents and videos to describe their relation to speaker, using generic kinship system from the original workshop.

Video Selection tools improved with ability to edit related introduction and reflective questions.

Audio and Text Instruction to improve accessibility.

7 Issues for Future Work

Each story provided for the repository contains material from many themes. It would be hard for the story providers to annotate these, and retain consistent set of tags. The web repository allows the annotation to be done online, but is it a slow process of generating clips one at a time. To improve this we need a selection of tags for annotating video clips derived from the themes presented in workshops and from the first stories collected.

There is also more options that need to be included in the generation of learning paths to allow more flexible use of videos and a greater variety of Unity scenes in which the videos can be placed. Also we have planned workshops with community members that will involve training for Aboriginal community members to learn how to submit their stories, and we hope this process will be a continuing process providing fresh material for teachers.

At present the games are run using the Unity game engine. however the system is designed to be independent of the environment used and the graphical scripting tools generate XML code that can then be interpreted in any game environment.

Also the scenarios will be tested with students, who will provide improvement for the teaching design, yet we find the simple scenarios already provide some idea of the complexity of Aboriginal society and experience.

8 Conclusion

Web service for collecting stories are already used by young Aboriginal people, however it will be harder for older people to negotiate the concepts. Hence this project uses a web design that allows the recording and submitting of stories to be separated into a two stage process where the younger people help their elders, and teachers work with elders to develop the learning environment.

Visual tools support the generation of interactive and agent based learning environments and provide for novel integration of material in learning games by novice users. The authoring system integrates video stories and simple agent interactions around a theme to provide an immersive learning environment.

It is also an aim of this project to increase Aboriginal people's skills in computing, through providing tools that inspire them to record and submit their stories. There are many other projects in Australia for collecting Aboriginal stories, and these tools are to help develop these into immersive learning environments.

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Effective Location-Based Geo-tagged Image Retrieval for Mobile Culture and Tourism Education*

Yi Zhuang[1], Dickson K.W. Chiu[2], Guochang Jiang[3], Hua Hu[4], and Nan Jiang[5]

[1] College of Computer & Information Engineering, Zhejiang Gongshang University, P.R. China
[2] Faculty of Education, the University of Hong Kong, HKSAR, P.R. China
[3] The Second Institute of Oceanography, SOA, Hangzhou, P.R. China
[4] Hangzhou Dianzi University, Hangzhou, P.R. China
[5] Hangzhou First People's Hospital, Hangzhou, P.R. China
zhuang@zjgsu.edu.cn

Abstract. With the development of Web 2.0 and location-based technologies, location- based image retrieval and indexing is now possible. This can provide high-quality support for field visits and teaching, which is an integral part for culture and tourism education. In the state-of-the-art retrieval methods, geo-tag and visual feature-based image retrieval has not been considered together so far. In this paper, we present an efficient location-based image retrieval method by conducting the search over combined *geo-tag* and *visual-feature* spaces. In this retrieval method, a cost-based query optimization scheme is proposed to optimize the query processing. Different from conventional image retrieval methods, our proposed retrieval algorithm combines the above two functions as uniform measure. Comprehensive experiments are conducted to testify the effectiveness and efficiency of our proposed retrieval and indexing methods respectively.

Keywords: social image, high-dimensional indexing, probabilistic retrieval.

1 Introduction

With the development of Web 2.0 and location-based query, location- based image retrieval and indexing have been increasingly paid much attention. In the state-of-the-art location-based image retrieval methods [1,2], *geotag*- and *visual feature*-based image retrieval has not been systematically studied so far.

Fig. 1 shows an example of images and their related spatial information from Google map. Different images have been annotated in the map, which is called *geo-tagging*. Geo-tagging is the process of adding geographical identification metadata to various contents, such as photographs, videos, websites, SMS messages, QR Codes [1], and RSS feeds. Such geospatial metadata usually consists of latitude and

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Fig. 1. Geo-tagging-based images

Table 1. The images with geo-tagged information

Images	***GPS***
I_1	(30,50)
I_2	(10,150)
I_3	(60,20)

longitude, though they can also include altitude, bearing, distance, accuracy data, and place names.

Geo-tagging can help users browse and watch the images with their location- specific information in an intuitive way. This can provide high-quality support for field visits and teaching, which is an integral part for culture and tourism education. For instance, learners can find images taken near a given location by entering latitude and longitude (see Table 1), or with values from mapping services or GPS, into a suitable image search engine. In addition, geo-tagging enabled information services can also potentially be used to find location-based news, websites, or other learning resources [1]. These can also provide learners and instructors with further reference information.

Geo-tagging can tell users the location of the content of a given picture or other media or the point of view, and conversely on some media platforms show media relevant to a given location. Therefore, it is important to model an image with both geo-tagged and visual features to facilitate location-based image browsing especially for culture and tourism education by a mobile tourism guide (*MTG*) system.

In most cases, learners would like to get some result images with a specific location, which cannot be achieved by traditional semantic- or content-based search. Moreover, the retrieval effectiveness can be further enhanced if the visual features can be involved in this search process. Therefore, in this paper, we propose a composite-feature-based image retrieval method that combines *geo-tag* and *visual* features together. To optimize this retrieval process, we also propose two histogram-based query cost estimation schemes called a geo-tag histogram(*GTH*) and a visual feature histogram(*VFH*). The main contributions of this paper are as follows:

1. We present an effective location-based geo-tagged image retrieval method by choosing composite features (i.e., *geo-tag* and *visual features*).
2. We introduce a *cost-based query order selection*(CQS) scheme to optimize the query processing.
3. We perform extensive experiments to evaluate the effectiveness and efficiency of our proposed retrieval method.

The rest of this paper is organized as follows. In Section 2, we compare related work. Then, we give preliminaries of this work in Section 3. In Sections 4, we first introduce the query cost estimation scheme, and then a location-based image retrieval method. In Section 5, we report the results of extensive experiments that are designed to evaluate the efficiency and effectiveness of the proposed approach. Finally, we conclude in the last section with our future work directions.

2 Related Work

Geo-tagged images are widely used in landmark recognition, trip visualization, and recommendation [3,5,6,7,8]. Luo et al. [9] have performed an excellent survey on some applications and approaches of geo-tagged media.

For tourism, Cao et al. [3] presented a recommendation framework in which popular sceneries are extracted by clustering geo-tagged images based on their locations. Image tags are also indexed so that users can either input a location or an image as the query. Based on the similarity to the query, representative images are returned to the user. TravelScope [7] enables users to take virtual tours in certain regions. Besides geo-tagged images, it also uses user-generated travel logs to discover points of interest. Chen et al. [5] used tourist maps with geo-tagged images to generate icons for landmarks, and also used geo-tags and user tags to cluster images, but without considering content similarity. Zheng et al. [10] proposed a *k*-means based method to classify the images for the landmark search results. De Silva et al. [6] demonstrated a system to render multimedia travel stories in response to spatial queries.

Besides geo-tagged images and videos, GPS trajectories are another form of human trails during traveling. Here GPS trajectories refer to the locations sampled by a certain time interval on dedicated GPS devices, like GPS navigators. GPS trajectories represent a vivid picture of user decisions and preferences in a more continuous way than geo-tagged images. They also preserve the transitions of people among the locations. Zheng et al. [11] pioneered in exploiting such properties to discover popular locations and travel sequences with HITS-based link analysis techniques. Zheng et al. [12] further developed such an approach for recommending locations and friends based on user GPS history. Meanwhile, GPS trajectories are also used to mine and rank semantic locations [4], and to recommend trips [10]. GPS trajectories are generally very detailed and concise. However, there are also concerns for the use of GPS trajectories for these tasks. Limited by the sample size, the data collected by dedicated GPS devices heavily depend on destinations people choose to travel to and the way people choose to travel. For instance, in a shopping complex with completely indoor venues together with limited car access, dedicated GPS devices are not able to provide information concise enough for the tracking of user trails inside the complex. On the other hand, if people choose to take buses or walks to their destinations, dedicated GPS devices are often absent in such trips.

3 Preliminaries

First, we briefly introduce the notations that will be used in the rest of paper.

Table 2. Meaning of symbols used

Symbols	Notations
ψ	a set of geo-tagged images
I_i	the i-th image and $I_i \in \psi$
n	the number of images in ψ
m	the number of reference images
$Sim(I_i,I_j)$	the visual similarity distance between two images
I_q	a query image user submits
$\Theta(I_q,r)$	a query sphere with centre I_q and radius r

Definition 1. *Geo-tag(GTag) can be modeled by a four-tuple:*

$$GTag ::= \langle tID,\ mID,\ GPS,\ uID \rangle \tag{1}$$

where

- *tID is the tag ID;*
- *mID is the tagged image ID;*
- *GPS is the location information of the mID-th image;*
- *uID is the user ID who assigns the geo-tag;*

4 Location-Based Composite Retrieval

In this section, to optimize a composite retrieval, we first introduce two Cost-based Query order Selection (CQS) schemes in Section 4.1. Then we propose a location-based composite image retrieval (LCIR) scheme in Section 4.2.

4.1 Learning-Based Query Cost Estimation

For this location-based composite image retrieval, there are two query order schemes:

1) *A geo-tag-based query is first performed, then a visual similarity query over the candidate images are conducted to obtain the result images*;
2) *A visual similarity query is first conducted, then a geo-tag-based query over the candidate images is performed to obtain the result images.*

For a large-scale image database, the above two query schemes often have two different query costs. So we propose a cost-based query order selection scheme in which two query histogram models (i.e., *GTH* and *VFH*) are introduced.

- ***GeoTag Histogram Model***

First, we propose a GeoTag Histogram(*GTH*) model shown in Fig.2. In this model, suppose that the lengths of the latitude and longitude of the map are X and Y, respectively, the whole spatial space (i.e., *map*) is partitioned into $n \times m$ blocks in terms of the longitude and latitude values. For each block, the probability that the geo-tagged images fall in this block is recorded.

Definition 2 (Block). *Block (denoted as B) can be modeled by a six-tuple:*

$$B := < BID,\ x_{TL},\ y_{TL},\ LatID,\ LonID,\ Per > \tag{2}$$

where

– *BID is the block ID which is represented as a concatenation of the longitude ID and the latitude ID of the block; formally, BID=LonID×c+LatID, where c is a constant;*

– x_{TL}, y_{TL} *denote the latitude and longitude values of the top-left of the block, respectively;*

– *LatID, LonID denote the latitude ID and longitude ID of the block, respectively; formally,* $LatID = \left\lceil \frac{x_{TL}}{X/m} \right\rceil + 1$ *and* $LonID = \left\lceil \frac{y_{TL}}{Y/n} \right\rceil$*;*

– *Per is the probability that the geo-tagged images fall in the block, formally denoted as:* $Per = \sum_{I_i \in BID} 1/|\Omega|$*;*

Definition 3 (Geo-Tag Histogram, *GTH*). *Geo-Tag Histogram (denoted as GTH) can be represented as a matrix in Eq.(3):*

$$GTH = \begin{bmatrix} e_{n1} & e_{n2} & \cdots & e_{nm} \\ \vdots & \vdots & \cdots & \vdots \\ e_{21} & e_{22} & \cdots & e_{2m} \\ e_{11} & e_{12} & \cdots & e_{1m} \end{bmatrix} \tag{3}$$

where each element(e_{ij})[1] *in the GTH is modeled by a triplet:*

$$e_{ij} := < xID,\ yID,\ value > \tag{4}$$

where

– *xID and yID correspond to the LatID and LonID of the block, respectively;*
– *value corresponds to the Per in definition 2;*

For a query request, centered by a query image I_q, r as a query radius and T_q as the query position, its affected blocks are shown by the shadow region in Fig. 2. With an increase of the number of blocks, the appearance probability (*Per*) is near to that of the sum of the probabilities of the affected blocks.

In Fig.2, the *GTH* of each image corresponds to a sparse matrix, since the *Per* values of a large number of the blocks in it are zero. To represent the *GTH* in a storage efficient way, we introduce a compact representation called *compact geo-tag histogram*, in which only blocks with non-zero *Per* values are recorded in the histogram as defined below.

Definition 4 (Compact Geo-Tag Histogram, *cGTH*). *Compact Geo-Tag Histogram (cGTH) can be represented as a non-zero array in Eq.(5):*

$$cGTH = [E_1,\quad E_2,\quad \ldots,\quad E_{|cGTH|}] \tag{5}$$

[1] Each element(e_{ij}) in the matrix corresponds to a block.

where each element(E_i)[2] *in the cGTH is modeled by a two-tuple:*

$$e_{ij} := < BID, Per > \quad (6)$$

where the definitions of BID and Per are the same to that of definition 2.
Table 3 shows an example of the compact structure of the *GTH*.

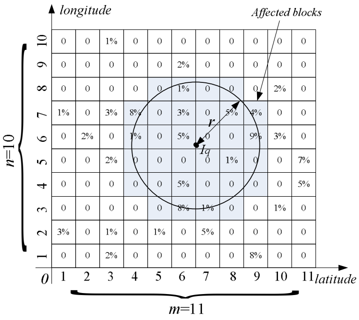


Fig. 2. An example of the *GTH*

Table 3. An example of the compact representation of the *cGTH*

BID	*Per*	*BID*	*Per*	*BID*	*Per*	*BID*	*Per*
103	2%	307	1%	604	1%	706	3%
109	8%	406	5%	606	5%	708	5%
201	3%	411	5%	609	9%	709	4%
203	1%	503	2%	610	3%	806	1%
205	1%	508	1%	701	1%	810	2%
207	5%	511	7%	703	3%	906	2%
306	8%	602	2%	704	8%	1003	1%

Algorithm 1. cGtag query cost estimation

Input: Ω: the image set;
T_q *(GPS.x, GPS.y)*: GPS information of I_q; *r*: spatial radius;
Output: P_1: the estimated query cost;
1. $P_1 \leftarrow 0$;
2. User submits a T_q and *r*;
3. the affected blocks are identified;
4. **for** each affected blocks B_i **do**
5. $P_1 \leftarrow P_1 \cup B_i.Per$;
6. **end for**
7. **return** P_1

- ***Visual Feature Histogram Model***

Similarly, for a similarity query, we also propose a visual feature histogram (*VFH*) model. In this model, *m* images are randomly selected as reference images I_R, then the corresponding visual feature histogram of each reference image is obtained according to the different sampled radius.

Definition 5 (Visual Feature Histogram, *VFH*). *A visual feature histogram(VFH) of reference image I_R can be represented by a vector:*

$$VFH = [e_1, \quad e_2, \quad ..., \quad e_{|VFH|}] \quad (7)$$

where each element(e_i)[3] *in the VFH is modeled by a triplet:*

$$e_i = < i, \ R, \ Per > \quad (8)$$

where
- *i is the ID number of reference image*;
- *R is a sampled radius;*

[2] Each element(E_i) in the array also corresponds to a block.
[3] Each element(e_i) in the array also corresponds to a reference image

- *Per is the ratio of the number of candidate images that are obtained by a query sphere centered as the i-th image and R as a query radius to that of all images*, formally denoted as: $Per=\sum_{I_i \in \Theta(\lambda_{rId},R)} 1/|\Omega|$.

In Fig. 3, suppose there are three reference images, I_{R1}, I_{R2}, and I_{R3}, the sampling radius(R) are 0.2, 0.4, 0.6, 0.8 and 1. Then, we can obtain their corresponding *VFH* as shown in Table 4.

Table 4. An example of the *VFH*

Per \ R / Ref. image	0.2	0.4	0.6	0.8	1
I_{R1}	11%	21%	29%	38%	44%
I_{R2}	13%	19%	31%	42%	53%
I_{R3}	15%	20%	35%	48%	60%

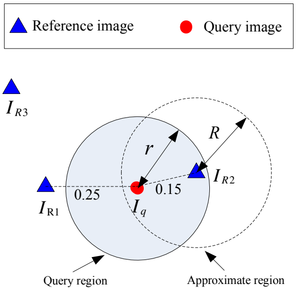


Fig. 3. An example of the *VFH*

Given a query image I_q and query radius(e.g., r=0.18), its nearest neighbor reference(*NNR*) image I_{R2} is first identified, then a approximate sampling radius (i.e., R=0.2) of I_{R2} is obtained according to the query radius. After scanning the Table 4, we can get the ratio of the number of candidate images to that of the all images (i.e., *Per* =13%), which can be regarded as a approximate query cost value (i.e., P_2) centered as I_q and r as a radius. Theoretically, with the increasing number of the reference images, and the improvement of the subdivision of the sampling radius, P_2 can approach the real query cost. Based on the above two histograms, we can estimate and compare the query costs of the two ways.

Algorithm 2. Visual feature query cost estimation

Input: Ω: the image set; I_q: query image; r: query radius;
Output: P_2: the estimated query cost;
1. $P_2 \leftarrow 0$;
2. User submits a I_q, r;
3. find the nearest neighbor reference image(*NNR*) of I_q;
4. for a new hypersphere(*HS*) centered as *NNR*(I_q) and r as radius
5. $\quad P_2 \leftarrow HS.Per$;
6. **return** P_2

4.2 The Query Algorithm

In this subsection, we present our approach for location-based composite image retrieval. The whole query processing can be divided into three stages:

1) *query submission* including query image I_q, query radius r, query geotag T_q, and spatial radius R;

2) *query order selection*: according to the query criterion, firstly, obtain the proportion P_1 of the candidate images corresponding to T_q and radius(R) from the *cGTH.* Then, find the nearest neighbor reference image (I_R) of I_q, and obtain the proportion P_2 of the candidate images corresponding to the query image (I_R) and query radius (r) from *VFH*. If $P_1 < P_2$, we can choose the first query scheme (lines 5-10); otherwise the second scheme (lines 12-18);

3) return the query result (line 19).

Algorithm 3. Location-based composite query

Input: Ω: the image set; I_q: query image; r: query radius;
T_q *(GPS.x, GPS.y)*: GPS information of I_q, ; R: spatial radius;
Output: S: the query result;
1. $S_1 = S \leftarrow \Phi$;
2. User submits a I_q, r and T_q information;
3. the query order selection is conducted;
4. **if** $P_1 < P_2$ **then**
5. **for** each image $I_i \in \Omega$ **do**
6. **if** $dist(I_i.GPS, I_q.GPS) < R$ **then** $S_1 \leftarrow S_1 \cup I_i$;
7. **end for**
8. **for** each image $I_i \in S_1$ **do**
9. **if** $vSim(I_i, I_q) < r$ **then** $S \leftarrow S \cup I_i$;
10. **end for**
11. **else**
12. **for** each image $I_i \in \Omega$ **do**
13. **if** $vSim(I_i, I_q) < r$ **then** $S_1 \leftarrow S_1 \cup I_i$;
14. **end for**
15. **for** each image $I_i \in S_1$ **do**
16. **if** $dist(I_i.GPS, I_q.GPS) < R$ **then** $S \leftarrow S \cup I_i$;
17. **end for**
18. **end if**
19. **return** S

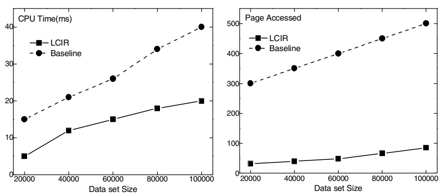
5 Experiments

In this section, we present an extensive performance study to evaluate the effectiveness and efficiency of our proposed retrieval and indexing method. The image data we used are over 100,000 geo-tagged images from *maps.google.com* [13] in which 64-D color histogram of each image is extracted as the visual features. We have implemented an online location-based image retrieval system based on Android platform [14] to testify the effectiveness of our proposed retrieval method. The retrieval approach is implemented in Java language. All the experiments are run on a Pentium IV CPU at 2.0GHz with 2 gigabytes of memory. As few research works have touched on the composite retrieval by combing the geo-tag and visual features, the baseline in the following experiments is a sequential scan without the CQS support.

5.1 A Prototype System

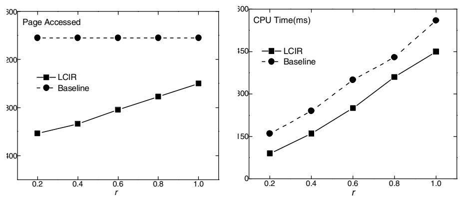
We have implemented an online location-based mobile tourism system to testify the effectiveness of our proposed retrieval method. Fig. 4 shows the retrieval interface of the system. The right part of the figure is the retrieval result visualized by a Google map in which users can select their interested image. The left part is the details of the image that the user chooses.

Fig. 4. An retrieval example



(a) CPU cost *vs.* Data size (b) I/O cost *vs.* Data size

Fig. 5. Effect of data size



(a) r *vs.* I/O cost (b) r *vs.* CPU Cost

Fig. 6. Effect of r

5.2 Effect of Data Size

The experiment measures the performance behavior with varying number of images. Fig. 5 shows the performance of query processing in terms of CPU and I/O costs. It is evident that the CPU and I/O costs of LCIR increase slowly as the data size grows. This is because the CQS scheme can effectively prune the search region and the computation cost of the candidate images is reduced accordingly.

5.3 Effect of *r*

In the final experiment, we proceed to evaluate the effect of *r* on the performance of a query process. Figs. 6a and 6b both indicate that when *r* ranges from 0.2 to 1, the LCIR is superior to the retrieval method without CQS in terms of page access and CPU cost. The results conform to our expectation that the search region of the LCIR is significantly reduced and the comparison cost between any two candidate images is reducing as well.

6 Conclusions

In this paper, we presented a location-based composite image retrieval (LCIR) based on *geo-tags* and *visual feature*s for mobile culture and tourism education. The prototype retrieval system is implemented to demonstrate the applicability and effectiveness of our new approach to image retrieval.

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Social Action-Based Learning in Construction Education: A New Teaching Strategy

Yu-Chieh Wu[1] and Jie-Chi Yang[2]

[1] Department of Communication and Management, Ming-Chuan University,
No. 5, De-Ming Rd, Gweishan District, Taoyuan 333, Taiwan, R.O.C.
wuyc@mail.mcu.edu.tw

[2] Graduate Institute of Network Learning Technology, National Central University,
No.300, Jhong-Da Rd., Jhongli City, Taoyuan County 32001, Taiwan, R.O.C.
yang@cl.ncu.edu.tw

Abstract. 3D model construction is one of the most important courses in digital media design. It provides the direct way for learners in creating real geometry in digital classroom. It has also been included as the required course in higher education. In this paper, we design a novel teaching strategy that combines social activity (facebook) and project-based learning as gaming in presentation. The social activity gives a strong motivation that activates students to self-study, while the project goal enhances the intensity of learning effect. In the social activity, students are required to promote the final product and try to demonstrate to people online. In teaching project goal, learners work together and learn to establish big project as team work. In the final stage, the proposed richman-like gamming competition is taken into place. We had applied the novel teaching approach in real university course. The empirical result showed that learners not only immersive in doing project, but also substantially improves the 3D modeling capability in course. Furthermore, some learners clearly indicated that the teaching method help to be learning much more actively.

Keywords: e-learning, higher construction education, 3D modeling learning, CAD learning.

1 Introduction

One of the best ways to learn 3D modeling design and construction is to be inspired by interesting learning materials and evaluations. In multimedia art design, the integration of 2D image processing and 3D modeling skills are often considered as the main object for higher educated students. For example, in image processing, learners need performing single photo processing via image authorization tools, such as photoshop or photoimpact. The concept in 3D models reveals the learners capability before creating the corresponding models. Cognition of the 2D and 3D space is the basis of the design activities. Hence, many opened courses started from 2D image design/processing and then talk about the 3D space concept before 3D modeling lectures.

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Several prior research works had been addressed the use of multimedia technologies as a part of learning materials. The well-known ARCS (attention, relevance, confidence, and satisfaction) model of motivation was formed in response to find more useful ways of understanding the major factors on the motivation to learning (Keller, 1983). ARCS model defines four major conditions (attention, relevance, confidence, and satisfaction) that have to be fulfilled to become and remain motivated (Dick, Carey & Carey, 2001). After applying the multimedia aided learning, learners' attention, should be ideally enhanced and promote learners' confidence and satisfaction in effective way.

Learning in 3D modeling design usually involves in a complex and dynamic process. Students start from something in mind which is not real but abstract. They are required to develop a 3D form through the use of 3D development tools. The main problem faced by students in the design process is that the limited ability of conventional media to generate a good visual presentation of more complex space (Kalisperis and Perhlivanidou, 1998). According to Lawson (1997), the architectural design is a process in which designers create spaces, places, and buildings that have a major impact on the human life. An earlier research study (Moum, 2006) investigated the use of high-tech-based visualization media for digitization of the conceptual architectural design process. Both (Fruchter, 1998) and (Ibrahim, 2007) present a positive effect when integrating design and construction process to support collaboration among team members. In addition, by the use of high-tech-based media, the cost of labour and material production can be greatly reduced.

In current, the Sketchup received a great attention and is becoming the main 3D architecture developing software in education and industry. To extend the 3D modeling skills, it is required to co-work with the other 2D image processing systems, such as photoshop and CAD. CAD tool can be used as a preprocessing tool in creating the 2D layout images, while the photoshop processing often adds the image special effect when generating 2D images. In the learning process of 3D modeling, SketchUp usually provides direct and clear view for students in space design. It inspired learners' attention via a simple and easy interface with efficient response and view (Liu and Guo, 2009). Meanwhile, some rendered tools also pluggable to SketchUp in which an even almost-to-real photo images can be generated. Another good property of SketchUp is that it does not only produces precise 3D models, but also sharable with the other 3D modeling software, like MAYA and 3Ds Max. The constructed 3D models can also now be viewed in most smart phone and smart Pad[1].

In this paper, we present a novel teaching strategy that combines social activity (facebook) and project-based learning in learning activity. The social activity gives a strong motivation that activates students to expand the time in self-study, while the project goal enhances the intensity of learning effect. In the social activity, students are required to promote the final product and try to demonstrate to people online. In teaching project goal, learners work together and learn to establish big project as team work. In the final stage, the proposed richman-like gamming competition is taken into place. We had applied the novel teaching approach in real university course. The empirical result showed that learners not only immersive in doing project, but also

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1 `http://www.sketchup.com/download/gsuviewer.html`

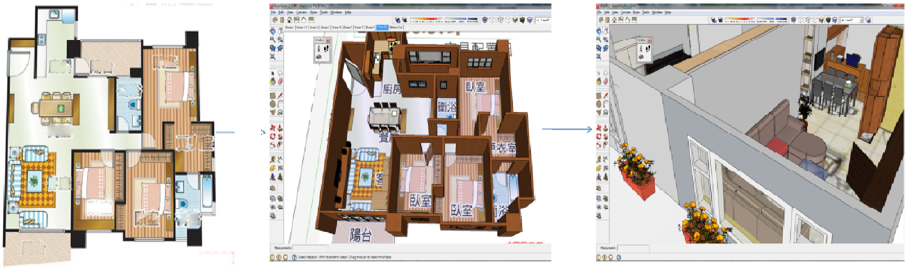

Fig. 1. An illustration of 3D modeling from normal 2D floor plan

substantially improves the 3D modeling capability in course. Furthermore, some learners clearly indicated that the teaching method help to be learning much more actively.

2 3D Modeling Sketching Tools in Education

In higher education, the 3D modeling techniques can be expected to a part of computer-aided learning. Novel technologies, modeling softwares are frequently updated. A set of image and video processing authorization tools is quite common seen in school. Usually, in the first year, students should major the basic Office tools, such as PowerPoint, Excel, and Access. In the second year, the Flash and Photoshop techniques are addressed in most design and construction – oriented colleges for some countries. For example, in Taiwan, the Powerpoint and Excel lectures are the basic required courses in the first year while the Flash and Photoshop are the optional courses. By means of the basic image processing experiences, learners could pick up the 3D modeling lessons as the main major subjects. However, before participating 3D modeling-related courses, the basic image processing skills are required.

Sketchup is one of the successful 3D modeling softwares that is easy to learn and easy to realize 3D models with exact and precise measurement. Many research studies had proposed to addressed the effect of using sketchup in education (Ibrahim and Rahimian, 2010; Afacan and Demirkan, 2011; Liu and Guo, 2009; Sampaio et al., 2010). Sketchup also is a pluggable software that allows developers append additional functions via script languages. One good property of SketchUp is that it does not only produces precise 3D models, but also sharable with the other 3D modeling software, like MAYA and 3Ds Max. The constructed 3D models can also now be viewed in most smart phone and smart Pad[2]. In this paper, we focus on the learning effects of using the SketchUp as 3D modeling tool in normal lessons.

Creating 3D models in Sketchup generally involves several stages, including the following items.

- Get 2D file (CAD file or floor plan image file)
- Import 2D file to 3D software

[2] `http://www.sketchup.com/download/gsuviewer.html`

- Make the measurement scales and boundaries of the arch
- Connect 2D file in 3D objects
- Create basic infrastructures in 3D
- Arrange interior layout
- Texturing objects
- Apply rendering to the designed arch

In basic, the Sketchup is not directly support CAD file. When importing the file, the edges are not connected as well as in the AutoCAD. To solve this, preprocessing technique is applied. First, we purge all the unused layers and edges in SketchUP. Then, blocks all layers and merge to single layer. Finally, we lock the newly merged layer as the bottom of the building. Users begin creating the 3D models through the above mentioned steps.

At a University of Taipei, in computer assisted learning program, included in the required courses in college, the skill of 3D modeling, interior design, house creation, 3D photo-match skills have been included as the main agenda goal in lesson. For the case of multimedia design, the most exiting lesson is to modeling the house inside, starting from normal floor plan that produced by the well-known autoCAD software. Fig. 1 gives a simple illustration of 3D modeling from normal 2D floor plan (using Google SketchUp).

Development of the Teaching Strategy

In the first 10 weeks of the in-class teaching activity, the normal teaching strategy forms the basis of the main teaching process. The instructor starts from empty file, and learners follows. The teaching process mostly synchronizes and follows the textbook. The teacher explains each function in the Sketchup and illustrates with empty example. Student can directly use smart phone to record the operation process during teaching and re-do in class or post-class.

3 Compound Teaching Strategy

Our teaching goal is to let the students creating and promoting the designed 3D models. In this course, the main subject is to design a house, including interior and outside infrastructure design. Our proposed compound teaching strategy relies on three main steps: 1) team work and 3D modeling, 2) strong force in social activity, and 3) monopoly-like game process. The first step is merely the implementation of the 3D models with team work. Learners are freely in choosing the group members. To have better quality in this assignment, each group is limited in less than 3 people. After grouping, each team can co-work and discuss the roadmap and then realize the 3D model.

Learners in the second step should login to the social activity platform - Facebook and try to interact with their friends or unseen people who try to access the page. In this step, students must present the created 3D models – house on their FB page. Every learner is required to promote the house online as well as putting the commercial ads and starting from their relations. There is no any burst time limitation in this step. But the deadline of closing the FB is one-day before the monopoly game process. Our assumption is that people often demonstrate the goods and beauty in personal pages, while less addressed in uninteresting and boring things. The created 3D models motivate learners in doing even better and better works since they have to show up in public. In this step, the number of response and goods is also a part of evaluation in this course. This strategy further activates students in doing the 3D model. Fig. 2 shows an example of the student's social activity in Facebook.

The third stage is to invite all learners in joining the monopoly-like game in class. Every student has a limited budget – say 20 million bills. Every team needs to define the selling price, ranged from 5 ~ 25 million. Every team needs to define the price before trading time and demonstration time in order to keep the fairness. To motivate trading, the students are encouraged to buy house. The best buyers can get additional credit if the bought house is the most popular product in class.

Fig. 2. An example of the student's social activity in Facebook

Before the monopoly game, each team has 5minutes in presenting their work and design. During the presentation, the game players can see the designed 3D models, FB records and logs, and rendered images, and even the prepared videos. Every seller can make use of the five minutes to customers. The demonstration is taking in predefined order which is chosen randomly. After the demonstration, there are 25 minutes for marketing and trading. Each person can visit the others and determine to buy or not. The price is also negotiable in this period. This is used to approach to real. In real-world, the buy and sell is free. Each team needs to collect the buyer's name and take the money. In the final stage, the instructor calculated the final results according to the performance of buy and sell. The buyers who own the house which is the most popular in the class are recognized as good buyers. Alternatively, the team who created the most popular house is also identified as the best sale team. Fig. 3 depicted the designed teaching strategy in 3D modeling lectures.

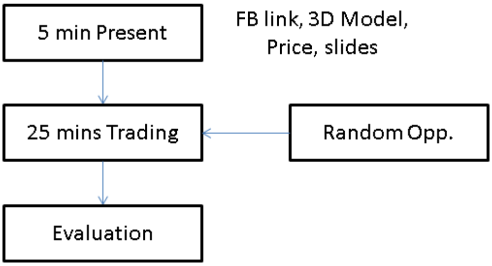

Fig. 3. An illustration of the monopoly-like game in 3D modeling course

4 Experiment

We apply our method to real courses in the opened courses of university. Testing subjects come from two sources: college of communication which includes communication department, dept. of radio and TV, dept. of advertising, dept. of journalism, etc. in Taiwan and the second students come from international computer science (CS) program students. Both courses were opened in the third-year in the university and hence the age were all ranged from 21~24. The course opened in communication-related departments was the option course in the college. Students who participated the course have various backgrounds in 3D design. All of them were fresh in 3D modeling and interior design. In this course the instructor can use their mother-language during tutoring. Since the course is the required course in the CS program, all the students who majored the course were come from the same department. In this course, the teacher needs to speak English because of the students were not local-student. Table 1 summarizes the statistics of the testing subjects.

Table 1. The statistics of the testing subjects

	Course Name	Female	Male	# of subjects
Communication-related Departments	3D Design (option course)	12	45	57
International Computer Science	Multimedia Design (required course)	15	10	25

The experimental flow can be found in Fig. 4. In the beginning stage, a pre-test is taken place in order to examine the initial differences between groups. The testing question includes the basic interior design in the textbook. Given an empty AutoCAD file and image, each learner needs to create the corresponding 3D models, while fill the requirements, such as 3 rooms, 2 toilets, 1 kitchen, and 1 living room. The two classes were evaluated with the same pretest questions. The test took 2 weeks. After the due day, the instructor evaluates the outcome for each student according to the model shape, geometry color, measurement, rationales, space usability, and completeness.

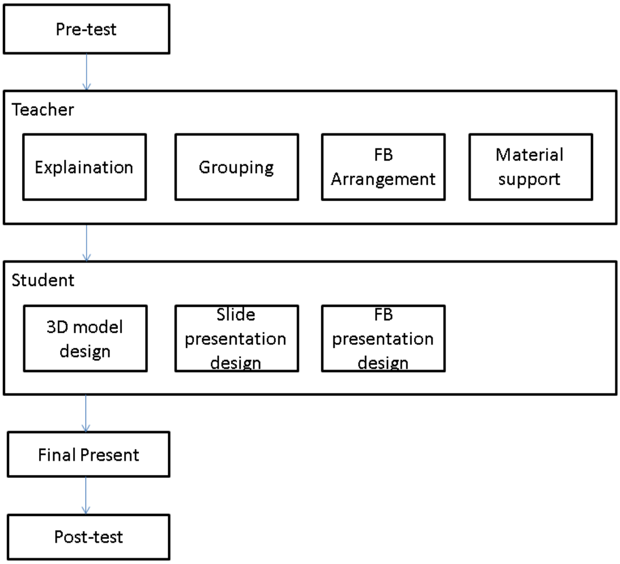

Fig. 4. Experiment flow of the designed teaching strategy

In the second stage of the experiment, teacher needs to explain the rules and goals of the project. In the following 4 weeks, the lecture is no change, i.e. teacher demonstrates how to create specific 3D models, design complex components, and how rendering tool is used. After formal learning, it is free for learners study and co-work offline. Each group could call meeting and discuss their group project. At this stage, some students start put a little outcome on Facebook in order to earn more times in social activities.

Fig. 5. Photos of the demonstration time for each team

Next step is the presentation day. As mentioned before, each group needs to demonstrate the designed house and play the monopoly-like game. Fig. 5 shows the student's demonstration show. At this stage, each group showed their product on the screen, while simultaneously transmit the same screen to the other students in class. In the end of the game, students are required to evaluate the 3D modeling capability with the same questions tested in pre-test. As pre-test, the instructor should evaluate the basic 3D model creation capability with the same evaluation metrics- model shape, geometry color, measurement, rationales, space usability, and completeness.

5 Results and Discussion

Fig. 7 shows the real trading time in the class. Students can negotiate price and house spec in this stage. It is observed that some teams have never change the price in selling stage, while the remaining (70%) teams reduced the price and no group rise the price up in both two classes. Table 2 and Table 3 list the paired t-test and one-way ANOVA test between the pre-test and post-test result.

Table 2. Paired t-test between pre-test and post-test

paired t-test	Comm. College		International CS	
	Pre-test	Post-test	Pre-test	Post-test
Mean	77.15	85.63	79.96	86.96
Variance	72.08	11.2	87.39	19.96
Subjects	57	57	25	25
Pearson correlation coefficient	0.52		0.29	
t – statistics	-8.75		-3.85	
p(T<=t) one-sided	<< 0.001		<< 0.001	
Threshold (one-sided)	1.67		1.71	
p(T<=t) two-side	0		0	
Threshold (two-sided)	2		2.06	

Column 2 and column 3 in Table 2 represent the communication college students and international computer science students, respectively. Before applying our teaching strategy in learning, the pre-test score in average is about 77~79. We also evaluate the statistical significance between the two groups (communication college and international CS) with pre-test scores. The t-test result is $p = 0.102$ which means there is no significant difference between the groups in the initial stage. After applying our teaching strategy, the paired t-test result indicated that the p-value is far lower than 0.001 in one-sided. As shown in Table 2, the mean value in post-test in Comm. college is 85.63 which outperforms the pre-test score (77.15). According to the one sided paired t-test result, our teaching strategy statistically significantly improves the student learning effect. The result is also true to the International CS students.

Table 3 provides another significant test between the pre-test and post-test results. The p-value for international CS students is 0.0014 which is also significant, while in the communication college the p-value is much lower than 0.0001. Consequently, both statistical testing methods agree that our teaching strategy significantly enhance the student learning in 3D modeling. We also apply t-test to evaluate the significance between the two groups in post-test performance. The p-value is 0.1 which means the

Table 3. One-way ANOVA test between pre-test and post-test

International CS	SS	freedom	MS	F	p-value	threshold
Between Group	612.50	1	612.50	11.41	0.001456	4.04
Within group	2576.42	48	53.67			
Sum	3188.92	49				
Communication College						
Between Group	2050.63	1	2050.63	49.24	1.83E-10	3.92
Within group	4663.74	112	41.64			
Sum	6714.37	113				

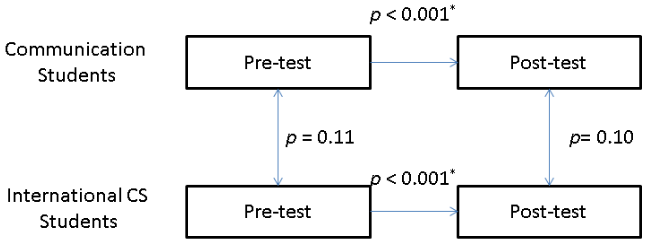

Fig. 6. Significant test between before and after applying the teaching strategy in the two classes

Fig. 7. Photos of student trading (25 minutes)

result is no difference between the two groups after applying our teaching strategy. Fig. 6 illustrates the significant test results.

Fig. 7 shows the captured photos where students are in trading and negotiate prices. After the monopoly game, most students agree that the teaching and learning process is strongly positive. The Facebook marketing phase activated them in doing better 3D model design. The monopoly game provides the platform that allows each team showing the constructed products. In the trading time, they enjoy interacting with the others in class which is also interesting and exciting. By following this course, there are more than 26 senior students joined the course next year in comparison to previous year where only 16 senor learners participated the course.

6 Conclusion

Computer-aided learning is one of the most important courses in higher education. This paper presents a new teaching strategy that enhances the learning motivations, self-learning ability, attitude, and team work effect. Our method involves in three steps: 3D modeling implementation, Facebook promotion and interaction, and the monopoly-like gaming process. We had applied the strategy in two classes in which students have various backgrounds. The experiment time is 5 weeks in total. The empirical result showed that learners not only immersive in doing their project, but also substantially improves the 3D modeling capability in course. Two statistical significant tests both agree that the designed teaching strategy significantly improved than before. The full lecture materials and information announcement is shown in the web site[3]. The site also includes the real video stream and photos that demonstrates the learners modeling outcomes.

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[3] Please refer the website:
`http://140.115.112.118/course/100-2MCU-Sketchup/index.htm`

A Preliminary Study on the Facebook-Based Learning Platform Integrated with Blended Learning Model and Flip Learning for Online and Classroom Learning

Kun-Hsien Li[1,*], Shi-Jer Lou[2], Kou-Hung Tseng[3], and Hsiu-Chu Huang[4]

[1] Department of Industrial Technology Education,
National Kaohsiung Normal University, Taiwan
D8869475@gmail.com
[2] Graduate Institute of Vocational and Technical education,
National Pingtung University of Science and Techology, Taiwan
lou@mail.npust.edu.tw
[3] College of Business and Management, Meiho University, Taiwan
x00000003@meiho.edu.tw
[4] Recreation and Tourism Management, SHU-TE University, Taiwan
francis@stu.edu.tw

Abstract. This study intends to integrate Facebook-based learning platform with blended learning model and flip learning strategies for sophomores, juniors and seniors. This study implemented the blended learning where Facebook-based online learning was integrated with classroom learning. In terms of teaching procedures, this study implemented flip learning strategies in the hope that learners can implement active learning to acquire better learning effectiveness and perception. The research results showed that: (1) the use of the platform that learners are accustomed to using as the basic learning platform can help promote online learning; (2) learners' participation in blended learning and flip learning is higher than that in traditional learning; (3) Facebook-based blended learning model and flip learning can both extend the width and depth of learning.

Keywords: Facebook-based Learning, Flip Learning, Blended Learning Model.

1 Research Motives and Purposes

Blended learning is the learning strategy integrating traditional classroom learning with online learning. The unique advantage of e-learning can meet the needs of knowledge learning (e.g. large amount of learning, rapid learning, learning at any time, learning at anywhere, interactive learning, community learning and diversification) [1]. However, it seems that the content of classroom learning alone in higher education of current formal education is significantly insufficient for learners. How to extend the content of courses, as well as after-school learning and discussion, has become an issue worthy of

* Corresponding author.

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investigation to increase the breadth of self-learning. Young (2002) indicated that the implementation of blended learning model in higher education has increased, and it is expected that the curriculum of blended learning may account for 80%~90% of all the courses in higher education[2]. It is clear that increasing attention has been comprehensively attached to blended learning.

Recently, another emerging trend of thought "flip learning" is on the rise where teachers are requested to motivate students to learn course content in advance, instead of going into a classroom with an empty head. During the course, teaching methods such as question asking, discussion and question answering are used, while the past teaching process is reversed to make teaching meets the needs of learners better. This study should help trigger college students' active learning and enhance their preparation.

With the e-learning promoted by online social networks, Prahalad (2002) found that during the entire teaching activities, the role of students has been changed from the listeners in traditional classroom learning to the co-creators of knowledge[3]. In the beginning of semester, I asked students in the classroom to understand whether or not they use Facebook Social Networking Site. the research objectives of this study are as follows:

- To understand whether college students' learning participation is increased using the Facebook-based learning integrated with blended learning and flip learning.
- To understand the learning effectiveness of college students using the Facebook-based learning integrated with blended learning and flip learning.
- To understand whether college students are satisfied with the learning where Facebook-based learning is integrated with blended learning and flip learning.

2 Literature Review

2.1 Blended Learning Model

Blended learning has been gradually applied in many colleges, enterprises and groups. The American Society for Training and Development regards blended learning as one of the approaches for knowledge transfer [4]. What is blended learning? The definitions of blended learning provided by current scholars are quite comprehensive[5]. Graham, Allen, and Ure (2003) summed up three common definitions[6], including the blending of different teaching media ([7],[8],[9]);the blending of different teaching strategies ([5], [10], [11]) and the blending of different teaching environments ([4]; [12]; [13]; [2]). Category 1 is the most well-known one, as well as the miniature of the blended model adopted in this study, namely, the so-called C+E model. The letter C is the abbreviation of classroom, and it denotes face-to-face teaching in classroom. The letter E is the abbreviation of e-learning, and it denotes e-learning. The order of presentation of these two teaching methods is not restricted, but included in the entire learning process. However, such an approach is a blended learning approach with a relatively narrower sense. At present, relevant media technologies have gradually improved, and thus more significant changes can be made.Rosenberg (2002) defined blended learning as the integration of at least two different learning media[14], teaching strategies and learning scenarios and the use of the approaches which are most suitable for learners to trigger the learning and convey knowledge and skills to achieve the ultimate learning objective, which is the definition of blended learning with a broader sense.At least two kinds of learning platforms (e.g. classroom, online C+E) can be extended from blended learning, and they can be integrated with different teaching strategies (e.g. online discussion, sharing and consultation) and teaching scenarios (classroom, home PC or mobile carriers). The concept and application of blended learning are all-inclusive.

2.2 Flip Learning

Flip learning-related models are not a brand new teaching strategy, but a more specific presentation of many teaching strategies. How flip learning starts to become a trend can be traced back to 2007. Jonathan Bergmann and Aaron Sams in the United States adopted the flipped classroom model, which achieved a good effect. Therefore, these two teachers called the model "flipped classroom," and started to advocate and promote it. Flipped classroom was then rapidly spread and expanded in the United States [15]. Flipped classroom has now been extended and transformed into flip teaching and flip learning which share the same spirit. Flip learning mainly includes two meanings: (1) learners initiate "self-regulated learning" via the platform before the class; (2) teachers can frequently use discussions and tutorials to replace one-way teaching before the class. Moreover, the content of self-regulated learning of learners can be diversified, as shown in Figure 2. The flipped classroom model can be divided into four areas, and the teaching can be provided through experiences (e.g. games, tours and online experiences), conceptual link, meaning construction and teachers' demonstration and application (which are generally promoted in classrooms). Peter Pappas (2009) suggested that the real purpose of flip teaching is to use the time of class in more in-depth learning activities because information transfer (instruction) is simply the most fundamental learning activity which intends to transform students from knowledge receivers to active learners. Flipped classroom, in nature, is an application of blended learning [16]. Therefore, this study integrated blended learning model with flip learning to promote teaching strategies.

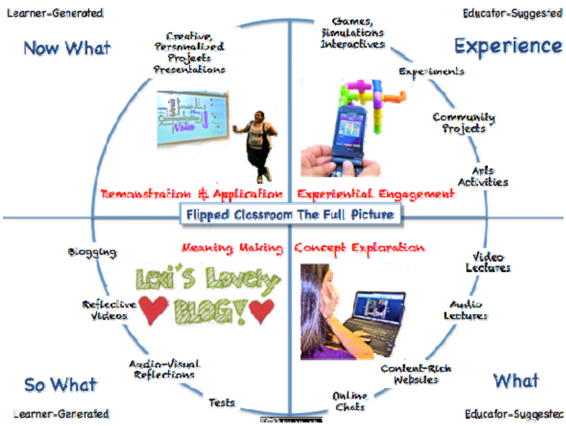

Fig. 1. The Flipped Classroom Model(Source: Jackie Gerstein(2011). The Flipped Classroom Model: A Full Picture.From: http://usergeneratededucation.wordpress.com/2011/06/13/)

3 Research Procedures and Implementation

The research procedures and implementation include three main parts and are described in order as follows:

3.1 Research Subjects

The research subjects were the sophomores, juniors and seniors in a certain national university in the southern Taiwan. The research background was an educational background, and the course title was "technology integration and education." A total of 45 students were selected as the subjects. 10 of them were male, while 35 of them were female. 42 of them were sophomores, 2 of them were juniors and 1 of them was a senior.This study selected 5 of the 45 learners for interviews. The background of the subjects interviewed is briefly described, as shown in Table 1:

Table 1. Brief Description on the Background of the Subjects Interviewed

Code	Place of Origin	Grade	Month of the Interview
M0001	Hualien County	Sophomore	2012/10
M0002	Tainan City	Junior	2012/11
F0001	Kaohsiung City	Sophomore	2012/11
F0002	Pingtung County	Sophomore	2012/12
F0003	Taichung City	Junior	2013/01

"M" denotes male, while "F" denotes female. The subjects were coded according to the order of interviews. On average, the subjects were interviewed monthly to understand their learning perception and opinions at each stage.

3.2 Implementation

The 18-week course instructed by the researcher in semester 1 of academic year 2012 and the Facebook-based e-learning platform were provided for the students. The subjects were informed every week of the course content in the next week four days prior to the class and were provided with the course-related files, data links and discussions. Discussions, practices, group competitions and teachers' demonstration and guidance were provided in the class. After the class, teaching procedures such as course sharing and course review and works appreciation were implemented.

This study analyzed and understood relevant patterns adopted by learners during this study based on the statistics of frequency of participation in online discussions, classroom observation, interviews and summative assessment, and course satisfaction survey. The objective of the analysis on discussion frequency and classroom observation was to understand learners' participation. The objective of summative assessment was to understand learners' learning effectiveness. The objective of interviews and course satisfaction survey was to understand learners' satisfaction with such learning strategies.

This study used systematic sampling to select the subjects for interviews. The learners were coded according to their class number. This study randomly selected 5 subjects for non-structured interviews, and performed a general survey on the rest of them. This study performed a survey on 45 students in the class. Afterwards, this study used SPSS 17.0 to perform descriptive statistics on frequency of participation in the discussions, summative assessment and course satisfaction survey. This study then analyzed the classroom observation and interviews one by one.

3.3 Research Tools

3.3.1 System Platform Tool

This study selected the social network platform used by most of the learners as the e-learning platform tool. The researcher activated the closed group function of Facebook. The internal application and implementation are described as follows:

- Functional Configuration and Use

According to the Facebook group function, as shown in Figure 2. Block A included functions of quick uploading, sharing and sending of photographs/videos, files and documents, article posting and question asking. Block B included the functions of searching and downloading of activities, photographs, files and documents. Block C included the function of sending messages to group members or groups. Block D included the function of monitoring the reading situation, including reading rate of learners. Block E included the functions of two-way group discussion or individual discussion. Block F included the function of searching for keywords and historical data.

Fig. 2. Functional Configuration and Use of Facebook-based Learning Platform

- Timing of Use and Procedures

This study actually implemented the teaching in the 18-week course. According to the teaching procedures, the data collection and implementation process are described as follows:

a. Before the teaching of unit: the learners were provided with the course content, relevant files and links via the Facebook-based learning platform weekly 4 days prior to the class. In addition, the statistic on number of browsing was recorded, and the learners were asked questions to enable them to explore the questions. Moreover, the online chat rooms were opened for discussion and question asking. The "statistics table of frequency of online participation in discussions" was used to record relevant data in this regard.
b. During the teaching of unit: the learners completed the course through oral reports, discussions, practices, teachers' guidance and question asking. They were reminded of the course focuses and assigned the homework before the end of the course. The process of the class was recorded in the "classroom observation form."
c. After the teaching of unit: the weekly course focuses were summarized in the Facebook-based learning platform within 5 hours after the class, and the learners were encouraged to share their learning feedback and works. In terms of learning process, the researcher provided teaching counseling via chat rooms. The data in this regard were recorded in the "statistics table of frequency of online participation in discussions."
d. At the end of the overall semester: at the end of the semester, the overall learning outcomes of learners were assessed to understand the learning effectiveness. The data were summarized in "Overall assessment." Moreover, "course satisfaction survey" was used to understand learning perception. This study selected 5 learners and interviewed them to understand the learning effectiveness.

3.3.2 Research Tools

This study used five record tools for analysis and exploration. The contents of various scales are as follows:

- "Statistics table of frequency of online participation in discussions": based on the roster of students, a total of three parts, the number of browsing (total number of browsing before/after the class every time), file download rate (number of files downloaded/total number of files downloaded X100%) and total number of articles posted were recorded. Recording mode. "the number of browsing" source of information released through the lower right corner of each platform have seen record compare with classroom asked to confirm the statistics ."File download rate" is hidden by the text in the file question, confirmation or reply to answer while the classroom is recognized as the download status records ."Total number of articles posted" to student's name into the search statistics.

- "Classroom observation form": the students' classroom performance, including their prior knowledge, classroom question-asking and classroom participation, were recorded.
- "Interview record form": the learners' perception was understood through their learning feelings, use of platform and course combination.
- "Overall assessment": the assessment on learning outcomes, including the tests of students' knowledge, skills and attitude meanings. The tests included both practices and written examinations.
- "Course satisfaction survey form": the overall course satisfaction survey form is a teaching evaluation form designed by the school, which includes five main items, teaching content and materials, teaching behavior, teacher-student relationship, teaching evaluation and comprehensive comments. A 5-point scale was used to present the results where 1 to 5 points denote the degree of satisfaction.

4 Research Results and Findings

4.1 Analysis on the Results of Learning Participation of Learners Receiving the Teaching of Facebook-Based Learning Integrated with Blended Learning and Flip Learning

This study performed the comparative analysis based on the records of "statistics table of frequency of online participation in discussions" and the interview content of learners, as shown in Table 2:

Table 2. Analysis on Online Participation in Discussions

Item	Number of People	Mean	Minimum	Maximum	SD
Number of browsing	45	297.47	200	385	37.76
File download rate	45	65.81	49.23	92.31	9.55
Total number of articles posted	45	20.78	12	30	3.21

As shown in Table 2, during the 18-week learning process, the average weekly number of browsing was greater than 10 (calculated based on the mean 297.47). The average number of articles posted was also 1 and above. Apparently, a significant number of learners participated in the online discussions. This study suggested that the overall performance of learners met the expectations. As for the file download rate, the file download rate of some of the files was high because they were the homework of learners. However, some of the files could not be downloaded. As a whole, the download rate of the course files of the class was high. To better understand the learners' feelings about participation in online discussions, this study interviewed learner M001:

The teacher would post some data and files every week. I would take a look at them to see whether they are interesting or not. I would download the files and data which were downloadable. In addition, other students' feedback to the course could also be shared online. I could review the content that I missed in class. I think it is good to use the Facebook-based learning. (M001 was interviewed on October 31, 2012).

The results showed that, learners were willing to participate in the online Facebook-based learning platform. In addition, their participation was high as well. The learners could better understand the course content through the sharing by other classmates. They also tried to understand the situations before the class. During the interview, another learner F001 said,

In fact, I frequently use the FB before the course. I would check my FB whenever there is a message. I would see the messages of the course every day. Therefore, I did not find it bothering to check the FB. I am used to checking the FB whenever I am free. Sometimes I did not download files because I live with my classmate in the same group who had downloaded them and we read the files together. (F001 was interviewed on November 4, 2012).

This study found that the use of Facebook-based learning platform integrated with blended learning and flip learning could increase learners' participation.

4.2 Analysis on the Results of the Learning Effectiveness of the Use of Facebook-Based Learning Platform Integrated with Blended Learning and Flip Learning

After understanding the learners' patterns of participation in online activities, this part of this study intended to investigate whether the Facebook-based learning platform integrated with blended learning and flip learning can achieve a certain learning effectiveness after being implemented for a semester, as shown in Table 3.

Table 3. Analysis on the Result of Learning Effectiveness

Item	Number of People	Minimum	Maximum	Mean Score	SD
Practical Works	45	72	90	86.85	2. 56
Written Examination	45	72	92	85.84	2. 50
Report	45	77	91	84.80	2.77

As shown in table 3, after learning for a period of time, the scores of most of the learners in the three tests (practical works, written examination and report) were more than 80 points, suggesting that the learners were familiar the course to a certain extent. As for the difference among learners, the SD of the all the three tests was <3, suggesting that the difference among learners was not significant. This study also interviewed the learners to understand their self-perceived learning outcomes. The learners M002 and F002 were interviewed.

> *The FB-based platform of the teachers can be used as reference for me to complete my works. The works of other students and the comments from the teacher can help me clarify the direction and inspire me. It is pretty convenient to check Facebook if I have any question. Besides, I can learn more from the Facebook-based learning platform. (M002 was interviewed on November 7, 2012).*

> *I think that this platform provided by the teacher provides direct links to a lot of useful information. In addition, classmates can also share information through the platform. Every time when I have to prepare for the examinations, I can directly check the records of the class. Therefore, it is convenient to review the course content and use the technology. However, it takes too much time to search for information. (F002 was interviewed on December 12, 2012).*

The interview data showed that the learners could engage in knowledge management through the learning-platform, and reviewed the past thoughts and memories of the course. Such a process could help learners learn and review the course. However, learner F002 indicated that it took too much time to search information, which was also the problem of the Facebook-based learning platform.

4.3 Analysis on the Result of Learning Satisfaction with the Facebook-Based Learning Platform Integrated with Blended Learning and Flip Learning

The learning satisfaction was divided into five dimensions, including teaching content & teaching materials, teaching strategies, teacher-student relationship, teaching evaluation and comprehensive comments, as shown in Table 4.

Table 4. Analysis on the Result of Learning Satisfaction

Item	Number of People	Mean	SD
Teaching Content and Teaching Materials	45	4.60	0.63
Teaching Strategies	45	4.65	0.61
Teacher-student relationship	45	4.60	0.68
Teaching Evaluation	45	4.56	0.66
Comprehensive Comments	45	4.62	0.63
Overall Evaluation	45	4.60	0.64

As shown in Table 4, learners' satisfaction with the five dimensions and overall evaluation of the Facebook-based learning platform integrated with blended learning and flip learning adopted in the course was satisfied and above (mean score >4). The mean score of teaching strategies (4.65) was the highest. In other words, the learners' satisfaction with the teaching strategies adopted in this study was the highest. Learners F002 and F003 were interviewed to understand the true feelings of the learners.

> *I think that the teacher providing us with the course-related data and content online in advance really helped us discuss with classmates in class. The class became more interesting and diversified. Before the use of FB-based learning platform, the teacher always kept explaining the course content. However, we barely understood it and had to study it again, which was really bothering us. (F003 was interviewed on January 9, 2013).*

> *In the beginning of the semester, I really was not used to prepare for class in advance. However, I found that I could not discuss with my classmates and the teacher without preparing for the class in advance. Afterwards, I would check the FB every week and shared my feedback after the class. To be honest, I think it is great to continue with the online learning. (F002 was interviewed on December 19, 2012).*

This study found that it took time for them to perceive the impact of this learning strategy. In addition, it is important to implement blended learning and flip learning accurately in a timely manner. This study found that students perceived higher learning participation (more learners' reflections, discussions and conversations). The learners agree that online learning can be used as the extension and prior knowledge of course learning. The overall learning satisfaction was extremely high.

5 Conclusion and Suggestions

5.1 Conclusion

Based on the aforementioned research analysis results, the following conclusions were reached:

- The use of the platform that the learners are accustomed to using can help promote online learning.This research result is consistent with that of the study by Wang (2012) on the teachers' use of Facebook-based learning[17]. This finding shows that the use of the system platform that the learners frequently use and are familiar with can significantly enhance learners' intention to use it because they do not have to learn to use the system.
- Learners' participation in blended learning model and flip learning is higher than their participation in traditional learning.According to the teaching strategies, the concept of flip learning puts emphasis on learner-based learning concepts. The teacher should insist on the learning which conforms to learners' learning autonomy, and learners should be able to fully implement self-regulated learning through question asking, discussion, article posting and works creation.

- The use of Facebook-based learning model integrated with blended learning and flip learning extends the width and depth of learning:In this learning platform, learners can acquire additional abilities and links with other information through the framework of basic background. Undoubtedly, during this process, the instruction of teacher is particularly important to significantly extend the width and depth of the overall learning content, as well as to indirectly increase the time of learning of course in every week.

5.2 Suggestion

According to the research conclusions mentioned above, the researcher proposed the following suggestions on teachers:

- The platform that the learners are frequently use or are accustomed to using should be used to design the e-learning platform:The learning platform that learners frequently use should be used as the fundamental framework. The Facebook used in this study is a platform with numerous users.
- Teachers should regulate the teaching and learning procedures to a certain extent during the implementation of blended learning and flip learning:During the implementation of new teaching strategies, teachers have to explicitly explain the teaching procedures and establish the standards on relevant process and scores to enable learners to adapt themselves to the platform and enjoy it, in order to fully implement such learning strategies.
- Blended learning-based flip learning should focus on students' active learning and exploration:The learning strategies adopted by teachers should be integrated with new teaching thinking. It is inadequate to adopt blended learning model and flip learning by implementing traditional teaching approaches, which may lead to the poor effect and the failure to achieve the learning effectiveness of flipped classroom and teaching strategies for learners.

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Using Social Networking Services to Support Learning

Elvira Popescu and Dorian Ghita

Computers and Information Technology Department, University of Craiova, Romania
popescu_elvira@software.ucv.ro

Abstract. Social media tools are increasingly being used in education, providing students with a medium in which they can actively engage with each other and with their teachers, co-create knowledge, share experiences, work and learn collaboratively. Learning implies not only access to information but also access to other people; in this context, social networking services (SNS) appear well suited for educational use, since they offer social space for people to gather online and make connections. The paper provides an overview on the use of these SNS to support learning. Two approaches are summarized: i) the pedagogical repurposing of existing popular SNS (i.e., Facebook); ii) the design of dedicated educational SNS. The latter is illustrated in more detail with the Lintend platform, a system conceived and implemented by the authors. A critical perspective is also included, and future research directions are drawn from it.

Keywords: social media in education, social learning environments, social networking services.

1 Introduction

Learning implies not only access to information but also access to other people [20]. Since learning mechanisms are triggered by certain interactions among peers, learning environments should be conducive to these interactions [5]. Therefore, students should be provided with a medium in which they can actively engage with each other and with their teachers, co-create knowledge, share experiences, work and learn collaboratively. Today, this social and collaborative context can be created with the help of social media tools, which have started to prove their suitability for education [18].

Social networking services (SNS), in particular, are a category of Web 2.0 tools which offer social space for people to gather online and make connections for various purposes. They can be classified in three categories [17]:

1. general social networks (e.g., Facebook[1]), used mainly for socializing, joining groups of friends, sharing personal information
2. professional networks (e.g., LinkedIn[2]), used for the exchange of work-related information and creating groups of experts in a particular area

[1] www.facebook.com
[2] www.linkedin.com

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3. online community platforms (e.g., Ning[3]), which allow the creation of custom social networks for a specific purpose.

All SNS implement the notion of "friend" or "connection" and allow for the creation of "groups" or "communities"; they facilitate communication, collaboration and sharing of different types of resources.

Statistics show that SNS are the most popular category of websites and their influence is in a continuous expansion. Figures are eloquent: 69% of online American adults use social networking sites, going up to 92% for the 18-29 age group, according to a 2012 study [3]. Facebook appears to be the most popular SNS, with 66% of online adults reporting using it; LinkedIn follows, with 20% adoption rate. Furthermore, 17% of American users' PC time is spent on Facebook [15]. Similarly, at the end of 2012, LinkedIn reported 200 million members, with 2 new members joining every second [16].

In this context of rising adoption rates for SNS in the overall population, a similarly increasing trend is visible in the student category, as captured in various recent studies [4, 6]. The same trend is valid for the teachers/faculty members, who prefer Facebook especially for personal and professional non-class activities [14]. At the same time, Higher Education is one of the top 3 largest industries represented on LinkedIn, with almost 2 million users [16].

Class use of SNS is more limited, but various potential educational applications have been found as well [17]. Thus, students could use social networking tools as support in their learning as follows: i) for interacting with peers; ii) for sharing experiences and ideas; iii) for asking questions and receiving answers from peers and experts; iv) for discussing problems encountered during their studies and getting peer feedback; v) for following experts in their field (in professional networks), which could also serve as an information source. Similarly, teachers can create custom social networks, forming online communities of students associated to a particular course; conventional dialogue and interaction with students are thus enhanced.

Overall, SNS encourage active participation, integration and interaction between learners, strengthen the existing social connections, boost peer support and provide discussion spaces. They are especially suited for informal learning, facilitating the creation of online learning communities who share common educational interests. The students' social driving force for learning, like impressing their peers or helping a group colleague, can also be leveraged through a social networking service [25].

The rest of the paper addresses two different approaches for using SNS to support learning: i) the pedagogical repurposing of a branded SNS (i.e., Facebook) (section 2); ii) the design of a dedicated educational SNS (i.e., Lintend) (section 3). A critical perspective is also included, leading to some future research directions (section 4), followed by conclusions (section 5).

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[3] `www.ning.com`

2 Using Facebook in Education: Case Studies

Since Facebook is the most popular SNS, it has also been the most widely used in educational settings [24]. Therefore, in this section we summarize several teaching practice experiences involving Facebook, as reported in the literature.

Wang et al. [26] describe the use of Facebook as a learning management system for two elective courses at the National Institute of Education, Singapore. 16 master students were enrolled in the first course and 15 undergraduate students were enrolled in the second course. The settings of the two courses were very similar. The tutor created a closed Facebook group that all enrolled students joined. The wall was used for posting announcements, sharing resources and getting feedback from peers. It was also convenient for keeping track of the activities taking place in the group, since every discussion topic created or picture uploaded automatically appeared on the wall. Since Facebook only allowed the posting of resources in image or video format, all other documents were first uploaded to Google Docs and links to them were shared on the wall. The weekly tutorial sessions were announced through the event function, and course materials were uploaded to the event, together with a representative picture of the session topic. Discussions took place both on the event page and on the group space.

A survey was conducted at the end of the courses, aimed at eliciting students' opinions regarding their learning experience with Facebook. Several limitations were identified:

- lack of support for direct uploading of learning resources in PDF or PPT formats
- lack of a threaded structure for discussions (chronological order only), which made giving replies cumbersome (e.g., students had to explicitly mention the comment referred to in their answer); this also made tracking discussion development quite complicated
- privacy concerns – e.g., students wanted to keep their school and personal lives separate; they were worried that their course contributions might be visible to their friends or that their personal information might be accessed by the tutor and peers (although this was not actually the case, since the students did not have to "friend" each other and the course group was closed).

Nevertheless, students were generally satisfied with the pedagogical, social and technological affordances of the Facebook group, with undergraduate students being more positive than master students. The authors conclude that Facebook group has potential for being used in educational settings, either in place of an LMS (in schools which could not afford one) or as a supplement for social interactions and personal profile spaces [26].

A very original instructional scenario is presented in [13]: a role-play assignment was conceived for an introductory psychology course, in which students were required to create the Facebook profile of a famous psychologist. More specifically, the study took place in the context of a course on "Abnormal Psychology", for undergraduate students from the Emerson College, Boston, USA. Students could choose between the Facebook assignment and a traditional term paper. The 22 students who selected the Facebook-based task were required to perform the following steps:

- Send a short proposal to the instructor, covering the selected psychologist, a description of her/his theory and motivating the choice
- Create the Facebook profile of the psychologist (with an identifying course prefix and appropriate privacy settings)
- Connect with the class – i.e., "friend" the course page and all the peers
- Build the Facebook page, including the following components:
    - *Information* - comprehensive biography in the personal information section on Facebook, containing accurate data but evoking also the character of the person
    - *Photos* – to help bring the subject to life
    - *Links* to various resources associated to the psychologist (journal articles, videos etc.)
    - *Notes* – 4-5 postings describing the theoretical model proposed by the psychologist and one note reflecting on the validity of the model and its current status in psychology
    - *Bibliography* – reference sources for all content posted in the profile
    - *Creative aspect* – to make the Facebook page engaging and interactive (e.g., bumper stickers, bookshelves, psychology gifts, quizzes etc.)
    - *Interaction and collaboration aspect* – visit peer pages, communicate with peers, add comments and critiques (from the point of view of the character).

Thus students adopted the role of their selected psychologist, built a profile that illustrated his/her theoretical and personal perspective and discussed and reflected on their theory, all by using Facebook features (*Basic info, Notes, Photo albums, Links, Wall, Status, Comment* etc.).

In order to assess students' overall experience, the authors applied a brief post-assignment survey. Students enjoyed the creative aspect of the assignment (in contrast to a traditional research paper), considering the task very interesting but also very challenging and requiring a lot of work. By carefully reviewing the Facebook profiles, the authors discovered that students delved into the personal details of their psychologists' lives; the occasional moments of humor and in-jokes reflect students' familiarity, engagement but also understanding of theory. The notes provided a novel and flexible space for the traditional process of research, integration, analysis and citation. Furthermore, students tended to browse through the profiles of their peers, thus being introduced to a wide range of theoretical models (rather than just their own, in case of a traditional research paper). The social medium also encouraged comparison among students, which led to an increased productivity. Overall, learners "become co-designers in the process and this, together with the natural playfulness of the medium, creates an empowering and productive learning experience" [13].

Another Facebook-based instructional scenario is reported in [7], for teaching introductory statistics to graduate students at the University of Minnesota, USA. A closed group was set up on Facebook that the students had to join and use as a discussion space for topics of interest to the course. More specifically, learners were asked to post 10 links to news articles related to the course content, together with short critiques and questions regarding the research or statistics reported in those articles. The student contributions were very good, although the dialogue and interaction were quite limited. In order to further boost student discussions, the assignment was slightly modified in the next edition of the course: students were asked to post up to 8 news article links, but also to respond to at least 4 peers' posts. Indeed, this led to much more student discussions, which sometimes continued even after the course ended.

Just like in the previous scenario [13], students could choose between this Facebook assignment and alternative tasks: i) writing a summary and critique of an academic journal article about a statistical analysis technique; ii) creating a short 3-5 minutes video to teach a course topic. Half of the 64 enrolled students chose the Facebook assignment, which, according to a post-course survey, was mainly motivated by the previous engagement and familiarity with the social networking site [7].

Other successful case studies reported in the literature involve various Facebook-based course settings, in which the SNS played different roles:

- A discussion place for students enrolled in an introductory organic chemistry laboratory; students could join a Facebook group and communicate with their peers and instructors, compare obtained data and generate more precise results [21]
- A collaborative space for students to build and discuss a library with videos, links, and pictures related to the course of "Distance Education" [2]
- A peer assessment space for students learning English as a foreign language; students were required to join a Facebook group, post writing assignments, evaluate their peers' posts and comment on the feedback received [22]
- A course management system for an "Internet and Health Informatics" class; the teacher posted all content for the course on the Facebook group wall, together with evaluation questions; students had to answer those questions as well as post at least 3 things they learned from each class [10]
- An information point for health-related courses; the instructor created a Facebook page for the course, posting notifications for available course materials, assessment reminders, links to interesting resources and various announcements; students could comment on the wall posts as well as ask questions that instructors would answer on a daily basis [9].

The results of all the above studies are encouraging, proving SNS potential for education, with a positive impact on learner motivation and satisfaction. In an attempt to exploit this potential, researchers have started to design special-purpose SNS for educational use, enhanced with dedicated learning support features [23]. Our own initiative in this area is detailed in the next section.

3 Lintend Social Networking Service

Lintend is an SNS implemented at the University of Craiova, Romania, as an educational support tool. The system offers the possibility to create a virtual presence for educational institutions ("schools") but also to form interest-based groups ("classes"). The main functionalities provided by the platform include:

- build complex profiles (both for individuals and institutions)
- create and join classes
- add social contacts
- create and share educational resources (courses, tutorials, articles, solved assignments) which can be recommended and commented on
- post news and comments
- send and receive private messages
- visualize timeline (collecting recent activity in all joined classes) and receive notifications for events of interest
- receive suggestions for resources and classes of potential interest.

Some of these functionalities are illustrated in Fig. 1 and 2. The student profile page (Fig. 1) features a short bio, some pictures and personal details, as input by the learner. It also gathers the resources uploaded by that student, together with those recommended by her, throughout the SNS. The list of classmates is also provided, and some classes are recommended for potential joining. A course page (Fig. 2) includes a description, the teachers in charge, as well as a list of uploaded files and comments; a course can be added as a reference for a particular class.

Students are instantly notified of all the events that happen in their classes and any actions performed by their social contacts, which are all made available on their timeline. Learners can therefore be constantly connected to their peers and receive immediate feedback to their questions or problems; communication and interaction with both peers and teachers are thus facilitated and enhanced. By being able to constantly follow the learning activity of their peers, students are more motivated and engaged.

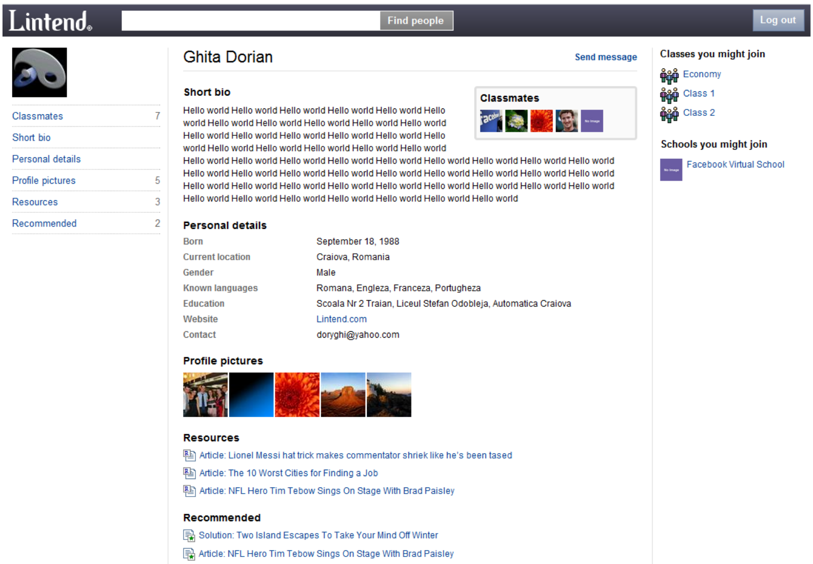

Fig. 1. Lintend social networking service – student profile page

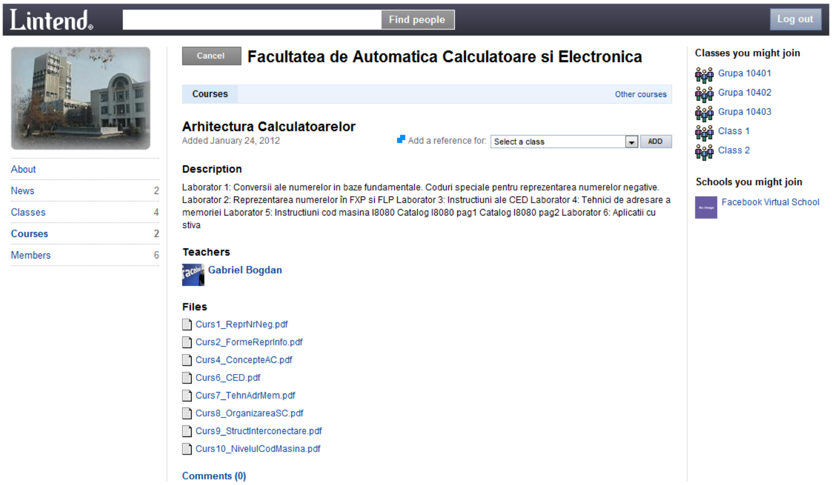

Fig. 2. Lintend social networking service – course page

Overall, Lintend caters to the needs of the new generation of learners, who were cradled in technology, are very social and in constant communication with each other, as well as strongly peer-oriented [25]. The system thus leads to the creation of online learning communities, helping the student find the right content (by means of peers' recommendations) and connect with the right people (peers with similar learning interests).

As far as implementation is concerned, Lintend was developed using ASP.NET and AJAX technologies and Microsoft SQL Server as DBMS. Lintend is currently at prototype stage and experimental evaluation is underway.

As future work, we plan to improve the system with more complex recommendations; Lintend could also be extended with a competence bartering functionality, which will facilitate peer-to-peer learning, as described in [11]. Finally, learner tracking support may be provided to the instructor, as monitoring and archiving students' activity is important for the teachers, especially if that activity is graded [7].

A similar initiative was developed at Tampere University of Technology (TUT), Finland [23]. TUT Circle, as it is called, is an SNS aimed at providing TUT freshmen with convenient tools for interaction and study support, bringing added value to the students in the context of their university life. TUT Circle was developed using Drupal, an open source Content Management System. The functionalities offered to the learners include: creation of a detailed profile, status updates, private messaging between users, suggestion of potential new friends (based on simple Social Network Analysis), tagging, personal dashboards (which collect both the students' own activity as well as their friends'), discussion boards, anonymous questions feature, teacher created surveys etc. Group support, which helps promote team-based learning, is one of the most important features, offering communication and collaboration tools (e.g., chat, write blog posts, edit wiki pages, share resources); groups can be created by any user, on any topic of interest. TUT Circle was successfully used at Tampere

University of Technology, not only to support learning but also to help new students create contacts and interact with each other [23].

4 A Critical Perspective

Despite the growing overall popularity of SNS, they are generally less used in educational settings, compared to other Web 2.0 tools such as blogs or wikis [14]. Teachers are usually more skeptical than students regarding the educational potential of Facebook [19]. Nevertheless, there are also students who consider Facebook reserved for personal connections and social networking, and hence not very suitable for academic work [12].

Some of the criticism is related to the general challenges of Web 2.0: security, safety and privacy threats, occasionally low quality of user generated content [1], promoting intensive multitasking, which could provide a superficial view rather than an in-depth understanding and lead to a short attention span and cognitive overload [25]. Furthermore, the use of Facebook may be felt as an unwelcome intrusion in their personal life by students and teachers, in case boundaries and privacy policies are not set. "Friending" students on Facebook may be an issue for some instructors and/or institutions, and no clear guidelines of conduct exist [7].

Further criticism comes from the commercial nature of the branded SNS, such as Facebook, which is said to limit their potential for education. Friesen and Lowe [8] argue that the business model underlying this kind of social media sites greatly influences the type of user experience provided. Since Facebook's main interest is to connect users with advertisers, this is reflected in its fundamental design decisions, in its structure and ultimately in its content: "informational design, architecture, and algorithm render advertising interests inseparable from what the user sees and is able (or not able) to do on a social Web service" [8].

According to [8], Facebook is based on an "architecture of conviviality", promoting gregarity, sociality and expanding connections (at the expense of discretion and selectivity). It facilitates the expression of agreement (through the "Like" button) but not of reservations and disagreement (since a "Dislike" button is not available). This is due to Facebook business model, where the option of expressing dissent for a brand or product would be contrary to the advertisers' interests. As stated in [8], being deprived of a "Dislike" option is not in line with educational principles. Indeed, cultivating critical thinking, the habit of comparing and contrasting theories, debating and expressing nuanced difference or disagreement are an essential part of the learning process.

We can only agree with Friesen and Lowe's assertion that "education is clearly a social process but it is probably much closer to an ongoing discussion or debate than an extended celebration with an ever-expanding network of friends" [8]. Nevertheless, it should be noted that, when used wisely, Facebook can provide this communication and interaction medium appropriate for argumentation and debate; the successful studies presented in section 2 are a clear proof of Facebook's potential for education.

Furthermore, the creation of special-purpose educational SNS (such as our Lintend solution) offers a dedicated learning space, free of any commercial imperatives. Of course, adding more features to encourage critical thinking, debate and quality assessment in these platforms is a worthwhile research direction. In its simplest form, this could be done by including some rating and tagging mechanisms for assessing students' contributions. A reputation system could also be conceived and more relevant recommendations could be provided, for both human and content resources.

5 Conclusion

The paper presented an overview of SNS use in education, starting with Facebook and continuing with special-purpose systems, dedicated to learning communities. While valid criticism points can be raised (as summarized in the previous section), successful teaching experiences hint at the educational potential of SNS, of "meeting the students where they are" and of facilitating social learning.

Of course, like any other technology, SNS are not a silver bullet and should only be used as support for a well grounded instructional design. In case of commercial SNS (such as Facebook), specific institutional policies with respect to external systems should be observed; furthermore, care should be taken to ensure students' privacy and minimize intrusion, by offering the possibility to keep their personal profiles hidden. Special-purpose educational SNS can alleviate this problem, while at the same time offering additional learning support. Further improvements and ongoing experimentation are needed to realize the full potential of SNS for education.

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Motivational Effect of Peer Review in Blog-Based Activities

Zuzana Kubincová, Martin Homola, and Veronika Bejdová

Faculty of Mathematics, Physics and Informatics
Comenius University of Bratislava,
Mlynská dolina, 842 48 Bratislava, Slovakia
{kubincova,homola}@fmph.uniba.sk,
veronika.bejdova@gmail.com

Abstract. Use of blogging activities in university courses has been showed to improve the primary learning outcomes while additionally reinforcing important professional communication skills. In order to fully use the potential of blogging lack of students' motivation to fully engage in the process may pose a major obstacle. It is not sufficient just to publish a few blog articles; instead, following the classmates' blogs and active participation in the discussions is vital to achieve desired results. In this paper we show that incorporating well organized peer review rounds into the process significantly increased students' participation, and in addition the benefits of such an exercise were perceived positively by the students.

Keywords: Blogging, engagement, motivation, peer review, social learning.

1 Introduction

Blogging has a well recognized potential as a learning activity [7]. As confirmed by a number of publications (e.g. [7,12,8,4]), together with other Web 2.0 tools it is well aligned with the essential features of educational theories such as social constructivism [2], constructionism [9], and connectivism [13] that perceive learning as a social process in which the knowledge is constructed in cooperation with others using the network technologies. These novel approaches in learning foster creative and collaborative work focused on construction of new knowledge, and they have potential to make the learning process more absorbing and even amusing for the students [10].

Encouraged by these findings, we have started to integrate blogging assignments into university courses as of 2006 [3]. It turned out that combining blogging with organized curricula and integrating it into course work is not a trivial task. Students are not always willing to undergo additional assignments just "for free" without any evaluation reward, while other students may object including such non-traditional assignments into their evaluation. In addition, involving students in active follow up and commenting on their colleagues blogs, which is an integral part of this activity, may be even harder task to accomplish. In our experience ill-organized blogging assignments may easily turn into write-only activity, negating most of their goals.

Aiming to overcome these issues, we have resorted to peer-reviewing process, which was found beneficial by other researches in the field [6,5,15,14,11]. Our main goals

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were to boost students' motivation and to increase their engagement in the blogging assignment. With help of our master student we have developed a dedicated tool for article submission, reviewing and organization of the process. The activity was well planned, with alternating writing and feedback rounds spread throughout the semester. Our first results after the first semester in which the system was applied are presented in this paper. We have observed a significant increase in the participation, and also in the overall engagement of our students. Apart from these observations we also saw improved grading, and we have conducted a questionnaire survey of the students' opinions in which the majority of students find the new reviewing process beneficial and useful.

2 Past Experience

Among the courses where we have employed blogging assignments were two courses of the applied informatics study programme: (a) Modern Approaches to Web Design (MAWD), which is mandatory at the master level however a number of bachelor students take it as optional course each year, blogging was included already as of 2006; and (b) Algorithms and Data Structures (ADS), a mandatory course of the bachelor level, which included blogging in 2009–2010 and in 2012 (see our previous report [3] for some more details on how blogs are used by the MAWD course). Both courses implemented so called *professional blogging* assignment where students are asked to publish blog articles on topics of their choice in order to share interesting additional information related to the course, their experience, and opinions.

The activity was extended throughout all semester, and it was not completely mandatory though it contributed to the grading by certain amount of points. The assessment methodology was slightly adjusted each year. The implementation of the assignment differed in each course, as we shall explain.

In the MAWD course, students received a certain number of evaluation points for each article they published (depending on its quality) together with teacher's feedback. Since we quickly learned that students tend to be ignorant of such voluntary assignments, save for the final part of the semester when they realize they could use some additional points, we gradually limited the number of articles allowed per week and even tried a decreasing maximum score per article in some years with moderate improvement in the students' publishing patterns.

In case of the ADS course, we took this experience into account and tried a different approach. The blogging activity was divided into three monthly phases. In each phase the students had to publish articles, and after the phase they received feedback together with *overall* evaluation points for the phase. The importance of regular publishing was stressed and reflected by the evaluation but most students tended to publish the articles towards the end of the phase anyway.

The didactic goals of the assignment, such as obtaining deeper insight into the course topics, improving learning outcome by social construction of knowledge, development of digital competencies, presentation and writing skills, and encouraging collaboration between students, require continuous and regular involvement of the students, which, besides for article writing, must also include active participation in reading and commenting on the others' work.

Despite for various strategies that we employed to boost students' motivation to participate in the assignment, their participation was rather low in the past years. The average overall participation rate was 36.2 % in case of MAWD (2007–2011) and only 15 % in case of ADS (2009–2010). See Fig. 2 for more details. Note that in the MAWD course the blogging assignment contributed to the grading in a higher degree, which partly explains the higher (albeit still small) participation rate. What is more, students mainly posted blog articles, we observed that they were not as willing to read others' postings and comment on them. We observed a decreasing trend in comments especially in the last years and it can be said that it was mainly the teachers who read the articles and provided feedback, which we did not find satisfactory at all.

3 Introducing Peer-Reviews

To improve students' motivation, and especially to encourage students to actively participate in reading others' postings and providing comments we implemented a number of changes in both courses as of 2012. Specifically, we incorporated peer-reviewing into the process but also improved the organization of the whole activity. We have also reserved some of the evaluation points for reading and feedback.

The whole assignment was split into two-week rounds with exactly defined deadlines, out of which the first week was dedicated to article writing and the second was entirely reserved for reading and feedback. Only the students who actually submitted an article in the given round were allowed to review in it and for this sake they were randomly assigned three articles submitted by their peers for review. Five of these rounds were planned spanning for overall 10 weeks, during which the students were supposed to produce 5 articles (one in each round) and to review 15 articles of their colleagues.

In addition to structuring the activity into consecutive rounds, the reviews were carried out in structured form using a predefined set of questions:

1. Was the article interesting for you?
2. Was the article useful for you?
3. To what extent was the article understandable for you?
4. To what extent was the article related to the course subject?
5. What is your overall assessment of the article?

The students had to answer on the scale from 1 to 5 points (worse to best). In addition they had to justify this assessment by a written commentary which was required and limited to at least 100 and at most 300 characters. A screen shot of the form showing Question 2 is shown in Fig. 1.

There were also significant changes in the evaluation of the exercise. While in the past we had solely rewarded students for article writing, now the evaluation points were split between writing and feedback. In case of the ADS course articles and reviews were evaluated and points were awarded after each round, together with teachers' feedback. Out of 15 evaluation points, the students could earn up to 5 points for the submitted articles (up to 1 point each), while the remaining 10 points were reserved for the feedback they provided to their colleagues (up to 2 points each round). Altogether the blogging

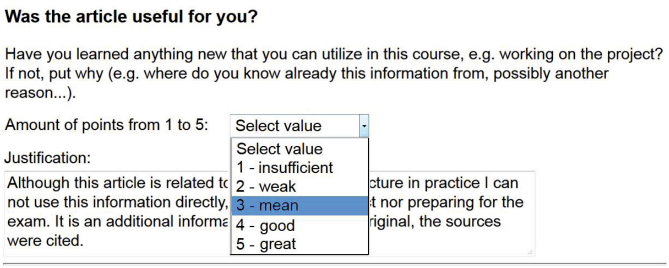


Fig. 1. Example of the usefulness assessment

assignment contributed to the grading by 12 % and was optional: the students who did not participate could still earn the A grading.

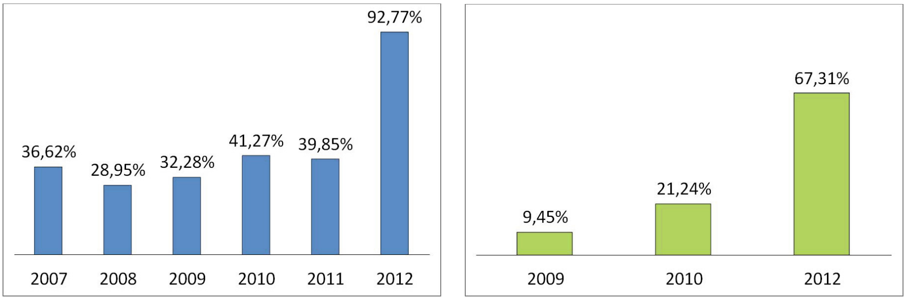
In the MAWD course we took a slightly different approach. The available share of 30 evaluation points was split into 3 even parts, first 10 points reserved for article writing, second 10 points for reviews, and the third 10 for any additional discussions under the submitted blog articles. In addition, while the students received verbal feedback after every round, the points were only awarded after the whole blogging exercise was over. For the submitted articles and for the reviews full 10 points were awarded if the student's contribution as a whole was found sufficient, otherwise 0 was awarded. For the comments a value between 0 and 10 was awarded. The reason for this rather specific methodology was to prevent the feeling that "I have still time to get some points," and to postpone the activity from round to round. Altogether the blogging assignment contributed to the grading by 25 %. The students who did not participate could still pass but they could earn the D grading at best. Taking such two different approaches will allow us to compare them in the next section.

4 Results

During the semester we were able to observe significant improvements in students participation in the blogging activities. To obtain deeper insight in the students' motivation and their overall opinion on the peer-review process we surveyed the students using questionnaires. We present the most interesting outcomes and we also add some of the teachers' observations in the very end of the section.

4.1 Participation Outcomes

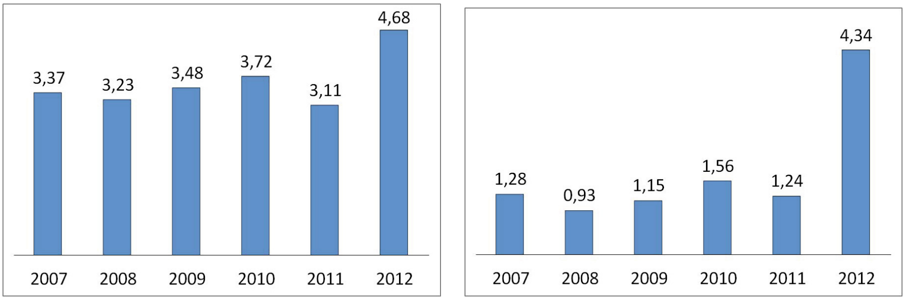
While in the previous years the participation rate was 36.2 % for MAWD and 15.0 % for ADS in average, after implementing the peer-reviews as described in the previous section, these rates rose to 92.8 % and 67.3 % respectively (more details in Fig. 2). The improvement is therefore immediately apparent. We remark that given the blogging was completely optional in the ADS course, the resulting participation rate is strikingly high, especially if compared to the previous years.



(a) (b)

Fig. 2. Students' participation in course blogging activities: (a) MAWD (b) ADS

Besides for the participation rates we were also curious whether the new format would encourage students to engage in the activity regularly, during a longer period. From the MAWD course data we are able to see that this was indeed the case – Fig. 3 (a) shows the average number of submitted articles per student who submitted at least one (i.e., per blogger). We can see that in 2011 this was 3.11 articles, while in 2012 it was 4.68. This means that in 2011 the students were engaged for 3.11 weeks on average (as the one article per week rule was in place), but in 2012 this was 9.36 weeks (one article per two-week round, counting in the reviewing periods as well). For comparison Fig. 3 (b) plots the averages per all students (even those who did not blog).



(a) (b)

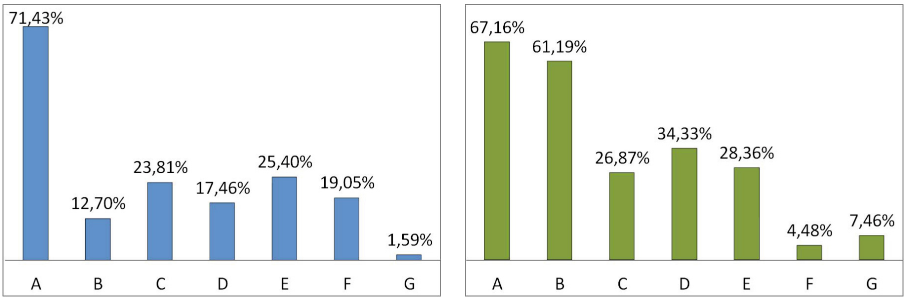
Fig. 3. Average number of articles in the MAWD course (a) per blogger (b) per student

4.2 Questionnaire Outcomes

In order to get better insight into students' motivation we surveyed their opinions on the blogging assignment and other course activities, and the utility perceived from these activities. We used our own questionnaire, which comprised of multiple questions in the following main areas: (a) attitude towards blogs and web information sources (even outside the course); (b) attitude towards course activities, the amount of required work, and the evaluation; and (c) experience and perceived utility of the blogging activity. For the lack of space we solely focus on (c) in this paper. The questionnaire was anonymous and consisted of closed-ended questions (many with the open last option “other”). It was administered after the blogging exercise was over and the sample of 65 MAWD students (78.31 %) and 90 ADS students (86.53 %) participated in it. Let us first have a look on three questions related to the students’ perception of the reading and reviewing activity:

Question 1: In what respect the reading, evaluating and commenting on the blog articles connected with the course was useful to you? Answer options (multiple select):

A. I have learned new information.
B. It helped me to understand the course subject better.
C. I was able to see how problems are viewed by my classmates.
D. I have learned to give constructive criticism.
E. I have learned to express my own opinion.
F. It was not useful at all.
G. Other.



(a) (b)

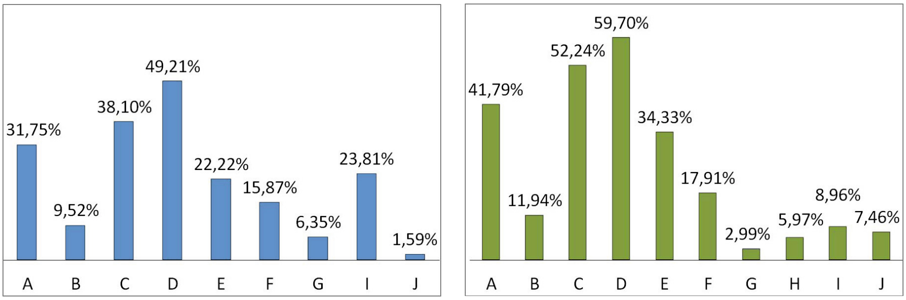
Fig. 4. Perceived utility of reading and reviewing others’ articles: (a) MAWD (b) ADS

From the results plotted in Fig. 4 we find that only a small part of students did not perceive any utility of the activity (F), specifically in case of ADS, only 4.48 %. In case of MAWD this value was higher (19.05 %). We expected that most students would answer that they learned new information (A) though the values are strikingly high. The biggest surprise, and definitely to the positive side, is that 61.19 % of the ADS students indicated that the activity was useful to understand the course subject better (B). Values for (D) and (E), still rather high particularly for ADS, are also encouraging.

Question 2: In what respect the reviews received from your colleagues were useful to you? Answer options (multiple select):

A. It helped me to write better articles in following rounds.
B. Thanks to the feedback I have understood the subject of my article better.
C. I received feedback on my writing skills.

D. I received feedback on the quality of my articles.
E. Errors in my articles were pointed out.
F. I learned other related information I did not mention in my article.
G. It helped me to improve my English (for articles in English).
H. It helped me to correct grammar errors in Slovak (for articles in Slovak).[1]
I. It was not useful at all.
J. Other.



(a) (b)

Fig. 5. Perceived utility of received reviews: (a) MAWD (b) ADS

From the results in Fig. 5 we again see that only a small part of the students declared the feedback they received as completely useless albeit the values are slightly higher then above. We may conclude that the students themselves perceived the activity of giving feedback to their colleagues important (slightly more useful then the actual feedback they have received). The students of both courses appreciated the colleagues' reviews mostly as a source of feedback about quality and the form of their writing and claimed that this feedback helped them to improve their next articles.

Question 3: In what respect the reviews received from the teachers was useful to you? Answer options (multiple select):

A. It helped me to write better articles in next phases.
B. It helped me to choose better article topic in next phases.
C. It taught me to work better with resources.
D. It raised my awareness of copyright issues.
E. It helped me to formulate better the reviews of the other students' articles.
F. It was not useful at all.
G. I did not receive any.
H. Other.

From the results in Fig. 6 we see that even less students perceived teachers' feedback useless (12 % for ADS and about 14% for MAWD). About 50 % of the students in both courses utilized the feedback from the teachers to improve their writing in next rounds. They also felt the teachers' feedback helped to choose further article topics better.

[1] As English was strictly required in the MAWD course, this option is missing in Fig. 5 (a).

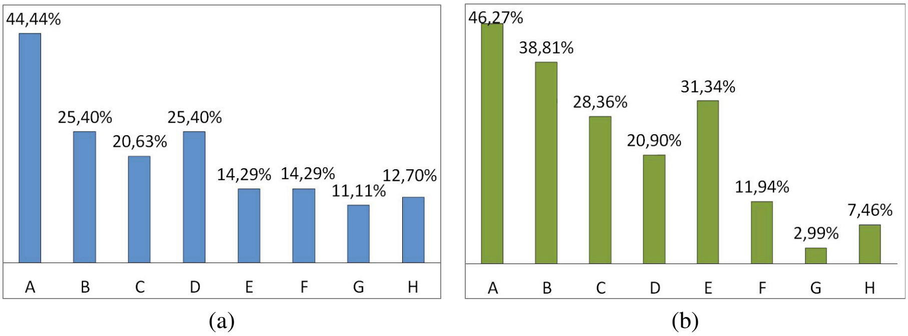


Fig. 6. Perceived utility of teachers' feedback: (a) MAWD (b) ADS

We remark that the students also received feedback on their reviews and especially in case of ADS they perceived it as useful to improve in the following review rounds.

While we also expected some perceived improvement in work with resources (C) and awareness of copyright issues (D) as we stressed this issues frequently in the feedback, the results are not particularly high in this case.

Finally, since the whole blogging activity followed a tight schedule with strict deadlines, we were curious if the students perceived this as useful, or restrictive, to the contrary. The following question was also included:

Question 4: Do you think that the exact deadlines for submission of articles and reviews were helpful in some of the following respects? Answer options (multiple select):

A. It helped me to better organize/arrange my time.
B. It helped me to publish a larger number of better articles.
C. It helped me to pursue the topics related to the course subject continuously.
D. It helped me to gain classmates' feedback continuously.
E. I did not like it.
F. Other.

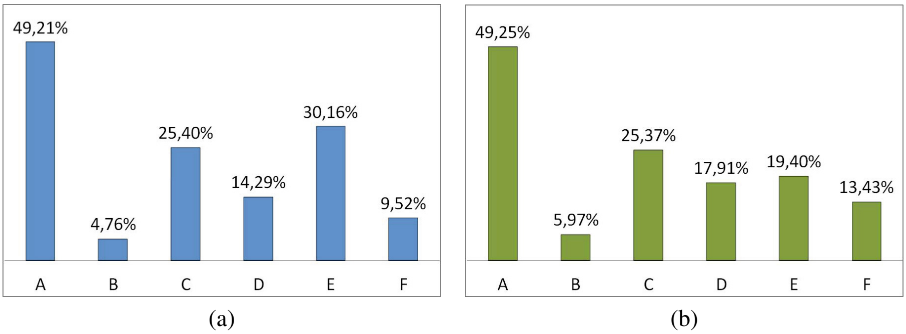


Fig. 7. Students' view on strict deadlines: (a) MAWD (b) ADS

The outcome (Fig. 7) was similar for both courses. Approximately one half of the students indicated that the deadlines helped them to organize their time better (A), and slightly more than one quarter gave the opinion that it helped them to follow the course continuously during the semester (C).

4.3 Additional Observations

During the semester we have observed that students took the feedback into account and many of them improved in article writing in the following phases. Many also improved in constructive critique, taking into account the feedback from the teachers on their reviews. A number of reviews even pointed out insufficient citation and improper work with sources. As we noted above our students are too often ignorant about these sensitive issues, so we were particularly happy for these comments. Also social learning was certainly in place as students did refer to their point of view on the discussed subject, asked for clarifications, etc. In fact, the average grading improved as well when compared to the previous years, in case of MAWD the improvement was by one grade [1].

On the other hand, the tight course of deadlines students had to follow proved to be a rather hard task for them. Many students missed a number of deadlines and they requested for late submissions, which however was not possible once the submitted articles were assigned for reviews. In the end we added additional rounds as we did not want this to be a major obstacle in the whole assignment. Also, while the 10 or 0 points rule implemented in the MAWD course proved to be motivating the students opinions on this were rather reserved. We can see from the survey results that indeed in case of MAWD the part of the students who participated even if they did not find it very useful was larger (approx. 25 %). This is probably due to the greater contribution of the assignment to the grading – they wanted to be sure that they will pass the course. Since in the end the participation rate in case of ADS (i.e., with less strict rules) was already very high, possibly relaxed rules and lower contribution to grading may still be enough to attract a significant number of students.

5 Conclusions

While blogging assignments can be beneficial for university students, it is not easy to motivate them for participation in this kind of course activity. To address this problem we have designed a well-organized peer review process that we have implemented in our teaching. In this paper we present the findings after the first semester with peer reviews. In comparison with the previous years, the participation of students significantly improved (by triple or even quadruple rate in different courses). In addition the students participated during longer periods of time and not just accidentally. Hence we conclude a significant positive effect on students' motivation.

In addition we have surveyed the students' opinions on such organization of the blogging activity. The students confirmed that the activity was useful as they learned new information from their colleagues' blogs, gained better insight into the course topics, improved constructive criticism and communication skills. The peer-reviews were perceived positively by a predominant majority of students, who took the colleagues' comments as useful feedback which helped them to write better articles in the next rounds. Students also appreciated the teachers' feedback as instrumental in continual improvement of their work. Although the strict deadlines were restrictive for several students who failed to submit articles and reviews in time, approximately one half of the students stated that the time schedule helped them to organize their work during the semester better. Altogether the deadlines were taken more positively than negatively.

In our research we collected and examined a larger set of data. From the outcomes presented in this paper but also elsewhere [1] we can conclude that the peer-review process raised the students' motivation to study and also to their acceptance of blogging in the educational process.

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Lecture Video Browsing Using Multimodal Information Resources

Haojin Yang, Franka Grünewald, Matthias Bauer, and Christoph Meinel

Hasso-Plattner-Institute (HPI), University of Potsdam, Germany
{haojin.yang,franka.gruenewald,matthias.bauer,Meinel}@hpi.uni-potsdam.de

Abstract. In the last decade e-lecturing has become more and more popular. The amount of lecture video data on the *World Wide Web* (WWW) is growing rapidly. Therefore, a more efficient method for video retrieval in WWW or within large lecture video archives is urgently needed. This paper presents an approach for automated video indexing and video search in large lecture video archives. First of all, we apply automatic video segmentation and key-frame detection to offer a visual guideline for the video content navigation. Subsequently, we extract textual metadata by applying video *Optical Character Recognition* (OCR) technology on key-frames and by performing *Automatic Speech Recognition* (ASR) on lecture audio tracks. The OCR and ASR transcript as well as detected slide text line types are adopted for keyword extraction, by which both video- and segment-level keywords are extracted respectively. Furthermore, we developed a content-based video search function and conducted a user study for evaluating the performance and the effectiveness of proposed indexing methods in our lecture video archive.

1 Introduction

In the last decade, digital video has become a popular storage and exchange medium due to the rapid development in recording technology, improved video compression techniques and high-speed networks. Therefore more and more universities record their lectures and publish them further online for the students to access. This results in a huge amount of multimedia data on the *World Wide Web* (WWW). How to build an efficient search function for finding lecture videos on the web or within large lecture video portals has become a challenging task.

Most of the video retrieval and video search systems such as Google, YouTube, Bing etc. reply on available textual metadata such as title, genre, person, and brief description etc. Generally, this kind of metadata has to be created by a human to ensure a high quality, but the creation step is rather time and cost consuming. Furthermore, the manually provided metadata is typically brief, high level and subjective. Therefore, beyond the current approaches, the next generation of video retrieval systems apply automatically generated metadata by using video analysis technologies. In this way, much more content-based metadata can be generated efficiently. Moreover, the temporal video information can also

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be adopted for some special retrieval tasks such as lecturer action and gesture recognition.

Text is a high-level semantic feature which has often been used for the content-based information retrieval. In our framework, we have developed an entire workflow for gathering video textual information, including video segmentation/lecture slide extraction, video OCR, ASR, and keyword extraction from OCR and ASR results. By using a *Connected Component* (CC)-based segmentation method, we can detect the unique lecture slides. The detected slide key-frames are further utilized by a video OCR engine, which consists of a two-stage text detection scheme and a multi-hypotheses framework for text recognition. To obtain *speech-to-text* information we use the open-source ASR software *CMU Sphinx*[1] in combination with our acoustic and language model, which have been trained for recognizing German lecture videos.

Keywords can provide a brief summary of a document and are thereby widely used for information retrieval in video portals. We have developed an automated method for extracting segment- and video-level keywords from OCR and ASR transcripts.

To develop a content-based video search engine in a lecture video portal, the search indices will be created from different information resources, including manual annotations, OCR and ASR transcripts etc. The varying recognition accuracy of different analysis engines might result in solidity and consistency problems. Therefore, we propose a new method for ranking keywords extracted from various information resources.

In order to investigate the usability and the effectiveness of proposed indexing features, we have conducted a user study.

The rest of the paper is organized as follows: section 2 reviews related work. Section 3 describes our automatic video indexing features, while section 4 details the user study result. A conceptional discussion of video search using multimodal information resources is provided in Section 5. Section 6 concludes the paper with an outlook on future work.

2 Related Work

Wang et al. proposed an approach for lecture video search based on video segmentation and video OCR [3]. The proposed segmentation algorithm in their work is based on the differential ratio of text and background regions. Using thresholds they attempted to capture the slide transition. The final segmentation results are determined by synchronizing detected slide key-frames and related text books, where the content similarity between them has been applied as the indicator. Since the animated content evolvement has not been considered, their system might not work robustly when those effects occur in lecture slides. Furthermore, the final segmentation result is strongly dependent on the quality of the OCR result. Therefore, it might be less efficient and imply redundancies, when poor OCR results were obtained.

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[1] `http://cmusphinx.sourceforge.net/`

Talkminer[2] is a lecture webcast search system which has been proposed by Adcock et al. in [1]. The system retrieved more than 37000 lecture videos from different resources as e.g., YouTube, Berkeley Webcast etc. The search indices are created based on the global metadata obtained from the video hosting website and texts extracted from slide videos by using a standard OCR engine. Since no text detection and segmentation processes have been implemented, the text recognition accuracy of their system is much lower than our system's.

Similar to Talkminer another lecture video search engine Yovisto[3] which is proposed by Sack et al. [11], utilizes an automated video segmentation method and a standard OCR engine for content-based metadata generation. Furthermore, the LOD (*Linked Open Data*) resource DBPedia [2] has been adopted to extract semantic entities from video lectures.

In the CONTENTUS [8] project, a content-based semantic multimedia retrieval system has been developed. After the digitization of media data, several analysis techniques as e.g. OCR, ASR, video segmentation, automated speaker recognition etc. have been applied for metadata generation. An entity recognition algorithm and open knowledge bases are used to extract entities from the textual metadata.

In both Yovisto and CONTENTUS a search function is provided based on the recognized semantic entities from the textual metadata. As already mentioned, searching through the information resources with various confidence scores, we have to deal with the solidity and the consistency problem. However the reviewed systems did not consider this issue.

In our previous work [13], we proposed a video visual analysis framework, which consists of a slide video segmenter, a video OCR engine, and an automatic lecture outline extraction method. In addition, in [12] we introduced a solution for improving ASR results of German lecture videos. We will thus give a general overview of our video indexing approaches in the next section.

3 Automated Lecture Video Indexing

We perform three analysis processes for the retrieval task, including visual video analysis, audio speech analysis and textual analysis.

3.1 Visual Analysis for Lecture Videos

Video browsing can be achieved by segmenting video into representative key-frames. Choosing a sufficient segmentation method is based on the definition of "video segment" and usually depends on the genre of the video. In the lecture video domain, a video sequence of an individual lecture topic is often considered as a video segment. This can be determined by analyzing lecture slide transitions. The traditional approaches utilize global pixel-differencing metrics for capturing slide segments [1]. We developed a novel CC-based method, by which

[2] `http://talkminer.com/`

[3] `http://www.yovisto.com`

the binary CCs are applied instead of image pixels as the basis element. In this way, high-frequency image noises can be removed in the frame comparison process by adjusting a valid size of CCs. Our method consists of two steps: in the first step, we try to capture every knowledge change between adjacent frames, for which we established an analysis interval of three seconds by taking both accuracy and efficiency into account. Since the result from this step may contain the progressive build-up of a complete final slide over sequence of partial versions, the progress continues with the second step intended to capture real slide transitions. Here, we apply a text line comparison method in different slide regions to determine whether two adjacent frames belong to the same slide.

Since the mentioned segmentation method is only defined for slide images, it might not be robust when videos with varying genres having been embedded in the slides and are played during the presentation. To solve this problem we have extended the original algorithm by using a *Support Vector Machine* (SVM) classifier and image intensity histogram features. The experimental results show that the achieved classification accuracy for recognizing slide frames is over 91% by using this approach.

Texts in the lecture slide are closely related to the lecture topic, can thus provide important information for the retrieval task. In our framework, *text detection* first determines whether a single frame of a video file contains text, for which a bounding box enclosing each text line is returned as the result. We have developed a two-stage approach that consists of a fast edge-based detector for coarse detection and a *Stroke Width Transform* (SWT)- and SVM-based verification procedure to remove false alarms. Then, the text segmentation process separates text regions from their background, for which we developed a novel skeleton-based binarization approach for processing video images. After this process, the text line images are converted to an acceptable format for standard OCR engines. For text recognition, we apply a multi-hypotheses framework to recognize texts from text line images. The subsequent spell-checking process will further sort out incorrect words from the recognition results. An in-depth discussion of the proposed segmentation and video OCR methods can be found in [13].

3.2 ASR for Lecture Videos

In addition to video OCR, ASR can provide speech-to-text information from lecture videos, which offers the chance to improve the quantity of automatically generated metadata dramatically. However, most lecture speech recognition systems cannot achieve a sufficient recognition rate, the WERs (*Word Error Rates*) reported from [7,6,5,4] are approximately 40%–80%. Therefore, we decided to build acoustic models for our special use case by applying the CMU Sphinx Toolkit[4] and the German Speech Corpus by Voxforge[5] as a baseline. We collected hours of speech data from our lecturers and compiled corresponding transcripts for the

[4] `http://cmusphinx.sourceforge.net/`
[5] `http://www.voxforge.org/`

acoustic model training. Furthermore, we developed a method to generate the German phonetic dictionary automatically. The experimental results show that the WER decreased by about 19%, when adding 7.2 hours of speech data from our lecturers to the training set. More information of our current ASR approach and the experiment results can be found in [12].

3.3 Textual Analysis for Lecture Videos

Regarding lecture slides we can realize that contents of title, subtitle and key point have more significance than that from the slide's body, as they provide a summarization of each slide. We thus classify the type of OCR text lines by using their geometrical information and stroke width value. The defined types include *title, key-point, footline* and *normal content*. Subsequently, we extract the lecture outline by using classified text contents, which can provide an overview of the lecture to the user. Moreover, each outline item with a timestamp can in turn be used for browsing within the video.

Keywords can summarize a document and are widely used for information retrieval in digital libraries. In our framework, segment-level as well as video-level keywords are extracted from OCR and ASR results respectively. For extracting segment-level keywords, we consider each individual lecture video as a document corpus and each video segment as a single document, whereas for obtaining video-level keywords, all lecture videos in the database are processed, and each video is considered as a single document.

To extract segment-level keywords, we first arrange each ASR and OCR word to an appropriate video segment according to the timestamp. Since our system only considers nouns as keywords, we thus extract all nouns from the transcripts by using the stanford part-of-speech tagger [10]. Then we use a stemming algorithm to capture nouns with variant forms but a common meaning. To remove the spelling mistakes resulted by the OCR engine, we perform a dictionary-based filtering process.

We calculate the weighting factor for each remaining keyword by extending the standard TFIDF (*Term Frequency Inverse Document Frequency*) score [9]. The TFIDF algorithm calculates keywords only according to their statistical frequencies. It cannot represent the location information of keywords, that might be important for ranking keywords extracted from web pages or lecture slides. Therefore, we defined a new formula for calculating the TFIDF score for segment-level keywords, as shown by Eq. 1:

$$TFIDF_{seg-internal}(kw) = \frac{1}{N}(TFIDF_{ocr} \cdot \frac{1}{n}\sum_{i=1}^{n} w_i + TFIDF_{asr} \cdot w_{asr}) \quad (1)$$

where kw denotes the current keyword, $TFIDF_{ocr}$ and $TFIDF_{asr}$ denote the TFIDF score computed from OCR and ASR words respectively, w is the weighting factor, n denotes the number of various OCR text line types. N is the number of available information resources, in which the current keyword can be found (the corresponding TFIDF score does not equal 0).

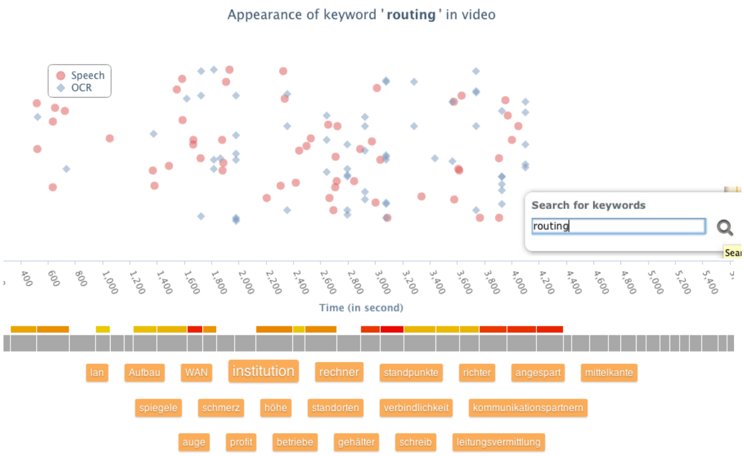

Fig. 1. Segment-level keyword browsing and keyword search function in our lecture video portal

Since OCR text lines are classified into four types in the previous analysis stage, we can calculate the corresponding weighting factor for each type and for each information resource by using their confidence score. Eq. 2 shows the formula:

$$w_i = \frac{\mu}{\sigma_i} \ (i = 1 \ldots n) \tag{2}$$

where μ is set to equal 1 and σ can be calculated by using the corresponding recognition accuracy, as shown by Eq. 3:

$$\sigma_i = 1 - Accuracy_i \ (i = 1 \ldots n) \tag{3}$$

Fig. 1 demonstrates the web GUI of the segment-level keyword browsing and search function in our lecture video portal. The detected Keywords are presented by plot-points in the scatter chart, the video will navigate to the position where the word has been spoken or appearances in the slide by clicking. Video-level keyword extraction works in a similar manner that we will discuss in section 5.

4 User Study

We conducted a user study with 12 students from our institute. These students are enrolled in computer science studies doing their bachelor's or master's degree. We wanted to identify how fast, how accurate and with the help of which video indexing tools a specific lecture topic can be found within a lecture video. Besides we meant to learn if video indexing tools could enable the learner to be more attentive and thus have a bigger learning success. Therefore, two tasks have been conducted:

- **Task 1** was to find an information in a complete lecture of about 1 hour. This task had to be done five times with the different setups, at randomly chosen but similar and non-repetitive lecture videos. The available setups to be used were
  - only the video in a seekable video player
  - video plus key-frames
  - video plus lecture outline
  - video plus keywords
  - video plus all available indexing tools.
- **Task 2** was to watch a video of 10 minutes. One time the participants were allowed to use all of the indexing tools on the video and for another video they were only allowed to use the video player without additional tools. After watching a video the students had to perform a small exam so we could measure their learning effectiveness.

During the user study each student had to work on his or her own and had an undisturbed working environment during the whole time. After a preliminary introduction, each student had one hour time to fulfill the requested tasks. All the videos were chosen carefully with similarity in complexity of the topic and findability of the required information in mind. The videos are part of computer science studies and they were held in the subjects' native language. The videos were chosen at random. No student knew about the topics before the beginning of the test procedure. Furthermore none of the students attended any of the lectures of the chosen subject (information security).

All the students who participated in the user study have never worked with the video indexing tools before the study. But even though they were new to them, every single subject was able to use them to their advantage after a small introduction. We found that the requested information were found faster and more accurate than searching without the video indexing tools whenever the students used key-frames, lecture outline or all of the available features (cf. Fig. 2 (a) and (c)). The only tool showing a slower processing speed were the keywords. In our understanding this is caused by the necessity to scroll the website down from the video player to the keywords GUI. Nevertheless, it achieved the best accuracy results as shown in Fig. 2 (c).

In the second task, we have prepared three multiple choice and a free-text question for each test video. In order to make the evaluation as general as possible, we have designed three methods for the result scoring:

- **W1** for multiple choice question: +1 for each correct answer, -2 for each incorrect/missed answer; for free-text question: +2 for each correct point.
- **W2** for multiple choice question: +1 for each correct answer, -1 for each incorrect answer, 0 for missed answers; for free-text question: +2 for each correct point.
- **Normalized W2** since the maximal number of correct answers for the multiple choice questions is different for each test video, we thus additionally built the normalized result of W2.

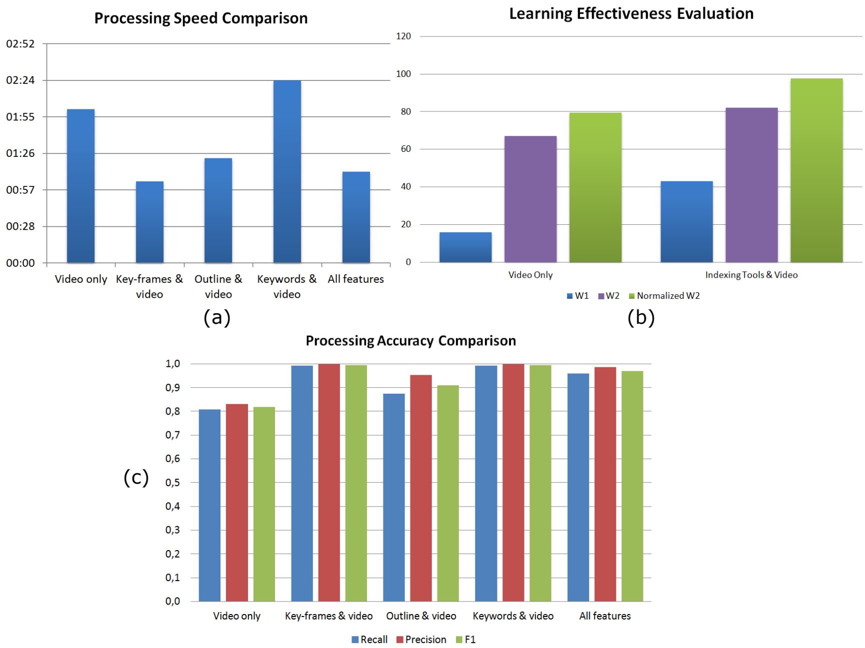

Fig. 2. (a) Processing speed evaluation results of task 1, (b) results of the learning effectiveness evaluation (task 2), where Y-axis presents the total score of the exam, (c) processing accuracy evaluation results of task 1

From the results presented by Fig. 2 (b), we can realize that the learning effectiveness can be improved measurably by using video indexing tools.

5 Video Search Using Multimodal Resources

As already mentioned, to build a content-based video search engine by using multimodal information resources, we have to deal with solidity and consistency problems. Those information resources might be generated either by a human or by an analysis engine. For the latter case, different analysis engines may have various confidence scores. Therefore, during the ranking process we should consider both, the statistical feature of the keywords and their confidence scores as well. We have thus defined a formula for computing the video-level TFIDF score, as shown by Eq. 4:

$$TFIDF_{vid-level}(kw) = \frac{1}{N}\sum_{i=1}^{n} TFIDF_i \cdot w_i \tag{4}$$

where $TFIDF_i$ and w_i denote the TFIDF score and the corresponding weighting factor for each information resource. N is the number of available information resources, in which the current keyword can be found.

Table 1. keyword-video matrix A

	v_1	v_2	$\cdots$	v_n
kw_1	a_{11}	a_{12}	$\cdots$	a_{1n}
kw_2	a_{21}	a_{22}	$\cdots$	a_{2n}
$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$
kw_m	a_{m1}	a_{m2}	$\cdots$	a_{mn}

In our case, video search indices can be built from three information resources currently, including global video metadata created by a human, ASR and video OCR words. As described in Eq. 1, the OCR text lines were in turn classified into several types, let $TFIDF_g$ and w_g denote the TFIDF score and the weighting factor for global video metadata, the formula can thus be extended as:

$$TFIDF_{vid-level}(kw) = \frac{1}{N}(TFIDF_g \cdot w_g + TFIDF_{ocr} \cdot \frac{1}{n}\sum_{i=1}^{n} w_i + TFIDF_{asr} \cdot w_{asr}) \tag{5}$$

The ranked video-level keywords can directly be used by a video search engine. In addition, the video similarity can also be further computed by using a vector space model and the *cosine similarity measure*. Table 1 shows an exemplary keyword-video matrix $A_{kw \times v}$, its columns and rows correspond to video and keyword indices respectively. The value of each matrix element is the calculated $TFIDF_{vid-level}$ score of the keyword kw_i in the video v_j.

Let each column of A denote a vector d_j which corresponds to a video v_j. Here, the dimension of d_j is the number of selected keywords. Let q denote the query vector which corresponds to another video v_k, the similarity between v_j and v_k can then be calculated by using cosine similarity measure according to Eq. 6:

$$sim(d_j, q) = \frac{\sum_{i=1}^{m}(a_{ij}q_i)}{\sqrt{\sum_{i=1}^{m}(a_{ij})^2}\sqrt{\sum_{i=1}^{m}(q_i)^2}} \tag{6}$$

Furthermore, the TFIDF score for the *inter-video* segment comparison can be derived according to Eq. 7:

$$TFIDF_{seg-inter}(kw) = TFIDF_{seg-internal}(kw) \cdot TFIDF_{vid-level}(kw) \tag{7}$$

By using this score, we are able to implement a video segment-based lecture topic search/recommendation function.

6 Conclusion and Future Work

In this paper, we presented an approach for automated video indexing and video search by using multimodal information resources. To retrieve textual metadata automatically, we developed a video OCR system and applied ASR technology. The segment- and video-level keywords are further extracted from OCR and ASR transcripts by extending the original TFIDF algorithm. We proposed a novel concept for content-based video search systems. A user study was conducted to investigate the effectiveness of proposed indexing methods. As future work, we will implement the proposed video search function in our lecture video portal.

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Evaluating the Digital Manuscript Functionality – User Testing for Lecture Video Annotation Features

Franka Grünewald, Haojin Yang, and Christoph Meinel

Hasso-Plattner-Institute (HPI), University of Potsdam, Germany
{franka.gruenewald,haojin.yang,Meinel}@hpi.uni-potsdam.de

Abstract. In current tele-teaching platforms the main challenges for learners are searching and filtering through the content and staying focused on learning with the help of the e-lectures. Video annotation and video indexing features may provide support for learners in this situation. In this paper we will introduce one solution for a lecture video annotation feature called the digital manuscript. Digital notes can be written synchronously or asynchronously to the time of the actual lecture. Different features such as instant time markers and formatting options are available. In order to prove our hypothesis that the digital manuscript feature enables students to better concentrate on watching the video lecture and thus results in an improved learning effectiveness, we conducted a user study. The results include insights into the perceived usefulness of the annotation functionality as well as a quantitative comparison of assessment results with and without the manuscript feature and the indexing features as comparison. An outlook to group functionalities as well as a semantic extension of the video annotation feature is finally given.

1 Introduction

The main challenges for learners in this decade are the enormous amount of resources and learning content available as well as the limited time to deal with all this information. Learning independent from place and time according to ones own speed and interests is one possibility to help overcome these problems. Teleteaching is a process invented to assist in time- and place-independent learning. But since lecture recording technology, like tele-TASK [10], becomes easier and faster to use, the amount of tele-teaching data grows rapidly as well.

Searching through all the content for a specific or even unspecified information and quickly grasping the essence of the lecture video are the main issues for students related to lecture videos. But searching through those videos is no trivial task, due to the nature of this content. Recorded lectures are multimedia content, that cannot easily be searched or indexed. Administrative metadata, that requires a lot of effort to produce, is often the solution to find the appropriate content.

Two main categories of solutions exist for this problem. The first is automatic metadata harvesting with the help of audio transcription of the lecturers' speech

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and optical character recognition of the screen grabbing signal from the lecturers laptop. Extracting all this data opens up the problem of a large amount of unprioritized metadata. To find the most essential information within this data is the next challenge. One of the basis for this paper are solutions to this issue. Those are indexing functionalities that help grasping the content of a lecture with the help of this automatically harvested metadata. Automatically extracted slides, that are provided in a timeline format, a lecture structure extracted from the lecturers slides enhanced with direct links into the video [11] as well as a keyword [3] functionality are the indexing tools suggested in our project. Since those tools are only used as comparison for the evaluation of the annotation tools in this paper, they will not be explicated further.

The second solution space opened up with the ara of Web 2.0 with which Tim O'Reilly [7] introduced the idea of communities of users that join together. The users in those communities create and share their own web content. The main advantages of this idea for tele-teaching are the enormous amounts of metadata that can be created by such a crowd of people as well as the fun that was observed people had working for the community. This active engagement and collaboration with fellow students also has benefits from the didactical side. Especially when using e-lectures there is the danger that students just lean back and consume the material without being active, because a lot of self-discipline is required to stay attentive in front of the computer alone at home for such a long period of time. In research about didactics it was found out, that the active involvement with the material and the exchange with learners is especially important for learning. To achieve those two things is therefore a goal for every online learning platform. To cope with this issue a lot of Web 2.0 functions, like tagging and rating of content, generation of playlists and adding of links to lectures were implemented [1]. Furthermore an annotation functionality was being developed that supports the creation of a digital manuscript for students [2]. This digital manuscript feature is the primary tool that will be evaluated in this paper. It will be compared with the performance of the previously mentioned indexing features. Since the functionalities mentioned all work in one and the same interface with video indexing features in conjunction with the video player containing the e-lecture, they were be evaluated together and will be compared at suitable points. The remainder of this paper is organized as follows: the next section will deal with related work to the presented features. Afterwards the functionalities, their theoretical as well as technical background will be explained in detail. In the section thereafter the test setup and design, the measures and data collection, the hypothesis and finally the test results will be elaborated. Finally, the conclusion and future work section will give details about further work planned to enhance the functionalities.

2 Related Work

Web 2.0 or community functionalities in tele-teaching can be separated in time-independent and time-bound activities. The chat functions, forums and the creation of playlists are time-independent activities. Tagging of videos can be both.

Annotation functionalities that utilize a timeline approach are time-bound activities. Setting time markers in order to save a bookmark of a certain position within the video as well as multimedia or textual annotations attached to the video are meant by annotation functionalities.

Research about annotation function is ongoing for about a decade now. Those functionalities were proven to be beneficial for students [12,5,8]. Browsing the video content is one thing that is enabled by textual annotations, because those annotations are a form of additional metadata. Furthermore not only free-text can be used as annotation, but also other media formats, like images, or even links [5].

A second benefit for the users is the process of annotation itself, as explained by Hofmann et al. [5], because it consists of didactically advantageous processes, like interpretation, weighting and reflection of the content. Thus digital annotation assists students in gaining a deepened understanding of the topic, as Zupancic stated [12]. Also, time-based annotations encourage more participation and discussions among students, because they serve as anchored discussions, as opposed to forums [12].

Several researchers focus on wikis as means for digital video annotation. Sack and Waitelonis [9] for example complement their academic video search engine Yovisto with a Wiki or enable collaborative annotation alternatively via tagging of lecture segments. Lecturers and students may add additional content to the e-lectures and serve as tool for further explanations or discussions of the video. The wiki content is not time-based, though and the tagging feature is not aiming at providing possibilities to write a whole lecture manuscript for students. O'Neill [6] describes a method, where the content of the lecture slides is copied into a wiki. Students are then asked to further enhance their script. A model how to visualize students' comments within the lecture recording was suggested by Lauer and Trahasch [6]. Hermann and Ottmann [4] describe the integration of lecture videos with a wiki, too. But they enable learners to discuss a certain topic and link specific positions of lecture videos within the wiki. The evaluation of those features showed, that it was evaluated very useful by e-learning experts as well as users.

In our work we want to provide wiki-like annotation features, but based on every of the individual lectures as we find the procedure to search and add lectures to topics too time-consuming and not too relevant for university teaching, as students are bound to learn on a lecture basis anyway. Further details about our solution can be found in the next section.

3 The Digital Manuscript Functionality

The wiki-like annotation feature is implemented for every lecture and is called digital manuscript, because it provides the functionality for writing a time-based digital lecture manuscript while watching the lecture. The workflow and use cases for students working with lecture recordings consist of two parts. The first use

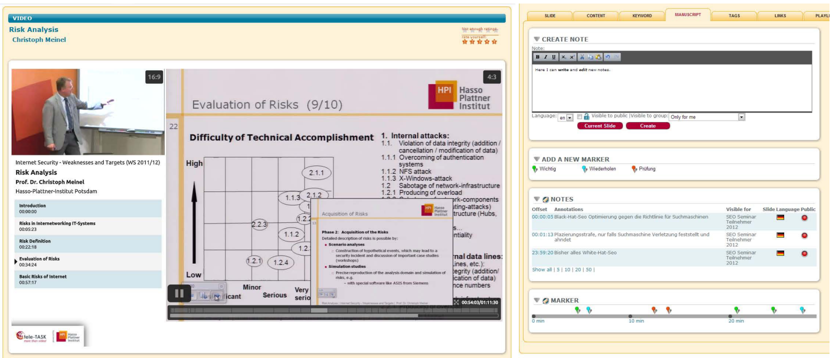

Fig. 1. Video player with indexing functions (left) and annotation interface (right)

case is the usage of the lecture recording at any time after the original lecture took place. This can be the case either when the live lecture is substituted with the recording or when the lecture recording is used to replay the lecture for revision or learning purposes. The manuscript interface would be situated underneath the video player where the lecture is replayed and thus allow the student to simultaneously watch the lecture recording and write notes to it.

The second use case is the live streaming. Students may watch a stream broadcasted while the lecture is actually taking place. The livestream is opened in an additional player. This player as well as a link to the manuscript interface are accessible via a live streaming calendar. The calendar provides an overview of upcoming events to the students. For each individual live event the optional live streaming links and a link to the annotation interface are displayed. Annotations in the live settings are saved with an absolute timestamp. When the lecture is saved in the portal, the relative offset to the beginning of the lecture is calculated and the live annotations are transformed to portal annotations so that the students using the live annotation feature may also benefit from the search and video structuring capabilities of the annotation feature.

In a pre-study with a few users as well as an analysis of the culture of participation paradigm [2] certain key aspects of the annotation functionality were found out. First of all the annotation interface should be easy and fast to use and should provide formatting possibilities. For the quick and easy approach we have therefore implemented a tool called *marker* that allows to set a bookmark at one specific time within the video with only one click. There exist pre-defined default captions, like "important", "exam", "revise" that students can use, but also individual markers can be defined. For the annotations with more formatting options, a textual annotation functionality with limited WYSIWYG functionality, called *manuscript*, was implemented (see figure 1 for both interfaces).

4 Evaluation with User Tests

Since the user acceptance is a crucial part of the success of the annotation features, a user test was conducted in order to evaluate those functions. In order to receive a multi-angle result, qualitative as well as quantitative, subjective as well as objective data was be collected. To be able to compare the results to those of other functions, the user study was conducted together with this of the indexing features of the portal [11].

The main question leading the design of this user test is: *Can annotation tools help the user to learn more effectively while watching a lecture recording?*

This section will start with explaining the test setup and design, continue with measures and data collection as well as the hypothesis and finish with the results of the user study.

4.1 Test Setup and Design

The test was undertaken in an artificial testing environment in a previously prepared setup. Twelfe single participants were recruited. They were all male bachelor or first semester master students at the Hasso-Plattner-Institute in the field of IT Systems Engineering. The test was done on a desktop PC. A website was prepared that included the videos used for each of the two tasks.

Since the aim was to compare the outcomes in speed and precision of different setups, we used a within-subject-design. This means that each test person was asked to perform all tasks. For each of the conditions in all tasks we prepared different videos. We randomly assigned an order of all tasks and which video would be given for which task in order to avoid influence of tiring and learning effects that might occur over time.

The test was started with a recruiting questionnaire aiming at eliminating effect due to previous knowledge of the participants. The first task within our user study concerned the further evaluation of the indexing features and will not be part of this publication.

Table 1. Listing of Conditions for the individual tasks

Condition	Tools allowed
1	Video only
2	All Indexing Tools
3	Annotation Tools (Digital Manuscript, Marker)

The second task included watching videos of about 10 minutes length each and memorize as much content as possible. After each of the videos the participant would be given a questionnaire including three multiple-answer questions and one free-text question. They would in no condition have access to the video itself or notes they produced while watching the videos. This was repeated three times until the participant had gone through all conditions. The participants knew that the time they needed was taken and they were observed while performing the tasks.

The test was concluded with a post-test-questionnaire asking for the subjective feedback about the tools used. Next, we will go into detail about the measure and data collection used.

4.2 Measures and Data Collection

Each of the test rounds was supervised by one test leader. It was the test leader's task to observe and note down what the test person did and said and to take the time needed for the tasks. In the first task, time and precision were the measures, since the speed and correctness should be evaluated. Since the first part of the test is not within the scope of this publication, we will not go into further details concerning this question.

For the second task the leading question was: Can video indexing tools / video annotation tools assist the learner in being more attentive and therefore learn more while watching lecture videos? In order to measure the attention we decided to measure the learning outcome. Therefore we used the previously mentioned exam-like questionnaires, one for each of the videos. Three different methods for grading were used [1].

Finally we were looking for answers to the question: How do students perceive video annotation tools? In order to answer this question the post-test-questionnaire was used. A combination of questions about different facets of each of the tools on a likert-scale, tables with pro and contra listings and free-text-questions were used.

4.3 Hypotheses

According to our research question described in the first part of this section, we postulated the following hypothesis for our user test:

Hypothesis 4.3.1 *Users keep more content of a lecture video in mind when they use video annotation tools besides watching the lecture.*

[1] In the first (W1) we gave +1 point for each correct and -2 for each incorrect or not selected answer of the multiple-answer questions. Each of the correct results of the free-text question was awarded with +2 points. In the second method (W2) +1 point was awarded for a correct answer, -1 for and incorrect one and 0 for a not chosen correct answer. Again each free text question was awarded with +2 points. A maximum of six points was available for the free-text-questions. One test consisted of three multiple-answer and one free-text-question. The maximum number of correct answers for the multiple-answer questions different for each video. That is why the third grading method (W2 - normalized) uses a weighted result of W2 in order to equalize the maximum number of points between the different test videos.

Hypothesis 4.3.2 *Users like video annotation tools and perceive them fun as well as fast and easy to use.*

In the next section we will give detailed insights into the results of the user study in regards to the hypothesis stated.

4.4 Results

Since the number of participants is relatively low, due to the within-subject-design and the length of the test, we are evaluating the qualitative as well as quantitative results for a more profound picture of the usefulness of the functionality. In order to compare the function with a different set of tools, indexing functionalities were tested in the same study for comparison with the annotation features.

Quantitative Results. Quantitatively we first compared the learning effectiveness of watching e-lectures with the help of annotation features to the effectiveness of consuming lecture videos without any additional tools and lecture videos enriched with video indexing tools. Compared to the video only version, the learning while at the same time writing digital time-based notes is considerably higher (see statistic on the right hand side in figure 2). There is also a noticeable difference between the effectiveness of the indexing features and the annotation functionality. Whereas the indexing functionalities account for better results than the video only version, the annotation features result in even higher scores. The results are not statistically significant though and need a higher number of test persons to ensure reliabilty. Also we need to further evaluate whether the cognitive load of the students increases too much when writing too many annotations and their concentration might thus decrease again.

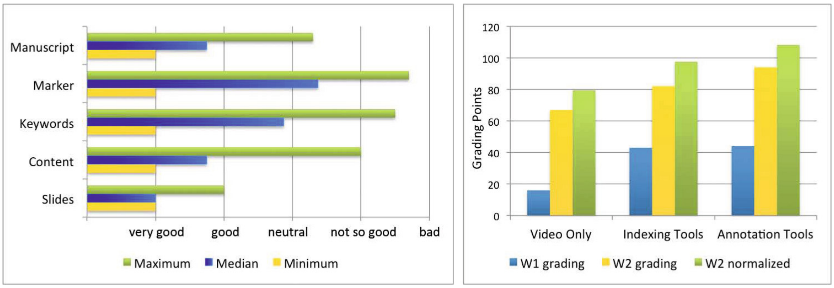

Fig. 2. Perception of Lecture Video Tools (left) and Learning Effectiveness Evaluation (right)

Second, we compared the subjective perception of the individual tools by the participants of the test. We did so by utilizing different questions within the questionnaire asking about how the test persons judge the tools, if they help them to view the lecture faster, if they were easy, fast and fun to use. An evaluation of the single aspects will follow in the next section about the qualitative results, since it was not enough data to deduce sufficient statistical evidence. A mean combination of all general answers [2] was used to compute an overall result of the perception. A Friedman-Test was used in order to determine if the ranking of the perception of the tools is significant. As it is, afterwards the Wilcoxon-Test was used to evaluate the significance values of the ranking. No α-adjusting has taken place, since the evaluation only has explorative character. Looking at the perception of the tools (see figure 2 on the left side) it is obvious, that the slide preview is the most appreciated of the tools with a median rating of 1,0 (very good), followed by the manuscript and content features with a median of 1,75 (good). The difference between the slide function and the two others is significant with p-values of 0,07 and 0,05. The differentiation between the manuscript and content function is not statistically significant. The keyword and marker functions received rather neutral results. Some reasons for that will be explained in the following section. The difference between the evaluation of the manuscript and marker function is significant with a p-value of 0,018, between manuscript and keywords as well with a p-value of 0,07. The distinction between marker and keywords is not statistically significant. The qualitative results follow in the next section.

Qualitative Results. In this section details of the perception of the annotation functionality will be elaborated and often re-occurring user comments evaluated. First of all it was obvious that usability issues were the key to the success of the functions. The marker function was not on the starting screen with the video player and the annotation feature, but it was necessary to scroll to reach it. Therefore it was often not even used by the participants and the feedback in the questionnaire was not too positive (see figure 3). The observation and comments by the participants revealed the same. Test persons wished for the video player and all tools on one screen without the need to scroll. Otherwise the comments revealed that the marker function itself would have been of use for a repeated viewing of the videos at a later point in time and also to revise for exams. Solutions offered by the participants were shortcut keys for three different types of markers and not using markers on its own, but tagging annotations with the different marker types.

The manuscript function received a lot more positive feedback. Most students agreed that the function is fast, easy and fun to use and gave it a good overall evaluation (see figure 3). The observation also showed that participants had no problem utilizing the feature to write digital notes while watching the lecture video. Positive comments given by the test participants included the fast and easy writing down of condensed lecture content that positively influences the learning and revision process, the positive impact of the direct connection of the annotation to the video position as well as the positive effect on the concen-

[2] The answers to the four items: how do you evaluate the following tools, the tool was easy to use, the tool was fast to use, the tool was fun to use.

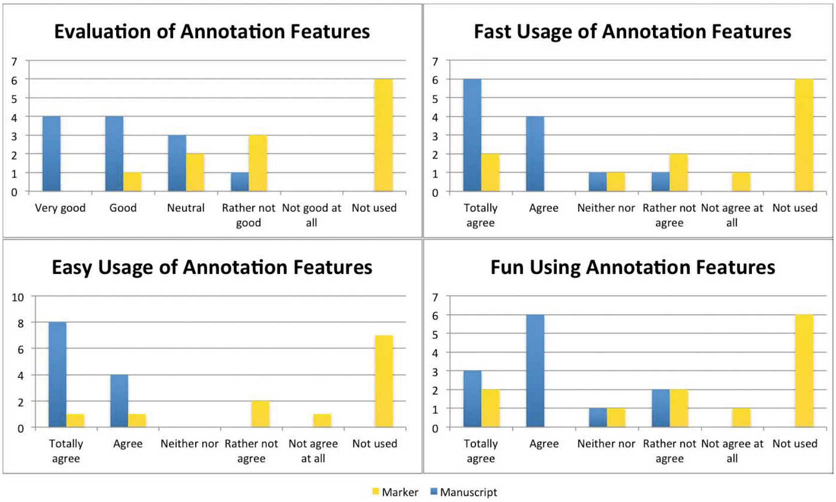

Fig. 3. Evaluation of perception of different characteristics of the annotation features

tration. Negative feedback dealt with the issues of usability, double stress when listening and writing at the same time, more desired formatting and editing possibilities and the time when the annotation is actually posted (which lies after the time the video dealt with the topic).

Looking at these qualitative as well as quantitative results, further points for future work can be detected that will be elaborated in the next section.

5 Conclusions and Future Work

In this paper we introduced a lecture video annotation functionality and evaluated it against a video only version and video indexing tools. We were able to proof the improved learning effectiveness of lecture videos enhanced with video annotation functions over the other two setups. Especially the manuscript functionality, that incorporates time-based textual video annotation with formatting options, supported the findings. Also the qualitative evaluation revealed that students perceive the manuscript functionality as useful, easy, fast and fun to use. Nevertheless the observations and also comments revealed that usability problems are still existing and are a major barrier for the marker feature and also an obstacle for the more extensive use of the manuscript feature.

We plan to further enhance the user interface and condense all functions to one notebook screen size in order to solve these issues. Furthermore we want to offer more formatting possibilities, shortcut keys for setting time markers and a hint when a slide change is coming up to allow an in-time posting of the annotations. The development and evaluation of the annotation features within a collaborative setting is in development at the moment. Students might share and jointly create lecture notes and thereby enhance their learning material.

In order to further support search and filtering within the tele-teaching portal, a semantic information retrieval module from the user-generated annotations is a next step ahead. By extracting the most important keywords from the annotations and performing a named-entity-recognition and disambiguation on them, it is possible to utilize the semantic web in order to retrieve contextual data to the lecture. The implementation of this extraction algorithm and a matching user interface is currently being planned.

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Using Visual Programming Language for Remedial Instruction: Comparison of Alice and Scratch

Ching Chang, Yu-Ling Lin, and Chih-Kai Chang*

Dept. of Information and Learning Technology, National University of Tainan
Tainan City, Taiwan, R.O.C.
chihkai@mail.nutn.edu.tw

Abstract. Scratch, a visual programming language, was used in many studies in computer science education. Most of them reported positive results by integrating Scratch into K-12 computer courses. However, the object-oriented concept, one of the important computational thinking skills, is not represented well in Scratch. Alice, another visual programming language, seems to have better illustration of the object-oriented concept for programming novices. To demonstrate effects of Alice and Scratch, we compared students' responses to both visual programming languages, especially for students with low performances, in an introductory programming course. The relationships among learning engagement, learning anxiety, and learning playfulness were explored. The results could be referred by computer science instructors to select proper visual programming language for remedial instruction.

Keywords: Learning engagement, Learning anxiety, Remedial instruction, Alice, Scratch.

1 Introduction

With the rapid development of computer and Internet technology, students are required to learn several different types of programming languages in order to help solve math, science, and engineering types of problems [5]. In other words, students, via cultivating their meta-cognitive knowledge, could develop their computational thinking (CT) to create programs with a logical procedure and learn the ability of logical thinking from programming languages.

Computational Thinking (CT) is a problem solving method that uses computer science techniques to solve problems, design a system and comprehend human learning behaviors. The procedure is to choose a proper way to state a question, create a model for the question and finally choose the best model to solve the problem [20]. The traditional way to learn language programming is that students are asked to memorize the commands (reserved words) and syntax to produce a simple program. However, some programming languages are required to operate correctly and grammatically with following exactly the rules-the syntax-of the language. It yet may not be able to guar-

* Corresponding author.

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antee that the program will work when there happens to a bit error. Besides, it becomes complex and complicated to find out the errors or complete the programs when the programs are expanded to a quantity of data in the course requirement. Students have more difficulty in dealing with complex, advanced, or hierarchy structure programs [21], due to the semantic or debugging issues. Their learning motivation and enjoyment might be declined that could cause lead to the increase of learning anxiety and lowers their engagement with the course [8]. Finding by Chang [4], students with high anxiety may hinder their learning of programming language and decrease their learning achievement in computer program design courses.

Nowadays, Scratch, Alice and NetLogo, visual programming languages, VPL, provides students with visual programming interface. Rather than learning an esoteric text-based programming language, visual programming language enables learners to program with effective and efficient without spending lots of time to specify the program textually. In other words, by manipulating program elements graphically, students' learning attitudes and motivation can be improved. They will find out that learning computer programming language is an interesting thing [1]. Teachers could instruct students to learn programming languages by adapting project-based learning to create an meaningful and playful project with programs that lead students to create digital games for learning. When involving in this particular learning context, students could easily understand the concept of complex and complicated programming languages and actively devote themselves to the study of computer programming. Thus, "learning by teaching and learning by design" can become the main focus for computer programming learning [14]. When students have positive impact upon their learning experiences, both factors of self-efficacy and transfer of learning can also be promoted. Transfer of learning can be identified as the study in relation to concept of the dependency of human conduct, learning, or production on prior experience. Most discussions of transfer learning are applied in the process of activating past learning experience to solve problems happened in new contexts [16].

Thus, engaged learners in high interactivity framework, providing them with simple syntax of visual programming interface to perform a game-based programming language, and focusing their study on the development of logical thinking and programming skills, students could quickly work on their ability of grasping the problem-solving method, improve their computational thinking skills and help them boost the high-level program language learning, such as Java, C++, or Python, for reaching the transfer of learning [3].

In order to understand how visual programming languages applied in remedial program, the study sets out to explore its impact on learning process in playfulness, learning anxiety and learning satisfaction in a computer programming course. A group of students who are university freshman students with studying high-level programming languages were participated in the study. Therefore, the research, by adopting Alice Program for the whole class students, aimed to examine (1) learning anxiety, (2) learning playfulness, and (3) satisfactions, when engaged learning in Alice programming learning context. In addition, informal interview was conducted to see students' learning experiences with relation to their learning anxiety and satisfaction. Apart from examining learners' learning process, the study also discussed Scratch Program applied in the remedial program and hoped to propose pedagogical implications for computer programming courses.

2 Related Research

Visual programming language can facilitate learning by manipulating program elements graphically and flowchart. The abstract concepts can be transformed into visual representation that helps students develop debugging skills, observing variables, and logic tracing that lead to correct their programs and solving problems. The study were simply looking to the most frequent use of features from Scratch and Alice Programming languages and examined how they were employed in the implementation of computer programming course.

2.1 Scratch Visual Program Language

Scratch (scratch.mit.edu) is a visual programming language that is developed by the MIT Media Lab with the rich media gallery. Scratch is one of the emerging technologies that can be applied to interactive game design, storytelling animation, and multimedia project in the classroom [2]. Scratch likes a block toy that create program by operating the elements of code fragments to assembly visual programs. Through operations in visual interface, learners could build their fundamental concepts in programming design. During the learning process, it can integrated with mathematical geometric, arithmetic, and statistical concepts to inquire the key elements of solving problems and cultivate their creative thinking for producing a joyful learning [9, 12]. The operational diagram is presented in Figure 1.

2.2 Alice Visual Program Language

Alice (www.alice.org) is developed by Carnegie Mellon University as a visual 3-D programming language. When students are engaged in the object-oriented program, the program could help students comprehend key conceptions of programming and problem-solving skills [6, 7]. When students are participated in the programming course, they could adapt this tool to create their own scripts and produce their own computer games and animation movies by controlling 3D objects. Throughout the process of learning, students can acquire the basis of computational thinking skills [13, 19], see Figure 2.

Fig. 1. Scratch interface snapshot

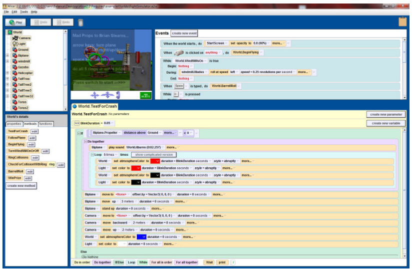

Fig. 2. Alice interface snapshot

2.3 Related Studies for Scratch and Alice

The research listed the studies about Scratch and Alice visual programming languages from the past few years. It is found that while utilizing Scratch to the learning in the computer programming course either in the university contexts or elementary environment, students' creative thinking, learning performance, and ability to solve the problems show a significant result [9, 15, 17]. In terms of Alice VPL study, some researchers use Alice VPL to the university information-management students and point out that Alice VPL is helpful in enhancing the development of concepts in computer programming [10, 11]. However, there appears no study conducted for university information-management students in the learning context in Taiwan. The research, thus, chose Alice programming language as a basis of implementing a supplementary programming course in a national university. We would like to find out students' learning process in terms of aspects of learning engagement, learning anxiety, and learning playfulness, when involving student in Alice Programming learning environment.

3 Methodology and Tools

3.1 Sample and Methodology

On account of the limited teaching resources in the current teaching contexts, the study confined itself to a purposeful sampling that selected target subjects were recruited from university freshman students in the Information Technology course at the southern part of Taiwan. Participated students were reduced to 35 people because of one drop-out student in the end of semester. Students are asked to take part in a remedial program for 3 hours after midterm test. We identified one group of students (whole class of students) to participate a post test (See the framework of research design in Figure 3). In the final-term test, questionnaires of the learning anxiety and learning engagement were distributed to the students with using a five-point Likert scale. It consists of five items ranged from strong agree to strong disagree. If the item is positively-keyed, the score is given as 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree. Negatively-keyed items, which are phrased so that an agreement with the item represents a relatively low level of the attribute being measured, are given scores in reversed order. Moreover, the informal interviews were conducted after the remedial instructions.

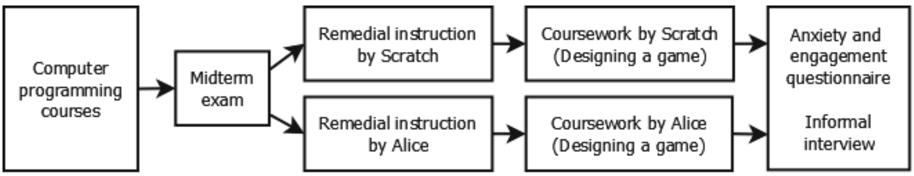

Fig. 3. Research design

3.2 Reliability and Validity of Learning Anxiety and Engagement Questionnaires

In order to understand students' learning process and reflections, the study adapted an questionnaire developed by Venkatesh, which is published in the Journal of Information Systems Research [18], to investigate learning engagement, learners' anxiety, and playfulness. To validate the questionnaires, Venkatesh usded exploratory factor analysis to measure two dimensions, including learning anxiety and learning engagement (i.e. playfulness and enjoyment). There are 9 items in the dimension of learning anxiety; 4 items are positively keyed and 5 items are negatively-keyed items. The KMO value is 0.859 in the dimension of learning anxiety that shows that there are common factors. Moreover, the Bartlett's test, which can be used to verify whether variances are equal across groups, shows that the $\chi 2$ value (200.170, df = 36) is significant to reject the null hypothesis. In other words, single factor in the dimension of learning anxiety is rejected. After further analysis, two dimensions, which are called low learning anxiety (low LA) and high learning anxiety (high LA) in this study, are more proper for analysis. After validation, the reliability (Cronbach's Alpha is 0.919) of the total learning anxiety dimension became acceptable.

For learning engagement, there are playfulness dimension and enjoyment dimension in Venkatesh's design. There are 7 items in playfulness dimension (4 items are negatively-keyed items) and there 3 items in enjoyment dimension. The KMO value is 0.781 and the χ^2 value (177.524, df = 45) is significant according the Bartlett's test. After factor analysis, the results are very consistent with Venkatesh's report. Furthermore, the Cronbach's Alpha value (0.838) is much better than acceptable threshold. It shows that the part of learning engagement measurement in Venkatesh's tool is extremely reliable.

4 Experimental Results

4.1 Analysis of Learning Anxiety and Learning Engagement

The study examined the use of Alice VPL as supplementary material in computer programming course via the questionnaire of learning anxiety and learning engagement. The results of the paired t-tests of the subjects' mean presented the findings that learning anxiety in either the high-level anxiety or the lower-level anxiety did not have a significant results This indicated a general tendency that do not have learning anxiety towards learning from Alice VPL. However, A5 from the aspect of high-level anxiety presented a significant finding that the design of interface from Alice VPL was considered as the improper design in having uncomfortable feeling (mean = 2.72, t = -2.567). We could further examine the underpinning reasons through informal interviews.

The t-value of the total learning engagement factor is significant ($t = 3.206$, $p = 0.003<0.01$). Moreover, the dimension of playfulness and enjoyment both have significant t-value (playfulness $t = 2.204$, $p=0.034<0.05$; enjoyment $t = 3.401$, $p=0.002<0.01$). That implies that students really enjoy and have fun in the Alice remedial instructions. Three items of the playfulness dimension do not reach the significant differences, including flexible (B3), playful (B5), and uninventive (B7). On the other hand, students would characterize themselves as spontaneous (B1), imaginative (B2), creative (B4), and original (B6) in the Alice remedial instructions. All items in enjoyment dimension have significant difference. In other words, all students think using Alice is enjoyable, pleasant, and fun. Table 2 shows the analysis of experimental results.

4.2 Summary of Interview Findings

After analyzing the data of the questionnaire of learning anxiety and learning engagement from quantitative analysis perspective, it is important to examine students' interviews to gain deeper insight into students' responses towards the learning from visual programming language in the instructional course. Seven students were chosen to interview for understanding their reflections on concepts of programming design in using Alice VPL. Several viewpoints were concluded.

- After learning the use of Alice VPL, the student reflected her reasons on why she felt uncomfortable because she was confused the learning, either using Alice VPL supported in the supplementary material or following the instruction from the formal course, although she thought Alice VPL was a great tool for helping her to conceptualize the programming design. However, she felt much easily to learn programming and generated a concept of formulating a programming after continually participating in the remedial program in visual programming language course.
- After learning the use of Alice VPL, the student recognized the concepts and structure (for instance iteration, logic expression, condition, array etc.) involved in programming design which he was confused in the past previous study. He reflected his perceptions on the observation and prediction of how the programming might changed after using visual Alice VPL. We could see the student's feedback on Alice VPL as a supported tool of assisting learning programming concepts, promote active participation, improving learning engagement, and lowering learning anxiety.

Table 1. Analysis of experimental results by using Alice for remedial instructions

	Items	Mean	SD	t-value Item	t-value Dimension	t-value Total
Low LA	A3 I do not feel threatened when others talk about programs.	2.94	0.838	-0.403	-0.113	-0.805
	A4 It wouldn't bother me to take programming courses.	2.89	0.867	-0.780		
	A6 I feel at ease in a programming class.	3.17	0.822	1.234		
	A8 I feel comfortable working with a program.	2.94	0.802	-0.421		

Table 1. *(continued)*

High LA	A1 Programs do not scare me at all.	3.10	0.821	0.781		
	A2 Working with a program makes me nervous.	2.92	0.623	-0.771		
	A5 Programs make me feel uncomfortable.	2.72	0.686	-2.567***	-1.379	
	A7 I get a sinking feeling when I try to design a program.	2.87	0.864	-0.927		
	A9 Programs make me feel uneasy.	3.15	0.844	1.138		
Playfulness	The following questions ask you how you would characterize your-self when you design programs:					
	B1 spontaneous	3.26	0.657	2.315*		
	B2 imaginative	3.63	0.731	5.087***		
	B3 flexible	3.17	0.822	1.234		
	B4 creative	3.49	0.781	3.679***	2.204*	
	B5 playful	3.23	0.843	1.604		
	B6 original	2.51	0.742	-3.870***		3.206**
	B7 inventive	2.94	0.802	2.315		
Enjoyment	C1 I find using the system to be enjoyable.	3.34	0.765	2.652*		
	C2 The actual process of using the system is pleasant.	3.37	0.731	3.006**	3.401**	
	C3 I have fun using the system.	3.46	0.701	3.861***		

**p<.05 ** p<.01 *** p<.001* *N = 3 5*

- The student had a positive learning experience of using Alice VPL in the programming course. He expressed his perceptions that he became more creative and acquired programming concepts and programming structure after learning from Alice VPL. It is important to see that Alice VPL supports students learning in not only building schema of programming but also understanding abstract concepts which can be adjusted or assimilated to other programming language learning. The student thinks there is no connection between VPL and inventive ability. Most interviewed students indicate that they never consider whether Alice will make them more inventive or not.
- Most students provided the positive comments towards learning from Alice VPL and gained better understanding of concepts and abstractions embedded in

programming design. They could pay more attention to programming course and concentrated on teacher instructions. Some students further shared their views that programming problems can easily and quickly be solved by recalling their learning experienced from using Alice VPL, once they encountered the problems out of the class, while others mentioned that it was two different dimensions of learning supplementary programming design from Alice VPL and participating regular course from the classroom instruction. Still others found Alice VPL a improper tool, for objects design and scenery settings were confused to a novice programmer that had a negative impact on focusing on programming design.

- In terms of the physical learning context, students addressed that the programming course should provide them with scaffolding through sequencing task in the order of complex to support their learning in either the classroom-based instruction or assignment appointed by the teachers. Besides, the difficulty of practical assignment may not beyond their ability because it may hinder their willingness to complete the assignment. It would be of great help to offer a teaching assistant to help them solve the coding problems while practicing in writing programs. The difficulty of the programming assignment should be arranged by a proper level-up roadmap.

4.3 Comparisons between Alice and Scratch

We have done the similar studies for the past few years that investigated students' learning behaviors from using Scratch visual programming languages and used the same scales to measure learners' engagement and anxiety. We would like to compare the differences between two programming languages. In the dimension of anxiety, both programming languages offer help for the whole class of students or low-achieving students to lower learning anxiety, after integrating these two supplementary programming languages into the formal programming curriculum. Although Alice VPL supports students' programming learning, the scores did not show a statistically significant effect. Students also commented that, compared to Scratch programming language, Alice VPL is more easily to lose focus in creating programs due to its complexity and complication of 3D object design and interface. In terms of aspect of Gameplay, the score of Scratch's playfulness presented a significant result ($t=-2.4452$, $p=0.147>0.05$) while Alice VPL's score showed a significant effect ($t=2.204$, $p=0.034<0.05$). It can conclude that Alice VPL can be more helpful to enhance learning motivation, promote active learning and foster creativity for programming learners than that offered by Scratch VPL. In the aspect of learning playfulness, both tools all presented a significant effect on the learning playfulness when the students experienced learning from both tools.

5 Conclusion and Future Works

The study explored the students' experiences of visual programming and analyzed their learning behaviors in relation to learning engagement, learning anxiety, playfulness when incorporating Alice VPL into supplementary materials. It is found that the students felt interested in learning programming concepts, which is evidence by the questionnaires as the item in playfulness that all showed a statistically significant result. Apart from playfulness during the learning process, student satisfaction also showed a significant effect. The active learning, creativity and ability to transfer of their learning to become concepts are also promoted, although it is less help to decrease learning anxiety.

In addition, the researchers, compared Scratch VPL with Alice VPL, found out that instructors could choose Scratch VPL as a supplementary material to help students to increase programming ability while teachers can select Alice VPL to interest learners in producing creative writing in programming design when implementing remedial program in computer programming course. Via analyzing the current teaching phenomena, we hoped that the study provided a general concept of application and selection of visual programming tools for computer programming educators to design their curriculum as well as provided a research basis for us to examine and refine the research methodology while emphasizing the necessity for students' programming improvement at college computer programming courses.

Lastly, it is suggested that curriculum instructors could adapt the blended learning of combining project-oriented or problem-based learning strategies with VPL to focus on computer programming learning on practical task development. Teachers could assign a problem-solving programming task that requires student to work with peers. Through scaffolding students' comprehension of programming concepts with a sequence of easy-to-difficult task, the instruction of computer programming may be easily scaffold students out of misconception.

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Methods Enabling Web-Based Learning of Control Algorithm Implementation Using Experimental Pilot-Plants

Witold Nocoń and Grzegorz Polaków

Silesian University of Technology, ul. Akademicka 16, 44-100 Gliwice, Poland
{witold.nocon,grzegorz.polakow}@polsl.pl

Abstract. The paper presents an overview of methods of providing an effective web-based education in the field of automatic control. To facilitate education in process dynamics and basic control problems, methods for web-based access to process simulators and controllers coupled with process simulators are discussed. Teaching the specifics of real processes is especially important, hence methods allowing a safe and appropriately abstracted access to real processes are discussed. Additionally, cooperation between students for control algorithms synthesis in web-based environment is discussed along with visualization methods.

Keywords: web-based learning, automatic control, IEC 61499, cooperation, visualization.

1 Introduction

The OpenCourseWare platforms gain popularity. The first global-scale project started at the Massachusetts Institute of Technology (MIT) in 1999 [1]. The original purpose of this project was to publish the MIT courses on-line for anyone to download the teaching materials, view video lectures etc. Since then, a more collaborative way of providing on-line courses emerged with distant students being able to ask questions, solving the given assignments and gaining credit for completed courses [2].

Specific fields of education require specialized ways of providing on-line educational contents to students. Therefore, this paper looks at methods of providing an effective web-based education in the field of automatic control, including remote access to experimental pilot-plants. Those methods enable different pilot-scale processes, for example the pH control process [3], to be accessed on-line.

2 Motivation

The education in the field of automatic control is a complex process. Apart from advanced mathematics and solid foundations in physics, students are required to master the intricate principles of process modelling and process dynamics. To gain a solid

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understanding of those topics, students should not only be able to learn the theoretical foundations but most importantly should develop a kind of a sixth-sense in how different processes behave, what kind of influences can be exerted upon those processes and what are the limitations of possible control actions. To facilitate the learning process in this field, the usage of process simulators is greatly advised. Therefore, a method of providing access to process simulators via the web-browser is highly recommended.

Once the students gain solid foundation in process dynamics, feedback control and other types of control strategies must be learned. For the students to be able to correctly select the proper control algorithms, assess the stability of the control loops and to properly and responsibly tune the control algorithms, it is necessary to provide them with the ability to connect different controllers to the processes under investigation. Again, methods enabling students to interactively switch between the available controllers, manipulate the tuning parameters and observe the behaviour of the previously studied process models subject to control is highly desired.

The learning process however, must not be limited to interaction with simulated processes only. It is paramount to enable students to work with real sensors, real physical processes and real control actuators. While the laboratory work is easily carried out for students attending classes, special attention must be paid to allowing remote students the access to real processes. Additionally, students must be able to work in groups. Therefore, a project-based approach must be introduced into the learning process. Again, a special environment is needed to enable a safe and effective utilization of real processes in such learning scenario.

This paper presents an overview of methods that provide students with the web-based access to process simulators, controllers connected with process simulators and most importantly, the real processes. Framework for a cooperative synthesis of control algorithms for pilot-plants is also presented. Additionally, visualization of students cooperation is discussed. As the programming environment the National Instruments LabVIEW [4] was chosen because of its popularity in teaching and research, and the broad instrumentation base allowing connection of a developed software platform to the real-world objects at the disposal of the authors.

3 Process Dynamics and Basic Control Algorithms Learning

The LabVIEW environment offers a method to publish the front panel of a working program using a web server [5]. The student accesses the program using a browser and can take control over this program. The only requirement for the user is to install the LabVIEW Run-Time Engine, which can be downloaded for free. Because the process of publishing the front panels of programs is automated, the effort on the teacher's side is minimal. More complicated and more flexible methods exist and will be explained in the later part of this paper. It is assumed however, that the easiest methods should be used first.

Web-based process simulators can be provided to students in two distinctive modes, depending on the learning scheme. In the first scheme, the students access the same instance of the simulator (Fig. 1).

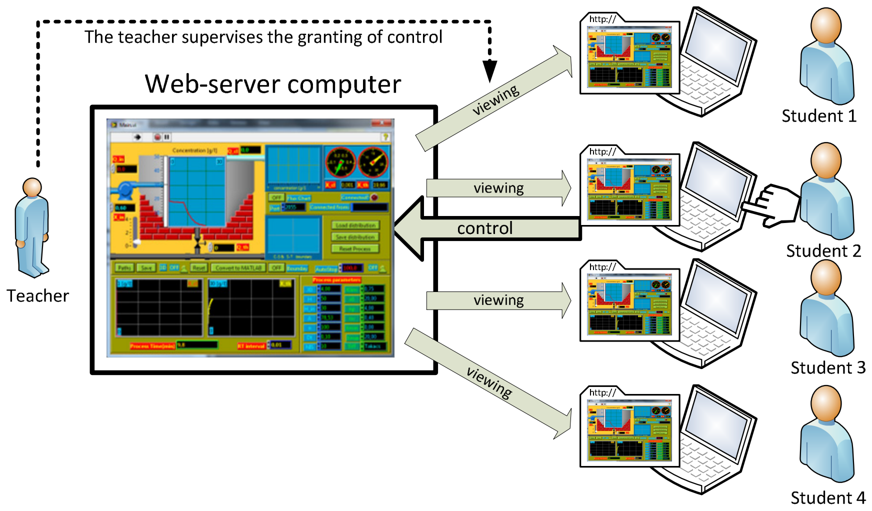

Fig. 1. Students accessing the same instance of the process simulator

In this case, the front panel of the same VI is visible to all students in the group. Control over the simulator enabling manipulation of the process parameters and input values is possible by one user at the time. Each student may request control over the simulator, but control will only be given when the current controlling client releases the lock. The teacher can take over control over the simulator at any time.

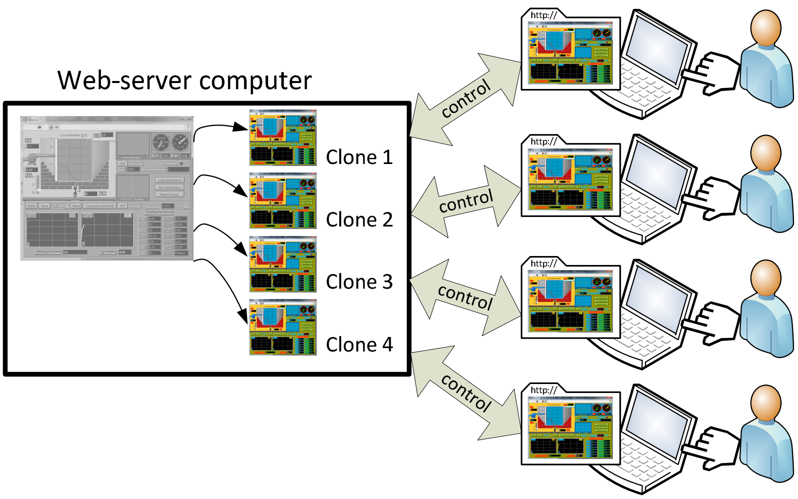

Fig. 2. Each student accessing a separate close of the simulation program

This scheme is especially useful in interactive web-based lectures, in which, apart from voice and presentation transmission, process simulators are presented and manipulated either by the teacher or by selected students answering questions.

In the second teaching scheme a separate clone may be provided for each student, enabling the manipulation of inputs to the process simulator without disrupting other students' investigations (Fig. 2) This scheme is appropriate for situations in which students access the simulator at any time for the purpose of home studying and additional familiarization with the particular process being investigated. Note, that the presence of the teacher is not necessary, as there is no limitation on the number of the connected clients.

The two teaching schemas are limited to only dealing with one simulator at a time. Teaching feedback control requires a controller to be coupled with the process simulator. Additionally, it is preferable to be able to switch between different controllers for the same process. Fig. 3 presents a scheme in which the server computer runs the process simulator and a number of different controllers. The selection of currently applied controller (Reg 1 in Fig. 3) is only possible when granted control of the main simulation program. The teacher is required to supervise the granting of control over the simulated process and the currently used controller.

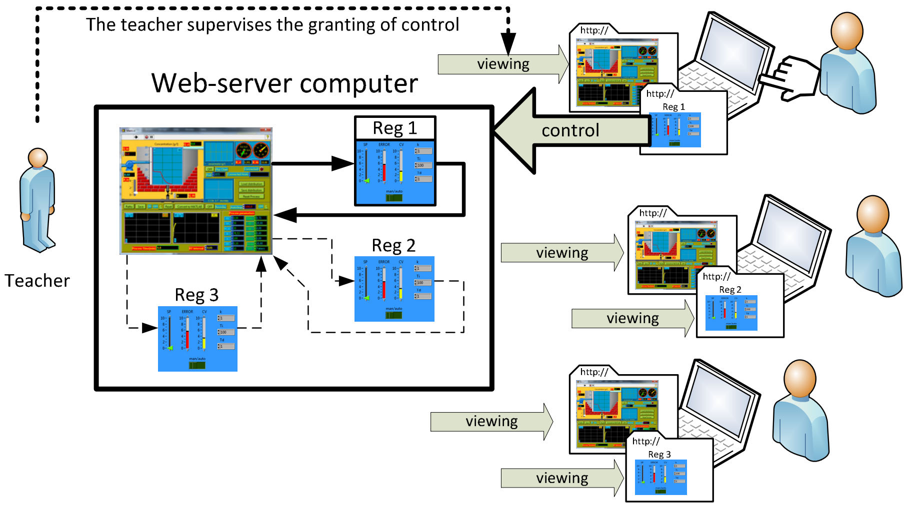

Fig. 3. Web-based access to a process simulator with the possibility to connect different controllers

The presented methods are characterised by a number of limitations. First, all the simulation and control applications must be explicitly connected with each other, with the proper switching logic. Therefore, it is not possible to easily change the structure of the control scheme at run-time and students are limited in their studies to the existing structure of the control system.

For the studies to go further it is necessary to expand the possible actions that the students can take while dealing with web-based automatic control studies.

4 Learning Control Using Pilot-Plant Installations

The publication of front panels in order to provide access to programs ran on the server could to some extent be also applied for providing the pilot-plant installations (i.e. real processes) to remote users. The limitations mentioned in chapter 3 apply. However, in case of real processes much more consideration must be paid to the maintenance of the equipment and safety of the process. This is especially important in case of plants involving biological processes. Incorrect control of such processes for a certain period of time may irreversibly destroy the biomass cultures.

The system for enabling web-based pilot-plant must be hierarchical in nature. The first control layer, which is the closest to the plant itself, is a basic control layer. The purpose of it is to connect to the process itself (measurements and control signals) and to implement all the safety-critical functions necessary for the particular plant. An example of a simple safety function is to prevent the heater in the tank to be turned on, when the tank is empty. An example of an advanced safety function is the monitoring of the biological reactor aeration in activated sludge processes [6]. While certain periods without aeration are required for complete removal of nitrogen from the wastewater, extended periods with low dissolved oxygen concentration will inevitably destroy the aerobic biomass culture also required in the process. This layer of control also enables the laboratory technician to take over control over the process to prevent unforeseen failures.

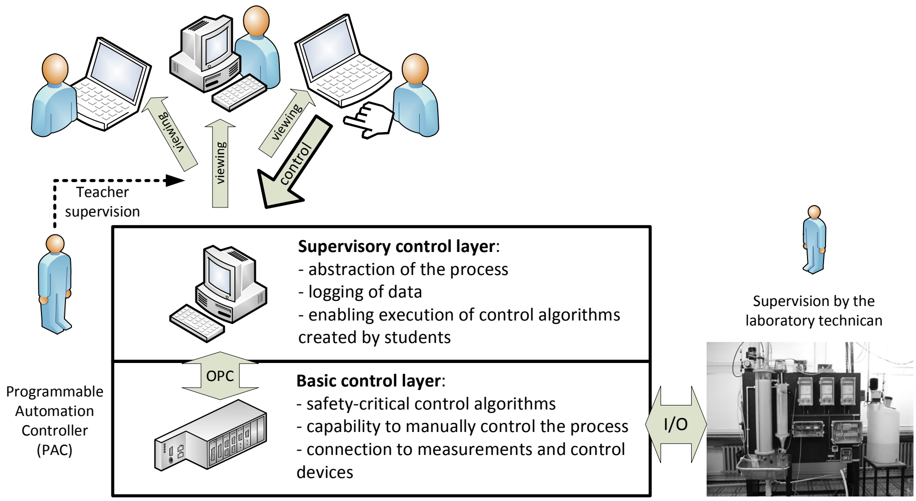

Fig. 4. Hierarchical structure of the system for web-based hands-on laboratory exercises

The supervisory layer on the other hand is crucial for the web-based access to the process. Apart from logging measurement and control data it should enable the execution of control algorithms realized by the students. This may either be realized by simply allowing students to connect with their software to the particular variables that are later used to generate control signals for the plant or by allowing control algorithms to be run in the supervisory layer (see chapter 5 for details). Most importantly, this layer allows for the abstraction of the particular process to the particular user. In this case, abstraction is defined as presenting the distant user with abstract variables that are not physically realized. For example, in the control of heaters, a pulse-width modulation (PWM) control may have to be realized. The student however may want to practice other algorithms assuming that the PWM algorithm is already implemented. The supervisory layer can implement the PWM algorithm, allowing the student to simply compute the appropriate set point for the PWM controller. In case of measurements associated with biological reactors, the oxygen uptake rate (OUR) may need to be computed from the dissolved oxygen concentration measurements. This is not a simple procedure [7] therefore, in certain cases the supervisory control layer implements this functionality giving the student an already computed value of OUR.

5 Cooperation in Control Algorithm Synthesis

The culmination of automatic control education must involve the cooperative aspect of student's work. Such a construction of the learning process follows the strong trend of project based learning, in which students work in real-world conditions under discrete teacher facilitation. To provide proper conditions for such cooperation, the structure of the system software should allow for creation of sub-modules and enforce their compatibility to some extent, to enable them to work together and interface with the real-world instrumentation, i.e. a synchronous Group Support System is required [8].

Development of computer programs that implement automatic control algorithms is a well-established area and has been standardized by the IEC61131 standard [9]. In the theory of dynamical systems, which is the basis for the control theory, the most common and widely used method of representation of complex dynamic systems is to picture them with block diagrams. In such a diagram, each of the blocks represents a more or less complex mathematical operation, and the structure of the connections between the blocks visualizes the data flow in the system [10]. The IEC61499 standard [11] introduces a completely new way of programming, involving the breakdown of the single monolithic program into separate function blocks (the program in each of the blocks still can be written in one of the traditional languages). The new ideas introduced by the IEC61499 standard are gaining popularity and are supported by automation equipment manufacturers. However, the ideas still do not provide any new methods to support multi-user work on a basis other than division of work on the source code of an application. A framework proposed in [12] tries to fulfil those requirements.

The general architecture of the proposed framework is presented in Fig. 5. The supervisory control layer implements the mechanisms for adding, deleting and editing blocks that constitute the control algorithms under construction.

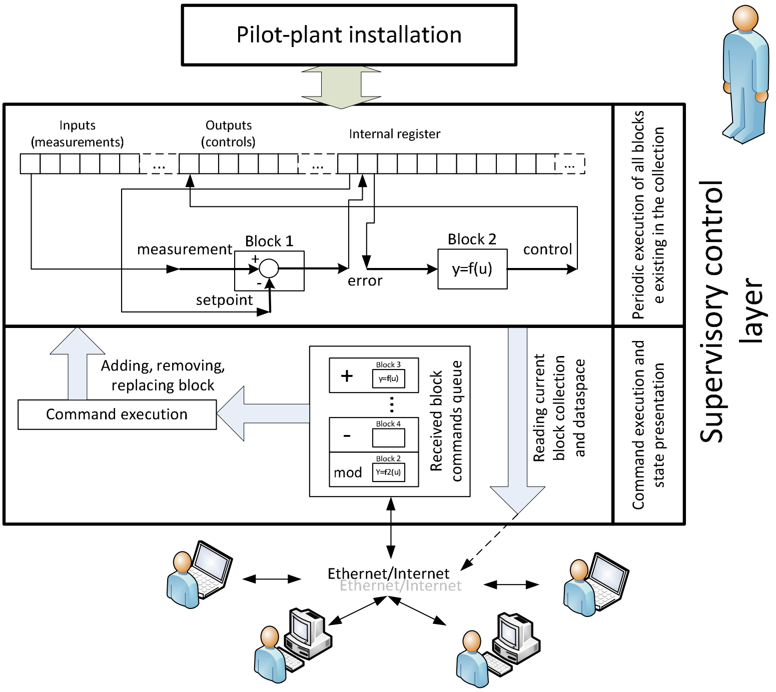

Fig. 5. Architecture of the framework for cooperative testing of control algorithms using experimental pilot-plants

The supervisory control layer is an application written in LabVIEW. It stores a data space which is divided into three regions: inputs for storing measurement values, outputs for storing control values and internal registers for additional values. The blocks are realized using an object-oriented paradigm as explained in [13]. The executed object is initialized by specifying input and output addresses. Blocks are stored in a container and are executed periodically. Those blocks correspond to the blocks described in the IEC61499 standard.

Individual blocks may be added by different students using commands received using a custom TCP based protocol, queued and executed in first-in-first-out order. To enable the cooperating clients to easily change the control algorithm controlling the process, a special type of block is provided. The purpose of this block is to execute any dynamical function the client wants. In order to do this, the block should accept the formula of the equation to be interpreted in each cycle. To enable effective interpretation of formulas, this process is broken into two steps. In the first step, the formula given by a simple string, is parsed into special arrays containing operand addresses and operator codes. This step, which is performed during object initialization is time consuming and is executed on the client computer. The object is than serialized and sent to the supervisory control layer. In the second step the actual computation of the formula value based on input values and other constants is performed. This operation is relatively easy as it only requires a one-time interpretation of consecutive operators and operands.

6 Web-Based, Multi-user, Visualization

The teaching supervisor should have an insight into the structure and design of the cooperatively developed control algorithms to be able to manage the entire process and to assess the contribution of individual students.

In the above cases, the primary channel of inter-actor communication is not a part of the system, and the supervisor / teacher is unable to monitor it. In the case of local cooperation, such as students cooperatively solving a task in a laboratory during a course, the communication consists solely of spoken messages. If the case of distributed work, the channel is replaced by instant messaging (IM) and voice chat rooms (VoIP). In each case the supervisor / teacher is not able to infer all the dependencies between the actors and needs an additional mechanism to monitor the activity of individual participants and relationships between them.

In the case of an industrial automation domain, the links between the cooperating actors are derived from the dependencies between the software components of the system. This results from the assumed model of dividing the work, in which each of the actors is responsible for some software components, of which inputs and outputs in the form of numeric variables are then connected to the inputs and outputs of components developed by other participants. Presentation of the connections between the components allows to graphically visualize the structure of the system.

Both the visualization and cooperation mechanism are based on a concept, well known in control theory and dynamic systems theory, of block diagrams. According to this concept, a diagram of a complex dynamical system is presented in the form of a directed graph, where nodes of the graph (represented by blocks) are the basic mathematical operations of dynamic systems theory (addition, multiplication, integration, differentiation), and the edges of the graph represent the flow of data between blocks. The use of this concept is wide and block diagrams are a representation easily readable for the industrial process engineers. It was therefore decided to develop a visualization mechanism compatible with the convention.

At first, it is assumed that the group support system facilitating collaborative work is equipped with a Web-based interface for accessing data on the structure of the system. In the case of cooperative development of control algorithms, the data on the system's structure are readily available, because they can be obtained directly from the internal database containing the currently operating software components. These data are converted on-the-fly to comply with a specifically developed XML Schema. The XML Schema is relatively simple because it describes a typical directed graph. Such formatted data (XML over HTTP) are versatile enough to be readable by a wide variety of programming environments and, if necessary, can be easily dynamically converted to other formats. In the described system, a proof-of-concept visualization environment was developed in JavaScript (ECMA-262), which displays the data in a graphic form as a force-directed graph. The application was not meant to be released to manufacturing, but only had to demonstrate validity of concept. After testing, it turned out that the basic information about the flow of data in the system is not sufficient to provide the instructor with the full insight into the system as the visualization lacks the relationships between actors. It was necessary to expand the definition of the graph to include ownership of individual software components. XML Schema definition has been extended, and the graph became a mixed graph with two classes of nodes. First class of nodes and the directed edges describe the basic flow of data, while the second class of nodes describes the actors and the undirected edges display the association between the actors and the components of the system.

In order to fully inspect the dynamically changing numerical environment it is proposed to add another Web service, which will provide only the numerical data (formatted in XML, linked to the directed edges described by the main Web service by XPaths). Cyclical querying the service allows to supplement the visualized structures with the real-time numerical data. Dividing the complete information about the system into two separate services is designed to save processing power and network bandwidth, because the XML data describing the structure can be of large size, and reading it with the same cycle as the numerical data would unnecessary consume resources.

As shown in the Fig. 6, the same configuration of components may be perceived quite differently, depending on whether the association between the actors and the software components are shown or not.

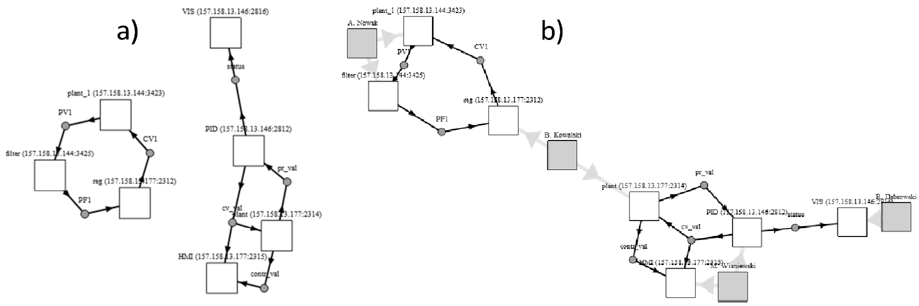

Fig. 6. Difference between the same block diagram without (a) and with (b) actors-components association visualised [14]

7 Concluding Remarks

The paper discussed various methods that enhance the web-based learning of automatic control by providing students with access to process simulators, simulated process control loops but also to real processes. The cooperative synthesis of control algorithms together with methods for visualization of the students cooperation have also been presented. While the presented solutions do not constitute a full and complete web-based learning framework, the particular technologies and methods should greatly enhance the learning process in the field of automatic control.

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Towards an Online Lab Portal for Inquiry-Based STEM Learning at School

Sten Govaerts[1], Yiwei Cao[2], Andrii Vozniuk[1], Adrian Holzer[1], Danilo Garbi Zutin[3], Elio San Cristóbal Ruiz[4], Lars Bollen[5], Sven Manske[6], Nils Faltin[2], Christophe Salzmann[1], Eleftheria Tsourlidaki[7], and Denis Gillet[1]

[1] EPFL, REACT, Station 9, 1015 Lausanne, Switzerland
firstname.lastname@epfl.ch
[2] IMC AG, Scheer Tower, Uni-Campus Nord, 66123 Saarbrücken, Germany
yiwei.cao@im-c.de,nils.faltin@im-c.de
[3] Center of Competence in Online Laboratories and Open Learning, Carinthia University of Applied Sciences, Villach, Austria
d.garbizutin@fh-kaernten.at
[4] DIEEC, UNED, C. Juan del Rosal, 12, 28040, Madrid, Spain
elio@ieec.uned.es
[5] University of Twente, Department of Instructional Technology, P.O. Box 217, 7500 AE Enschede, The Netherlands
l.bollen@utwente.nl
[6] COLLIDE Research Group, University of Duisburg-Essen, 47047 Duisburg, Germany
manske@collide.info
[7] Ellinogermaniki Agogi Sxoli Panagea Savva, Dimitriou Panagea str., 15351 Pallini, Greece
eleftheria@ea.gr

Abstract. Nowadays, the knowledge economy is growing rapidly. To sustain future growth, more well educated people in STEM (science, technology, engineering and mathematics) are needed. In the Go-Lab project we aim to motivate and orient students from an early age on to study STEM fields in their future educational path by applying inquiry learning using online labs. This paper presents an inquiry learning portal where teachers can discover, use and enhance online labs appropriate for their courses and students can acquire scientific methodology skills while doing experiments using the labs. The Go-Lab portal architecture is presented, which contains a repository of online labs, inquiry learning spaces and complementary services. The paper discusses a first version of the portal and our future plans.

Keywords: online lab, portal, design, inquiry learning, metadata, architecture, interoperability, lab repository.

1 Introduction

In this day and age the knowledge economy [7] expands rapidly, we need to motivate more young people to choose science and engineering as their future career path to keep our future economy competitive. To engage students in science and technology,

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various reports [17,16] suggest to include scientific inquiry in their courses. The Go-Lab project[1] [11] aims to encourage students to engage in scientific topics and get acquainted with scientific inquiry methodologies through the use of remote laboratories, virtual experiments and data sets (henceforth simply referred to as 'online labs').

Online labs are a good means to teach scientific inquiry skills to students and an aid for teachers to illustrate scientific theory [11]. Inquiry learning typically leads students through various phases, e.g. orientation, conceptualization, investigation, conclusion and discussion, where students create hypotheses, evaluate them through experiments and then reflect on them, possibly repeating the cycle. This type of learning shows benefits over typical lectures or demonstrations [12].

Although labs for teaching have become available recently, a widely used online lab portal integrated with a ready-to-use learning environment is still missing (see Section 3). Usually, individual online labs are operated, maintained and promoted by the lab owners, which causes a high operational cost and limited access. Through the Go-Lab portal, we aim to establish a federation of online labs where lab owners can promote their labs, and teachers can find labs to support their activities and share their resources with others. We do not aim to replace teachers, but rather enable teachers to support and aid students who are working with online labs.

This paper presents the first two steps in the development life-cycle [1] of the portal, namely requirement analysis and systems design. Section 2 describes the requirements for the Go-Lab portal. Based on this, Section 3 compares existing portals. Afterwards, Section 4 presents the architecture of the portal and Section 5 discusses the implementation. Finally, Section 6 concludes the paper.

2 Requirements of the Go-Lab Portal

This section focuses on the first step of the development life-cycle [1], namely requirements analysis, by first setting a common terminology, identifying the main portal users, describing the usage and afterwards discussing requirements.

2.1 Terminology

Online labs are remote laboratories, virtual experiments or data sets accessible from the browser through apps. *Apps* are Web applications (e.g. OpenSocial gadgets), for example to operate a lab or support learning (e.g. via scaffolding).

Inquiry learning spaces (ILS) are learning environments that can contain labs, learning resources and apps to enable inquiry learning. *Learning resources* are typically texts, videos and other materials to assist and assess students. Teachers usually set up an ILS for their students. An ILS can be shared with other teachers who can repurpose and adapt it to fit their purpose.

2.2 Users, User Story, Functional and Non-functional Requirements

We identify three types of portal users: *lab owners*, *teachers* and *students*. A lab owner is a user who operates and publishes a lab. A teacher is a user who teaches with an ILS.

[1] The Go-Lab project, `http://www.golab-project.eu`

A student is a user who carries out inquiry learning activities in an ILS. The following user story provides more context on the portal use.

User Story. On the Go-Lab portal John searches for interesting activities for his physics course. While browsing through the 'Big Ideas' in science section, he finds an appropriate topic about particle interactions, where he selects the 'Conservation of Momentum' activity, using the 'Hypathia' lab by CERN. He opens the activity in the learning environment to try it out. The observation phase and its learning resources are shown and he can edit the resources and apps. An available learning scenario instructs how he can teach with this activity. John decides to add a recommended scaffolding app. Additionally, he rewrites some of the explanations and tips to better fit the knowledge of his students. After tweaking each inquiry learning phase, he teaches with this learning environment in class. Afterwards, he decides to publish his environment back on the Go-Lab portal and share it on Facebook with his colleagues.

Functional Requirements Analysis. In this section we focus on the main functions of the portal, required by the portal users to fulfill their needs.

- *Publishing labs.* Lab owners publish a lab and describe it with metadata.
- *Creating ILS.* Lab owners create ILS to demonstrate a lab and teachers create ILS for students.
- *Modifying ILS.* Teachers adapt existing ILS, e.g. localize the content to the mother tongue of their students or adapt it for a different age group.
- *Publishing ILS.* Teachers publish their ILS to enable reuse.
- *Using ILS.* Teachers run activities using ILS. Students use ILS provided by teachers to conduct experiments.
- *Supporting Apps.* Students practice inquiry learning through apps (e.g. a hypothesis app or online lab apps). Teachers monitor student progress through learning analytics apps.
- *Supporting Learning Scenarios.* Teachers create learning scenarios for ILS. Students use learning scenarios provided by teacher when studying in ILS.
- *Searching Labs & ILS.* Teachers search for labs and ILS using various search filters, e.g. age and scientific domain.
- *User management.* Users log in only once to access all portal resources. Several login options are provided depending on the acceptable privacy level.
- *Social features.* Teachers and lab owners tag, comment and rate labs and ILS, and share them on social networks.
- *Tracking user activities.* The activities of portal users are tracked and used for learning analytics, recommendation and scaffolding apps.
- *Recommendation.* Recommendation of labs, ILS and apps are provided when searching, creating and editing ILS and labs.
- *Scaffolding.* Students receive assistance from scaffolding apps (e.g. prompts and feedback) based on learning analytics and teacher configurations.

Non-functional Requirements Analysis. Apart from the previous requirements, there are also non-functional requirements that impact the design.

Go-Lab needs to provide a common, ubiquitously accessible ILS platform, so schools do not need to spend resources on installing and administering software. The portal should federate labs and other lab repositories. To provide this federation and to support a common ILS platform, interoperability of the labs is essential. When targeting school students, special attention to usability and data privacy (e.g. anonymizing the tracked user activities) is needed. The Go-Lab project aims to support 1000 schools in 15 countries, which requires a high scalability and availability of the portal, as well as internationalization support.

3 State of the Art

Existing portal solutions for online labs are reviewed and summarized in Table 1 and we evaluate their fit with the requirements presented above. We identified five main solutions in the research literature, namely the GOLC consortium's Lab2Go[2] portal [4], the Library of Labs (LiLa)[3] [15] portal created by a European consortium using MIT's iLab Shared Architecture (ISA)[4] [10], the LabShare[5] [6] portal initiated by an Australian consortium, and the University of Deusto's WebLab-Deusto[6] [8].

Table 1. Fit between existing portals and Go-Lab requirements. Legend: requirement supported (+), partially supported (∼), not supported (-), unknown (?).

Functional requirements	Lab2Go	LiLa	ISA	LabShare	WebLab
Publishing labs	+	+	+	+	+
Creating ILS	-	∼	-	-	-
Modifying ILS	-	∼	-	-	-
Publishing ILS	-	∼	-	-	-
Using ILS	-	∼	+	+	+
Supporting Apps	-	-	-	-	-
Supporting Learning Scenarios	-	+	-	?	∼
Searching Labs & ILS	+	+	-	-	-
User management	∼	∼	+	+	+
Social features	+	+	-	∼	-
Tracking user activities	-	∼	∼	+	+
Recommendations	-	-	-	-	-
Scaffolding	-	-	-	-	-

Table 1 shows that the main requirements which are met by the existing portals are *publishing labs*, *searching for labs & ILS*, *using ILS* and possibly *tracking user activities*. Furthermore, several of these portals offer some kind of user management system

[2] `http://www.lab2go.net`
[3] `https://www.library-of-labs.org`
[4] `http://ilabcentral.org`
[5] `http://www.labshare.edu.au`
[6] `https://www.weblab.deusto.es`

and provide some social features. Unfortunately, several requirements are not properly supported by any of the portals, such as facilities to create, modify and publish ILS. Furthermore, recommendation and scaffolding are both not supported by any portal. In a nutshell, existing portals mainly work as repositories of labs and provide only support to lab owners to publish labs and to teachers to find and use labs. As they do not provide their own learning environment, it is difficult for such portals to empower teachers by not supplying them with adequate support for modifying, reusing and publishing ILS. Go-Lab precisely aims to fill this gap by providing support for both lab consumption and lab creation.

4 The Go-Lab Portal Architecture

Based on the requirements, this section describes the Go-Lab architecture. For its design, we have applied several software design principles [20]. Foremost, the design should be *loosely coupled*, meaning that each component requires little knowledge of the definitions of the other components [20]. This principle enables abstraction of each component, which allows a design that can change over time. Additionally, each component should have *high cohesion*, which refers to the degree to which a component is semantically self-contained [20]. Applying *'separation of concerns'* enables modularity, as each component takes care of a separate task [20]. Finally, the design should support *subsetability*, which is the ability to produce subsets of the system. This allows us to follow an iterative and incremental development strategy and have a basic portal available soon.

4.1 Overall Architecture

The high-level Go-Lab architecture, illustrated in Fig. 1, consists of two main components with a graphical user interface (GUI), namely the *lab repository* and the *ILS platform*. Both are supported by components for *user management* and tracking user activities for *learning analytics and recommendation*. By splitting up the portal functionality in this way, each component serves a very different purpose and we aim to satisfy the requirements and design principles stated above. The components have well-specified interfaces and protocols, which allow interchangeability (e.g. the ILS platform could use another repository that implements the same specification of the `Publisher & Instantiator` interface) and other third-party platforms can make use of each component separately enabling wider adaption of Go-Lab technology.

The next section elaborates on the components of the architecture.

4.2 Components and Interface Specification

The Lab Repository stores labs, apps and inquiry space templates (or ILS templates), together with their metadata. An ILS template describes the structure and content (i.e. the labs, apps & resources) of an ILS. Additionally, an ILS template can also contain a learning scenario provided by teachers that describes how to use the ILS in a pedagogical context.

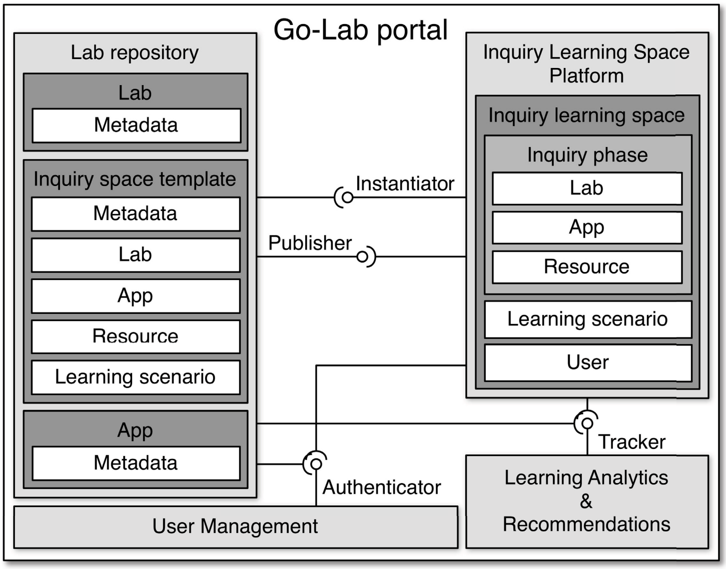

Fig. 1. The architecture of the Go-Lab Portal

The Inquiry Learning Space Platform (ILS platform) allows teachers and students to use labs and apps in an ILS for inquiry learning. Teachers can create an ILS consisting of labs and apps available from the lab repository through the `Instantiator` interface and enrich the ILS with uploaded or online resources. Afterwards, teachers can provide students with access to the ILS, where students can conduct experiments.

Such an ILS can also be published on the lab repository via the `Publisher` interface. While publishing an ILS, teachers provide metadata that describes the ILS together with pedagogical information and possibly a learning scenario. By publishing an ILS template to the lab repository, other teachers can find it there, reuse it in the ILS platform using the `Instantiator` interface and adapt it to the needs of their students.

The *Learning Analytics and Recommendation* component collects user activities through the `Tracker` interface from the lab repository and the ILS platform that can anonymize the data for privacy reasons. The collected data is used to provide teachers with learning analytics apps to monitor student progress; lab owners can monitor the use of their labs, while students benefit through scaffolding apps. The tracked user activities are also employed for personalization of the portal, e.g. through recommendation of apps, labs and resources.

The *User management* component is in charge of user authentication and user profile management through the `Authenticator` interface to the lab repository and ILS platform enabling single sign-on for the portal.

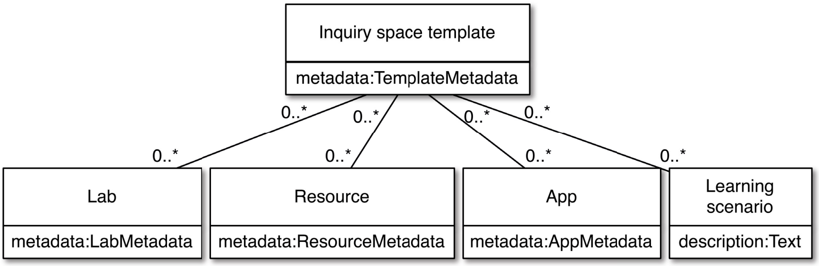

Fig. 2. Go-Lab metadata overview

4.3 Portal Interoperability

To achieve a federation of labs and to increase the potential uptake of the Go-Lab software, interchangeability of the portal components and interoperability using open specifications is important. The Go-Lab architecture achieves the technical, syntactic, semantic and pragmatic interoperability levels of the Conceptual Interoperability Model [19]. This section elaborates on interoperability enabled through the labs, metadata and the interfaces between components.

Lab Interoperability enables the integration of labs with an ILS platform, which is often difficult due to the wide variety of labs and their technical differences (e.g. implemented as a Java Applet or a Flash application). To make labs interoperable with learning environments different approaches are possible. For instance, the LiLa project [15] bundles labs in SCORM [3] packages, but this does not always enable proper interoperability since SCORM is not designed for interactive labs and the support of the latest versions of SCORM by learning environments is low. In Go-Lab, online labs will be provided as *smart devices* [9] that make labs more ubiquitous, autonomous and self-aware. The smart device paradigm abstracts the details of each lab on the server-side by providing a specified set of web services [9]. This interoperability layer allows the ILS platform to run any lab supporting the smart device paradigm and smart device compatible apps can be reused to operate numerous labs.

Making existing online labs smart device compliant might require the implementation of the specified web services. In some cases it will be impossible to change the lab implementation. To enable interoperability with such labs, we will provide a *smart gateway* that transforms existing labs to be conform to the smart device specification [9]. In this way interoperability between any online lab and the ILS platform is enabled.

Metadata Interoperability is the ability to exchange metadata with minimal loss of content and functionality between different systems [14]. Several initiatives [22,18] are currently working on metadata specifications to describe online labs and related resources. Their main reason is to allow wider discovery of online labs, but metadata can provide more benefits. Apart from search and discovery of labs and apps in the lab repository, metadata is also used to exchange data between the portal components to enable interoperability and exchangeability. For instance, this interoperability and exchangeability allows exchanging the lab repository with a third-party repository that applies the same interface and metadata specification; similarly the ILS platform could be switched. In the Go-Lab project, metadata is used to describe labs, apps, resources and ILS templates (see Fig. 2) in a linked data approach. The metadata specification will be based on a combination and extension (based on Go-Lab requirements) of the ROLE Ontology and the GOLC specification [18] and is currently being finalized. The reuse of existing open specifications will provide access to existing labs and resources, as well as services.

Interface Interoperability allows different implementations of components of the Go-Lab portal to be interchanged. This can be achieved by specifying the component interfaces and the data that is exchanged (metadata interoperability). For instance, the lab repository could use another learning environment that specifies the `Instantiator` and `Publisher` interface. Additionally, the `Authenticator` interface enables the interchangeability of, for instance, the default user management with an LDAP implementation.

5 Implementation of the Go-Lab Portal

Based on the presented design, we have started the portal implementation following an iterative and incremental approach. In parallel with the architectural design, we have also designed a GUI mockup[7] using participatory design.

The lab repository is implemented on top of the existing ROLE Widget Store [5] that is built with Drupal[8]. Drupal is a widely used, open source content management system that allows high scalability. Labs, apps, resources and ILS templates will be described with metadata (e.g. functionalities & 'Big Ideas' in science categories), which is used to organize and search for labs, apps and ILS templates. The existing functionality for learning scenarios in the ROLE Widget Store is reused. In a first implementation phase, we aim to implement publishing labs, apps and ILS templates and integration with the ILS platform through the `Instantiator` interface.

The ILS platform is implemented on top of the Graasp platform [2], which is a social media platform that supports personal and collaborative activities using resources and OpenSocial apps. Currently, Graasp already allows teachers to build a basic ILS. In a first phase, this functionality will be further extended and a dedicated GUI for students is under development. Part of the learning analytics and recommendation component will be integrated with Graasp using the OpenSocial specification together with the ActivityStreams specification to represent the user activity data [21].

In a later phase, the user management component and other more advanced functionality will be implemented. The full metadata schema will be gradually implemented.

[7] The mockup is available at
`http://www.go-lab-project.eu/content/prototypes`
[8] Drupal, `http://www.drupal.org`

6 Conclusion and Future Work

The architecture described above aims to satisfy the requirements and design principles. Each of the components in the architecture handles a well-defined coherent set of tasks, which fulfils the *'separation of concerns'* design objective. Through well-defined interfaces and metadata specifications, we enable a *loosely coupled* architecture with *high cohesion*. The portal architecture follows the *subsetability* design principle and thus allows an iterative and incremental development. Moreover, this enables early deployment in real-life settings, which will be exploited for participatory design evaluations.

One of the main requirements has been achieved, i.e. to provide a common, ubiquitously accessible inquiry learning environment without any installation hassle. Various design decisions contribute to this. First, the smart device specification and smart gateway for online labs empower interoperability between any lab and the ILS platform. Second, the Go-Lab portal provides a seamless integration between a repository of labs and a learning environment. The integration is supported by the well-defined interfaces and metadata specifications to exchange data.

Personalization is a powerful mechanism to assist users. The architecture enables personalization through recommendations and apps, e.g. (i) recommendations will be provided based on tracked user activities, (ii) learning analytics apps support awareness and self-reflection and (iii) scaffolding apps assist students. Through the separate learning analytics and recommendation component, user traces can be tracked over all portal components, data privacy can be ensured by anonymization and various implementations are possible applying different data processing techniques. The separate user management component facilitates the integration with various authentication systems of large educational institutions.

To really create an impact, it will be very important to attract many teachers and lab owners to use the portal. That is why we see the Go-Lab portal as a two-sided marketplace where ILS are provided by suppliers (lab-owners and teachers), and used by customers (teachers). Such markets typically benefit from network effects [13], that is, the more suppliers the market attracts, the more customers will join. In turn, more customers will attract more suppliers, creating a positive feedback loop. The challenge with such systems is to jump start this process. On the one hand, we believe that empowering teachers by allowing them to easily customize and republish ILS will lead to a greater supply. On the other hand, we are including STEM teachers from the start of the project on a large scale (100 teachers the first year up to 1000 teachers after three years) through our partnership with organizations such as the European Schoolnet[9] leading to a large user base.

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[9] European Schoolnet, `http://www.eun.org`

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Temporal Faceted Learning of Concepts Using Web Search Engines

Zheng Xu[1], Lin Mei[1], Shunxiang Zhang[3], and Feiyue Ye[2]

[1] The Third Research Institute of Ministry of Public Security, Shanghai, China
[2] Shanghai University, Shanghai, China
[3] Anhui University of Science and Technology
{Xuzheng,sxzhang,fyye}@shu.edu.cn, l_mei72@hotmail.com

Abstract. In this paper, we propose the problem of generating temporal faceted learning of concepts. The goal of the proposed problemisto annotate a concept with semantic, temporal, faceted, concise, andstructured information, which can release the cognitive burden of learning new concepts for users. The temporal faceted annotations can help users to learn and understand the unfamiliar or new emerged concepts. We propose a general method togenerate temporal faceted annotationof a concept by constructing its learning words, learning sentences, learning graph, and learning communities. Empirical experiments on LinkedIn dataset show that the proposed algorithm is effective and accurate. Different from the manually generated annotation repository such as LinkedIn and Wikipedia, the proposed method can automatically generated the annotations and does not need any prior knowledge such as ontology or the hierarchical knowledge base such as WordNet. The proposed method usesWeb search engines as a temporal faceted learning platform, which can add the new meaning and update the old meaning of concepts.

Keywords: Temporal facetedlearning, semantic annotation, content analysis, Web based learning.

1 Introduction

Given a new concept to the user, she/he may use Web search engines to index the Web pages, which may help users to learn the concept accurately. With the sophisticated algorithm, web search engines has made accessinginformation as easy as lifting a finger.Relatedresearch [1, 2, 3] suggests that when faced withdifficult questions, people are primed to think about computers. When people expect tohave future access to information, they have lower rates of recall of the information itself andenhanced recall instead for where to access it. In other words, when faced with a concept, users prefer to use search engines other than learn it by their own prior knowledge.

In order to provide an accuracy annotation for a concept, in this paper, we study the problem of automatically generating temporal faceted annotation (TFA) of concepts.We want to provide temporal and faceted information for a concept, which indicates the semantics anddiverse meaningsof the concept. What is a good semantic

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annotation of a concept? Let's see one example from the Cambridge Advanced Learner's Dictionary. Theannotationof a concept is structured as follows. First, the definition of the concept is presented. Second, some example sentences are given to show the usage of the concept in context. Besides, a visual thesaurus graph of the concept is given to show some related concepts.

Analogically, if we can provide the structured and semantic related informationof a conceptfor a user, it will be very helpful for her/himto understand and further explore it. Of course, the annotation in Cambridge Advanced Learner's Dictionary is incomplete. The concept is temporal changed, the new meaning may add to the concept. For example, "Gangnam" is a region in the Seoul of Korea. But with the popularity of the song "Gangnam Style" recently, the concept "Gangnam" may be related to a popular music. Thus, we must add the temporal feature to the semantic context. Besides the temporal feature of a concept, the faceted annotation also should be considered. For example, "apple" is not only a kind of fruit but also a famous computer brand. Let's see another example from LinkedIn. The experience of "Barack Obama" in LinkedIn is listed as the time sequence. In different time interval, the concept "Barack Obama" has different semantic annotations. Thus, inspired by the annotations from dictionaryand LinkedIn, the temporal faceted annotation should include:

1) **Learning sentences.** Given a concept, the learning sentence can help the users to understand the meaning of it. Moreover, the learning sentences can help users to uses the concepts in a real context.

2) **Diversity meanings.** Given a concept, we should give the different meanings, which can help users learn and explore the concept.

3) **Semantic related concepts.** Similar to the synonyms or thesauri in a dictionary, the related concepts should be added to the temporal faceted annotation.

4) **Temporal meanings.** In the different time interval, the concept may have different meanings. The appropriate semantic annotation in different time interval should be mined.

To the best of our knowledge, thetemporal faceted annotation has not been welladdressed in existing work. The major contributions of this paper are as follows:

1) In this work, We propose a general approach to automatically generate structured temporal faceted annotationof a concept including learning words, learning sentences, learning graph, and learning communities.

2) Different from the manually generated annotation repository such as LinkedIn and Wikipedia, the proposed method can automatically generated the annotations. Moreover, the proposed method does not need any prior knowledge such as ontology or the hierarchical knowledge base such as WordNet.

3) Empirical experiments on LinkedIn datasetshow that the proposed algorithm is effective and accurate for generating TFA.

The rest of the paper is organized as follows. In Section 2,we formally define the problem of TFA. In Section 3, weintroduce how to generate the TFA of a concept by Web search engines. We discuss our experiments andresults in Section 4 and the related work is given in Section 5.At last, some conclusions are given.

2 Problem Formulation

In this section, we formally give the basic definitions of the problem oftemporal faceted annotation (TFA).Let $C = \{w_1, w_2, ..., w_n\}$ be a concept containing a set of words, which can be seen as a query to the Web search engine. Let $S = \{s_1, s_2, ..., s_m\}$ be a set of documents related to the concept. Based on the two basic data, we denote four basic definitions of temporal faceted annotation of concept *C*.

Definition 1. Learning Word (LW): A learning word is semantic related to the concept *C*, which appears frequently in the documents set *S*. The set of learning words of the concept *C* is denoted as:

$$LW_C = \left\{ lw_1, lw_2, ..., lw_{|LW_C|} \right\}. \tag{1}$$

Definition 2. Learning Sentence (LS): A learning sentence contains a sequence of words, which appears in documents set *S*. The set of learning sentences of the concept *C* is denoted as:

$$LS_C = \left\{ ls_1, ls_2, ..., ls_{|LS_C|} \right\}. \tag{2}$$

Definition 3. Learning Graph (LG): A learning graph is a data structure of the learning words, which reflects the relation betweenlearning words. The nodes *N* in the learning graph are the learning words of the concept *C*. The edges *E* in the learning graph are the relations between the learning words. The learning graph of the concept *C* can be denoted as:

$$\begin{aligned} LG_C &= \{N, E\} \\ N &= LW_C \\ E &= \left\{ e_1, e_2, ..., e_{|E|} \right\} \end{aligned} . \tag{3}$$

The edge e_k can be denoted as a triple $e_k = \langle lw_i, lw_j, \lambda \rangle$, which means the edge e_k is from the node lw_i to lw_j with the weight λ.

Definition 4. Learning Community (LC): A learning community is a subgraph of the learning graph, which reflects a part of meaning of the concept *C*. The set of learning communities of the concept *C* is denoted as:

$$\begin{aligned} &LC_C = \left\{ lc_1, lc_2, ..., lc_{|LC_C|} \right\} \\ &\forall lw_i \in lc_i \wedge lw_j \in lc_j \rightarrow lw_i \neq lw_j \end{aligned} . \tag{4}$$

The set of learning communities is a segmentation of the learning graph. Each learning community is a part of the learning graph, which is with no common learning words of other learning community. Thesefour definitions are the basic semantic annotation of a concept *C*, which can be used for concept learning.We add the temporal feature to the semantic annotation of the concept *C*.The following example is a temporal faceted annotation of the concept "apple", which is generated of the top ten snippets by the web search engine Google[1].

[1] The searching results are obtained in the data 10/29/2012.

Example: A temporal faceted annotation of "apple" in the year 2012

Learning Words:

$LW(2012)$= {iPhone, iPad, Mac, tree, fruit, records,…}

Learning Sentences:

LS_1 = {Apple designs and creates iPod and iTunes}

LS_2 = {The apple is the pomaceous fruit of the apple tree}

Learning Graph

N = {iPhone, iPad, Mac, tree, fruit, records,…}

E = {<iPhone, iPad, λ_1>, <tree, fruit, λ_2>,…}

Learning Communities:

CC_1 = {iPhone, iPad, Mac, iPod, computer,…

CC_2 = {fruit, tree, rose,….}

CC_3 = {records, sound, Beatles,….}

We define the problem of generating **Temporal Faceted Annotation (TFA)** as:

Input: Given a concept C and the time interval $\langle t_s, t_e \rangle$

Output: The temporal faceted annotation of the given concept C, including the learning words, thelearning sentences, the learning graph, and the learning communities from the starting timestamp t_s to the ending timestamp t_e.

Of course, the proposed TFAproblem is not easy, which includes twochallenges:

1) It is not easy to find the appropriate knowledge base for generating temporal faceted annotation. The background, the prior knowledge, or the ontology is all not clear before the users provide the concept.

2) It is not immediately clear to select appropriate computation method for ranking the temporal faceted annotation. Since the temporal faceted annotation may be large for a given concept, it is necessary to select the best related annotation for the users;

On the other hand, the above challenges also show the advantages of the proposed method. The proposed method integrates the temporal and faceted feature of the concept and do not need any domain knowledge or manual ontology.

3 Generating Temporal Faceted Annotation

In this section, we present the method for generating TFA of a concept. First, we introduce the feasible repository for collecting annotations. Second, the methods for obtaining four basic elements of TFA are given. At last, the ranking mechanism for selecting appropriate TFA is proposed.

3.1 Temporal Faceted Annotation Repository

In order to generate TFA of a concept, it is necessary to choose an appropriate repository. Herein, we use Web search engine such as Google to get the annotation related to a concept. The reasons are as follows.

1) **Updating Information Rapidly.** The meaning of a concept refreshes with the time. For example, the concept "US President" may be related to "George Bush" in 2007. But in 2008, "Barack Obama" was related to the "US President". Besides the temporal change of the concept, the new concept may appear. For example, the concept

"iPad mini"occurred in the October of 2012. Web search engine, as a biggest information repository of the world can keep up with the change and evolving of the concepts.

2) **Convenient Interface for Temporal Features.** It is important to obtain the related information of a concept in a given time interval. Web search engines such as Google provides the interface for searching web pages in a given time interval.

Snippet is a brief window of text extracted by a search engine around the query words in a web page.Processing snippet isalso efficient as it releases the trouble of downloading Webpages, which might be time consuming and parsing infeasible. In the following section, we denote the snippets of a concept as $S_C = \{s_1, s_2, ..., s_m\}$.

The steps for obtaining the resources from the repository (in this paper, we choose Google as the TFA repository) are as follows:

1) Issue the concept C and time interval $\langle t_s, t_e \rangle$ as the query to the Google;

2) Get the page counts of the query in the time interval, denoted as $P_C(t_s, t_e)$;

3) Get the snippets of the query in the time interval, denoted as $S_C(t_s, t_e)$;

We develop a parsing tool for extracting the page count and snippets from the searching result html pages. In this paper, we parse the top 20[2] search results of the concept by Google.

3.2 The Generality of Learning Words

In this section, we present the methods for generating learning words of the concept. In section 3.1, we collect the snippets of a concept from the annotation repository. We aim at extracting appropriate words from the snippets. We also give each word a weight, which reflects the importance of the words against the concept.

Since the snippets may contain stop words such as "in", "a", the Stanford tagger is used to reserve the noun words in the snippets. The noun words have real and clear meanings, which can reflect the real context of a concept. Besides the extraction of learning words, the weight of each word should be given to reflect which is the most associated to the concept. Some existing work such as tf-idf [4] is used to give a weight to the word. In our work, we use the snippet frequency (SF) of each word to rank their importance against the concept. For example, if a word appears in 10 snippets of total 100 snippets, the snippet frequency of it is 0.1.

Using snippet frequency as the ranking schema is low complexity and accuracy. The top searching results are usually related to the query. The word with high snippet frequency is usually more related to the query than that of low snippet frequency.

3.3 The Generality of Leaning Sentences

Comparing with the learning words, the learning sentence can be understood by the users more easily and clearly. The learning sentence is composed of the learning words, which can reflect the relations of the words. For example, the sentence "Apple designs and creates iPod and iTunes" reflect the relation between the learningwords

[2] The low number of search results may lessen the recall and the high number of search result may lessen the precision.

"iPod" and the concept "apple". Users can understand the relation between the learning words and the concept by the learning sentence. Of course, mining the learning sentence is easier than mining the learning words. The string segmentation algorithm is used when scanning the end of a string. In our work, we suppose the ending string of a sentence is '.', '?', '!', and '…'. If the string segmentation algorithm scans the ending string, then the scanned string can be seen as a sentence. Obviously, a learning sentence can appear in different snippets, and a snippet can provide different learning sentences. The weight of learning sentences can be computed by the sum of snippet frequencies of their words. For example, the sentence "Apple designs and creates iPod and iTunes" contains two learning words "iPod" and "iTunes". Then the weight of the sentence is the sum of the snippet frequency of these two words. The basic idea is that the high weight sentences should contain high weight learning words.

3.4 The Generality of Learning Graph

The learning sentences can reflect the relations of the learning words. Unfortunately, the learning sentence can only reflect the relation of a few words since the length of sentence is limited. In the definition 4, the learning graph is denoted as the learning words and the edges between them. The nodes of the learning graph can be got from the learning words set. The weight of the edge between two learning words is computed by the pointwise mutual information (PMI) [5].The nodes with high number of edges are that with the high snippet frequencies. This feature of the learning graph is easy to be understood. The learning words with high snippet frequencies appear in many snippets, which may co-occurrence with many different learning words. Of course, we can optimize the learning graph to help users understand the concept more clearly. The edges with the low weight can be deleted in the learning graph. Generally, we want to remove the low weight edges as much as possible in the condition of reserving the connectivity of the learning graph. We use the spanning tree algorithmto the learning graph. In our work, we revised the algorithm as the maximum spanning tree, which reserves the high weight edges as much as possible.

3.5 The Generality of Learning Community

The semantic of a concept may be in different aspects. For example, the concept "apple" can be seen as a fruit, as a computer company, or even as a daily newspaper. In this paper, we use Girvan and Newman(GN) algorithm [6] to detect the learning community of the learning graph. In our work, we use GN algorithm to cluster the words with the same semantics. We want to detect the words set which mentions the same meanings of a context. In order to detect the communities efficiently, we employ the GN algorithm on the spanning tree of the context graph. For example, the learning words "iPhone", "iPad", "Mac" in the community with blue nodes reflects that "apple" is a computer company. Thelearning words "fruit", "tree", "rose" in the community with black nodes reflects that "apple" is a kind of fruit. We compute the weight of context sentences by the sum of snippet frequencies of their words. Since different sentences may reflect the different meanings of a concept, we also divide the context sentences into different communities.

Table 1. The selected results of the experiments on LinkedIn dataset

person	Experiences extracted from learning sentences
Tanya Berger-Wolf	University of New Mexico(2003-2004), DIMACS(2003-2004), University of Illinois at Chicago(2005-2007, 2010-now), University of Illinois(2008-2009)
EvgeniyGabrilovich	Israel Institute of. Technology(2003,2005-2006), Microsoft Research(2004), Yahoo(2007-2012), Google (2012-now)
Andrew Tomkins	IBM Almaden Research(2003-2005), IBM Research(2004), Yahoo Research(2005-2009), Google(2010-now)
Elizabeth Churchill	FX Palo Alto Laboratory(2003), Palo Alto Research Cente(2004), Yahoo Research(2005-now)
Steffen Staab	University of Karlsruhe(2003-2004), University of Koblenz-Landau(2004-now), Institute for Web Science and Technologies(2010-now)

4 Experiments and Results

The LinkedIn page of "Barack Obama" has four experiences including the president, US Senator, State Senator, and Senior lecturer in law. The different experiences are with the different time interval. For example, he is a state senator of Illinois from 1997 to 2004. In this experiment, we want to generate the TFA of the people in different time interval according to his/her experiences in LinkedIn. If the TFA includes the experience in the correct time interval, we can say that the proposed method performs well in temporal aspect. We select 20 persons who are chairs, members, or keynote speakers of the International World Wide Web Conference from 2009 to 2013. All of these persons have LinkedIn pages and complete experiences. The complete names of these people are set as the query to Google.

We consider one data of the TFA of each query: the learning sentences. The learning sentences reflect the exact meaning of the query, which can be seen as a background of the query. For example, the learning sentence of the query "Virgilio Almeida" in 2011 is"Virgilio Almeida is the IT policy secretary at the Brazilian Ministry of Science and Technology (MCT)". But in 2009, the context sentence is "Virgilio Almeida is a professor of computer science at the Universidade Federal de Minas Gerais (UFMG)". The learning sentence of the different time interval can be matched to the experience from the LinkedIn. Table 1show some selected results extracted from the context sentence of the queries. Totally, the twenty queries generate 175 experiences (2003-2012). If the set of the context sentences contains the right experience, then we think the semantic context is correct. The precision of the experiment is 95%, which means that about 95% sentences contain the right experiences of the person. The recall of the experiment is 82%, which means we mine about 123 right experiences from the learning sentences. The missed and incorrect experiences are usually caused by the recall of the returned search results by Google and the same name of the other people. The experiments in LinkedIn dataset show the accuracy of the proposed TFA method.

5 Related Work

With the explosion of community contributed multimedia content available online, many social media repositories (e.g. Flickr, Youtube, and Zooomr) allow users to upload media data and annotate content with descriptive keywords which are called social tags. These tags can be seen as a type of semantic context of the objects such as images or videos. In the area about the usage patterns and semantic values of social tags, Golder [7] mined usage patterns of social tags based on the delicious dataset. Davis [8] concluded that social tags were semantically richer than automatically extracted keywords. Suchanek [9] used YAGO and WordNet to check the meaning of social tags and concluded that top tags were usually meaningful. Halpin [10] examined why and how the power law distribution of tag usage frequency was formed in a mature social tagging system over time.

Recently, many researchers investigated the applications of social tags in information retrieval and ranking. In [11], the authors empirically study the potential value of social annotations for web search. Zhou [12] proposed a model using latent dirichlet allocation, which incorporates the topical background of documents and social tags. Xu [13] developed a language model for information retrieval based on metadata property of social tags and their relationships to annotated documents. Bao [14] introduced two ranking methods: SocialSimRank, which ranked pages based on the semantic similarity between tags and pages, and SocialPageRank, which ranked returned pages based on their popularity. Schenkel [15] developed a top-k algorithm which ranked search results based on the tags shared by the user who issued the query and the users who annotated the returned documents with the query tags. Radinsky [16] proposed to use temporal information as a complementary source of signal to detect semantic relatedness of words. The temporal semantic relatedness of two words can be computed in the different time interval.

The annotation of concepts can be used in building Semantic Web. Zhuge [17, 18, 19] Semantic Link Network (SLN) to organize Web resource based on semantics, which is a loosely coupled semantic resource model that can semantically link resources and derive out implicit semantic. Luo [20, 21, 22] proposed Association Link Network (ALN), which is designed to establish associated relations among various resources (e.g. Web pages and documents) aiming at extending the hyperlink network WorldWideWeb to an association-rich network.

6 Conclusions

A temporal faceted annotation consists of a set of strongest context indicators. We propose a general approach to automatically generate structured annotationof a concept. The proposed TFA structure integrates the features from dictionary, Wikipedia, and LinkedIn, which is helpful for users to understand and explore the concept.

Empirical experiments on LinkedIn dataset show that the proposed algorithm is effective and accurate for generating TFA. Different from the manually generated contexts repository such as LinkedIn and Wikipedia, the proposed method can automatically generated the annotation. Moreover, the proposed method does not need any prior knowledge such as ontology or the hierarchical knowledge base such as WordNet.

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An Approach to Model and Validate Scenarios of Serious Games in the Design Stage

Amel Yessad, Thibault Carron, and Jean-Marc Labat

LIP6, CNRS UMR 7606, Université P. & M. Curie – Paris 6
4, Place Jussieu, 75252 Paris Cedex 05, France
{Amel.Yessad,Thibault.Carron,Jean-Marc.Labat}@lip6.fr

Abstract. Scenarios of serious games become more complex, highly interactive and hard to validate by humans due to the number of possible paths. Increasingly, authoring systems are proposed to support the designers in the scenario's elaboration. These systems need tools to model and validate the interactive scenarios. But often, only testing activities with beta testers attempt to ensure the reliability of games' scenarios, once the serious game is developped. Indeed, testing activities could reveal errors and bugs in the interactive scenario but they are not sufficient and not adapted to validate scenario in the design stage.

To be of any real value, for any learning system, a scenario must verify properties. This paper addresses both the modeling and the validation of Interactive scenarios in the design stage of serious games. We aim to support authoring systems for scenarios, to verify serious game's properties and thus to increase the design quality of serious game.

We propose a formal framework to scenario's modeling and validation in the design stage. First, we use Coloured Petri nets (CPN) as a modeling language. Then, the formal validation of the interactive scenario is performed by means of CPN Tools, an industrial-strength computer tool for analysing CPN models. Using CPN Tools, it is possible to investigate the behaviour of the modelled serious game using simulation and to verify properties by means of model checking.

Keywords: Serious Game, Interactive Scenario's Verification, Model Checking, Couloured Petri nets.

1 Introduction

Context. Serious games can be defined as "(digital) games used for purposes other than mere entertainment" [1]. They are a way to help people to acquire domain knowledge and develop skills. Particularly, we share the definition of [2]: "a serious game is a virtual environment and a gaming experience in which the contents that we want to teach can be naturally embedded with some contextual relevance in terms of the game-playing [...]".

Actually, scenario of serious games become more complex and interactive and requires a delicate engineering process, involving several stakeholders (domain experts, teachers and game designers). We are interesting to interactive scenario of serious games that has high degrees of variability in responses to learner's interactions; the scenario is nonlinear and the game actions are partially ordered; the learner-players can

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evolve in different ways in the scenario game. This means that the unfolding of the game will emerge from the players interactions.

Problem. Traditional game design often makes use of branching story lines to achieve the players influence, leading to an explosion of paths and content elements that is difficult to manage manually [3]. This is more critical when the scenario is highly interactive in multi-player serious games; on the one hand, it is extremely easy for the human designer to miss some interaction patterns when designing such systems, leading to gaps and malfunctions in the system design. In addition, multi-players serious games are often nondeterministic where the interleaving of interactions between players makes difficult to predict in advance by designers all states of the game. On the other hand, scenarios have to verify constraints and properties related both to the learning purposes and to the entertainment. Thus, it seems relevant to propose tools to designers in order to support their authoring activities.

We consider that authoring systems have to implement two main functionalities:

- Supporting designers in the interactive scenario modeling
- Analyzing the scenario model in order to verify their properties and constraints, defined by designers

Contribution. In this paper, we propose a formal framework that aims to support the implementaton of these two functionalities for authoring systems. This formal framework offers a common language to stakeholders in order to speak the same language during the design of a serious game.

First, we propose a generic pattern to specify a serious game's scenario. This latter is decomposed into single activities of partial order and a high number of game paths becomes possible, depending on the choices and actions of the player. The activities can be collaborative or individual, imply or not shared resources and/or require a limited duration. This generic pattern is our reference model for specifying a serious games scenario.

Then, we use Petri nets, to model this generic pattern. The advantage is that the Petri nets can simulate dynamically an order of actions (or events) . Better yet, a Petri net unlike static models is an explicit runtime model that allows to explore automatically all game paths. The use of Petri net may not directly reduce the amount of actions that have to be authored, but offers a greater degree of non-linearity and variation within the possible actions/events. Among the types of Petri nets, we use the Coloured Petri Net (CPN) because they are more compact than simple Petri Nets thanks to the use of the token's colours that reduce the net symmetries.

Finally, we use model checking to analyze and verify properties of the CPN. It allows to debug automatically interactive scenarios and is a powerful approach for the formal verification; it provides automatically complete proof of correctness, or explains, via counter-examples, why a scenario is not correct [4].

Content. Section 2 presents relevant properties for serious games. Section 3 details our methodology and the type of Petri Nets we use. Then, the case study is presented and treated in section 4.

Table 1. Classification of properties (invariants, reachability and temporal)

	Learning-dependent	Game-dependent
Inv.	*"The learner can always improve his skills or at least maintain them" "The player can always call for help"*	*"It is always possible to perform an action before the game ends", "a player can always replay an action"*
Reach.	*The player can acquire all skills", "The player reaches a quiz"*	*"The player can reach the virtual lab"* or *" "The player can win (respectively lose) the game", "'win a duel", "avoid the monster" or "unlock the door"*
Temp.	*"The player can not complete the level as long as he does not have the competence C"*	*"The player must perform at least one game action before winning or loosing"*

2 Relevant Properties for Serious Games

Our work aims at verifying automatically (using model checking) properties of serious games in the design stage. We classify expected properties along two axes (see table 1). A serious game is a system which combines features relating to games and learning. Thus, the first classification axe deals with the type of a property:

- Learning property: it is related to the learning characteristics like the skills, the business process or the quizes .
- Gaming property: it is related to the fun like win a duel, avoid the monster or unlock the door.

The second axis defines the scope of a property (and therefore, the algorithms that are used for the scenario validation):

- Invariant are properties that are always verified in the game,i.e., in any state of the game.
- Reachability properties are the properties that are verified in at least a game state that is reached from the initial state. The occurrence or not of this state depends on the sequence of actions of the player.
- Temporal properties that are expressed using a temporal logic [5] like CTL or LTL and involve several states of the game and often express a sequence of game's states and define causal relations between states in the game.

Table 1 provides instances of properties that show intersection between the two axes.

3 Formal Framework to Scenario Authoring

Today, the video game industry uses human testers to detect bugs in games. Obviously, testing activities are costly, unreliable and especially can't detect design bugs. It is difficult to detect that the set of constraints defined by the designer on scenario lead to a coherent and reliable scenario. Indeed, given the numerous interactions player-player and player-virtual object, it is possible that the scenario has problems: lock or deadlock of players, players who win without having acquired all the skills or the scenario do not take into account the pedagogical constraints of teachers (ex. prequisite constraints between skills). These scenario problems have to be verified in the design stage before the implementation of serious games.

3.1 Generic Pattern for Serious Games

Our research focuses on multi-player serious games where scenarios are highly interactive. The scenario is composed of activities and often presented to players as challenges. A learner can perform an activity if he has the required skills and/or virtual objects prerequisite for this activity. Virtual objects describe the game state and include the inanimated objects (e.g. a key), the non player characters (a wizard) and the other learners. In an activity, the learner acquires new skills and/or new virtual objects that allow him to perform other activities. An activity can be a learning activity, a gaming activity or both.

Figure 1 represents a diagram that describes relationships between activities. Activities can be performed in sequence (*e.g.* Act1, then Act2), in parallel (*e.g.*Act2 and Act3) or with some exclusion (*e.g.* A player who performs the Act6 can not perform the Act4 because he loses the vo4).

That is obvious that describing all the activities of the scenario leads to a complex model where the properties become extremely difficult to verify manually. Thus, it seems useful to model the serious game scenarios by a formal model that we can execute in order to verify automatically properties.

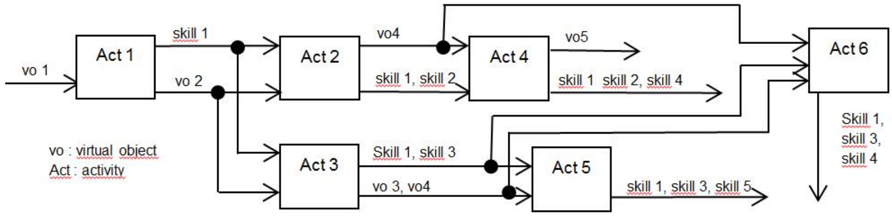

Fig. 1. Scenario of a serious game

3.2 Coloured Petri Nets (CPN)

Among the multiple variants of Petri Nets, we chose Coloured Petri Nets (CPN) which allow to get a reasonable sized model of serious game scenarios, thanks to the use of colors to model data.

CPN models are formal -in the sense that the CPN modelling language has a mathematical definition of its syntax and semantics. This means that they can be used to verify system properties, i.e., prove that certain desired properties are fulfilled or that certain undesired properties are guaranteed to be absent [6].

The CPN model of a serious game describes the states of the serious game and the events (transitions) that can cause the serious game to change state. By making simulations of the CPN model, it is possible to investigate different paths of the scenario and explore the behaviours of the serious game. The goal of simulation is to debug and investigate the serious game design and the real benefit is that the CPN model can be simulated automatically in order to verify serious game properties. We provide here an informal presentation of CPN and use them to model the serious game scenario of the Fig. 1.

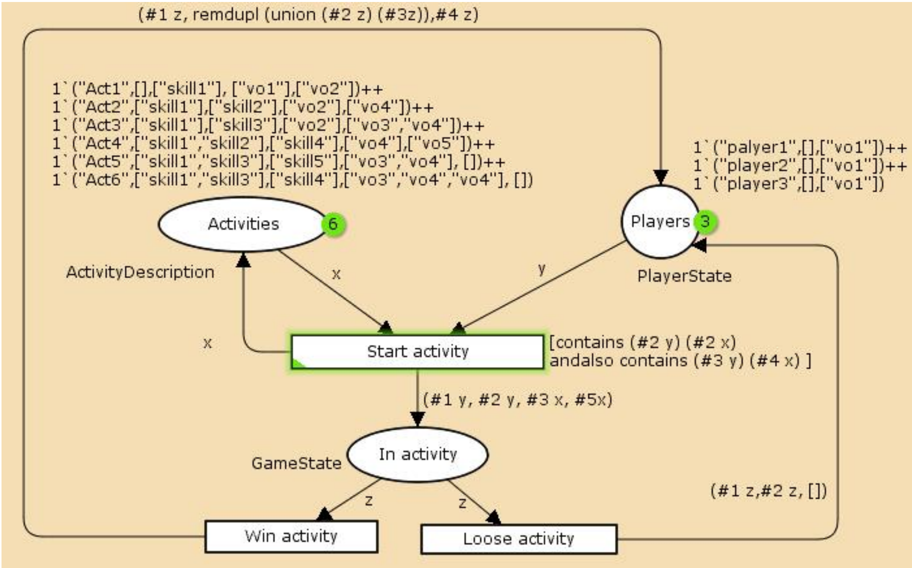

Fig. 2. Modeling a game scenario in CPN

Informal Definition and Example. A CPN is a bipartite graph composed of places (circles), that represent resources (*e.g*, the current state of a player in the game) and transitions (rectangles) that represent actions. When a transition is fired, it consumes resources (called tokens) to produce new ones. Some guards ([conditions] written near a rectangle) can be added to transitions. Each place has the following inscriptions:

- Name (for identification).
- Colour set (specifying the type of tokens which may reside on the place).
- Initial marking (for each place, a multi-set of token colours).

For instance, the colour set `PlayerState` of the place `Players` is defined by the declaration sentence: `colset PlayerState=product Player*SkillList*VOList;`. It means that the tokens containing in this place, are 3-tuples of the type `PlayerState`. Each transition has the following inscriptions:

- Name (for identification).
- Guard (boolean expression containing some of the variables).

Each arc has the following inscriptions:

- Arc expression (containing some of the variables). When the arc expression is evaluated it yields a multi-set of token colours.

The CPN of Fig. 2 models the serious game scenario of the Fig. 1. Place `Players` holds tokens where each token represents the list of the player's skills and the list of the player's virtual objects (In CPN language, a list is denoted []). The initial marking in place `Players` contains one token per player (identified by the variable `y`). For example, the token `("player1",[],["vo1"])` describes the state of the player `player1` that has no skill (the skill's list is empty) and has only one virtual object `vo1`.

Place `Activities` holds the required skills and required virtual objects for each activity. The initial marking in place `Activities` contains a token per activity (identified by the variable `x`). An activity's token is an 5-tuple composed of an activity's identifiant and four lists: the prerequisite skills, the acquired skills, the prerequisite virtual objects and the acquired virtual objects. For example, the token ("Act4",["skill1","skill2"],["skill4"],["vo4"],["vo5"]) describes the activity `Act4` that requires both the skills `skill1` and `skill2` and the virtual object `vo4`. This activity allows a player to acquire the skill `skill4` and the virtual object `vo5`.

An activity begins (firing of the transition `Start activity`) only when its prerequisite skills and virtual objects are included in those of the player. This condition is described by the guard `[contains (#2 y) (#2 x) andalso contains (#3 y) (#4 x)]`. We note that the symbol # is used to return a specific element of the token. For example, #2 y returns the second element of y (in our case, the player's skills). At the end of the activity, the player may fail (transition `Loose activity`) or succeed (transition `Win activity`).When the player succeeds an activity, he increases his skills with the acquired skills of the activity (the player's skills bocome `union (#2 z) (#3z)`) and wins new virtual objects (the player's virtual objects become `#4 z`).

Interest of CPN. CPN models are appropriate to model interactive scenarios for three main reasons.

First, their capacity to structure data in tokens with lists allows to capture the dynamic part of serious games well: here, both skills and virtual objects vary depending on the progress of the player in the game (and can be empty).

Second, they provide an easy modeling of operations such as union or inclusion in transition guards and on the arcs. This allows for more compact and more flexible specification.

Third, a CPN preserves the use of symmetry-based techniques allowing efficient state space analysis [6]. This last point is very important for the formal analysis of serious games. Indeed, the CPN is more compact than the equivalent Petri net without colours and the analysis techniques may be more effective.

4 Application to a Case Study

We have apply our automatic verification approach to a dozen scenarios of serious games. Here, we detail the modeling of one scenario multi-players. The objective of this section is to show the feasability and the interest of our formal framework.

Table 2. Description of scenario's activities

Activities	Input	Output
review addition tables (a_1)	*"player prepares his bag" (vo_1)*	*"addition tables" (sk_1), "player leaves the village" (vo_2)*
exercise on simple additions (a_2)	*"player at the foot of the mountain" (vo_3)*	*"simple additions" (sk_2), "player on top of the mountain"(vo_4)*
exercise on simple substractions (a_3)	*"player on top of the mountain"(vo_4)*	*"simple substractions" (sk_3), "player at the foot of the mountain" (vo_3)*
exercise on addition with holes (a_4)	*"player helps the hermit to complete accounting papers"(vo_5)*	*"simple additions" (sk_2), "player wins telescope" (vo_6)*
exercise on hard additions and hard substractions (a_5)	*"simple additions" (sk_2), "simple substractions" (sk_3), "player meets a wizard" (vo_7)*	*"complicated additions and substractions" (sk_4), "player wins telescopic ladders" (vo_8)*
exercise on simple multiplications (a_6)	*"simple additions" (sk_2), "simple substractions" (sk_3), "player on one side of the gorges" (vo_9)*	*"simple multiplications" (sk_5), "player on the other side of the gorges" (vo_{10})*
exercise about finding errors on simple multiplications (a_7)	*"simple additions" (sk_2), "simple substractions" (sk_3), "player helps the dragon to finish his homework " (vo_{11})*	*"simple multiplications" (sk_5), "the dragon frees the beautiful girl for reward the player" (vo_{12})*
game activity (a_8)	*"player leaves the village"(vo_2)*	*"player at the foot of the mountain" (vo_3)*
game activity (a_9)	*"player at the foot of the mountain"(vo_3)*	*"player helps the hermit to complete accounting papers" (vo_5)*
game activity (a_{10})	*"player wins telescope"(vo_6)*	*"player meets a wizard" (vo_7)*
game activity (a_{11})	*"player wins telescopic ladders"(vo_8)*	*"player on one side of the gorges" (vo_9)*
game activity (a_{12})	*"player on the other side of the gorges"(vo_{10})*	*"player helps the dragon to finish his homework" (vo_{11})*

4.1 Brief Presentation of the Scenario

The story of the serious game takes place in the middle ages where the most beautiful girl of the village was kidnapped by a dragon and imprisoned in a tower in a distant country. The village's boys go looking for her. They have to resolve computational problems in order reach the tower and liberate the beautiful girl from her prison. The scenario of the serious game is the following: the player has to climb up mountains, has to down mountains, has to reach the hermit's shack and has to win the authorization to look into the Hermit's telescope. After that, he meet a wizard, has to win a telescopic ladder and use it to get over the gorges. Finally, the player meets the dragon and has to help it to resolve computational problems. If the dragon is glad, he shows the magic door of the tower to the player and frees the beautiful girl.

During this game adventure, learning activities or game activities are proposed to players to allow them to progress in the game scenario.

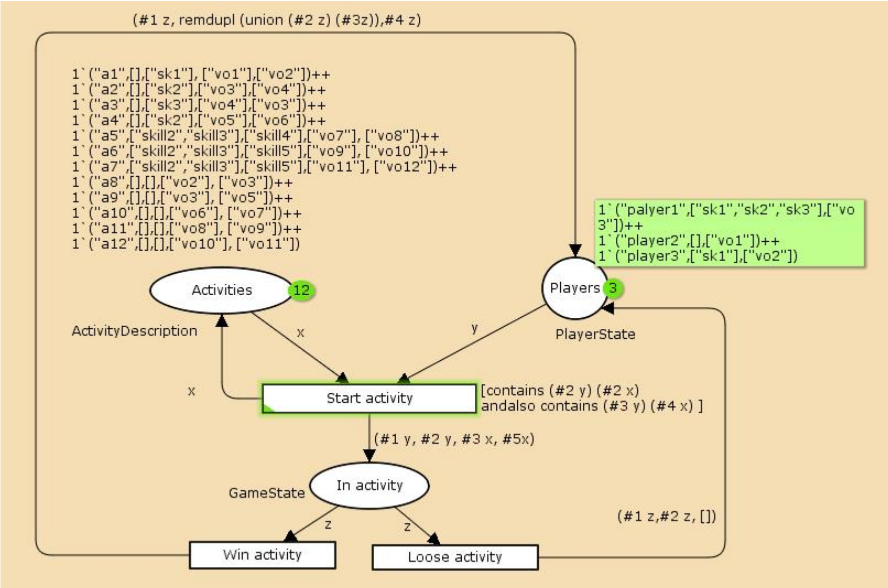

Fig. 3. The CPN model of the game adventure

4.2 The Case Study

the scenario above allows players to acquire skills (*e.g.* mastering the multiplications) and/or virtual objects (*e.g.*the hermit's telescope). Activities are proposed to players in some order, depending on the player's skills and the game state. The inputs and the outputs of each activity are presented in table 2. We deliberately distinguish virtual objects (vo_i) and skills (sk_i) in the description of an activity (a_i). We note that the virtual objects represent the game state such as "the player meets a wizard" or "the player wins a telescope".

4.3 Modeling the Scenario of the Case Study

To verify the scenario above, we transform its activity diagram into a CPN where $Activities = \{a_1, a_2, a_3, a_4, a_5, a_6, a_7\}$, $Skills = \{sk_1, sk_2, sk_3, sk_4, sk_5\}$ and $VirtualObjects = \{vo_1, vo_2, vo_3, vo_4, vo_5, vo_6, vo_7, vo_8, vo_9, vo_{10}, vo_{11}, vo_{12}\}$. We consider that initial marking `M` of place `Players` is such that for each player p, `M` contains the token $\{\langle p, \emptyset, \{vo_1\}\}$. It represents the start of the scenario, i.e., each player starts by preparing its bag and has not skill yet. The initial marking `M'` of place `Activities` is the multiset $\{\langle a_1, \emptyset, \{sk_1\}, \{vo_1\}, \{vo_2\}\rangle, \langle a_2, \emptyset, \{sk_2\}, \{vo_3\}, \{vo_4\}\rangle, \langle a_3, \emptyset, \{sk_3\}, \{vo_4\}, \{vo_3\}\rangle\}, \langle a_4, \emptyset, \{sk_2\}, \{vo_5\}, \{vo_6\}\rangle, \langle a_5, \{sk_2, sk_3\}, \{sk_4\}, \{vo_7\}, \{vo_8\}\rangle, \langle a_6, \{sk_2, sk_3\}, \{sk_5\}, \{vo_9\}, \{vo_{10}\}\rangle, \langle a_7, \{sk_2, sk_3\}, \{sk_5\}, \{vo_{11}\}, \{vo_{12}\}\rangle, \langle a_8, \emptyset, \emptyset, \{vo_2\}, \{vo_3\}\rangle, \langle a_9, \emptyset, \emptyset, \{vo_3\}, \{vo_5\}\rangle, \langle a_{10}, \emptyset, \emptyset, \{vo_6\}, \{vo_7\}\rangle, \langle a_{11}, \emptyset, \emptyset, \{vo_8\}, \{vo_9\}\rangle, \langle a_{12}, \emptyset, \emptyset, \{vo_{10}\}, \{vo_{11}\}\rangle\}$. This CPN

Fig. 4. Simulation tool palette

models how players acquire skills and virtual objects. When a player loses an activity, his skills are not changed but he loses his virtual objects. When he wins an activity, he may acquire new skills or/and virtual objects.

The model of Figure 3 represents the game state where (1) the $player1$ masters the addition tables (sk_1), the simple additions (sk_2) and the simple substractions (sk_3) and he is at the foot of the mountain (vo_3) and (2) the $player2$ does not yet play and (3) the $player3$ masters the addition tables (sk_1) and left the village (vo_2) .

4.4 Scenario Simulation

Since the formal representation of the serious game allows the construction of the reachability graph, we can verify invariant, reachability or temporal properties.

We use the simulator of CPN Tools [6] to execute scenario. CPN Tools uses graphical simulation feedback to provide information about the markings that are reached during a simulation. It allows to explore step by step the scenario execution. A simulation tool palette offers many tools for simulating CPN models as shown in Fig. 4. The available tools (from left to right) are [6]:

- Return to the initial marking.
- Stop an ongoing animated automatic simulation.
- Execute a single transition with a manually chosen binding.
- Execute a single transition with a random binding.
- Execute an animated automatic simulation, i.e., execute an occurrence sequence with randomly chosen binding elements and display the current marking between each step.
- Execute a fast automatic simulation, i.e., execute an occurrence sequence with randomly chosen binding elements without displaying the current marking between each step.
- Evaluate a CPN ML expression.

5 Conclusion

We presented a formal verification-based approach to the design of serious games. It relies on Coloured Petri Nets (CPN) and the use of model checking to verify automatically behavioral properties of serious games. Our objective is to reduce cost and complexity of serious games elaboration by enabling error detection at design stage.

One interesting point of our approach is to provide a procedure helping engineers to elaborate the design of their serious game. In particular, we propose a classification of properties that are relevant in that domain. It is then possible to infer from these patterns an efficient verification procedure involving the appropriate model checkers (i.e. the one that implements the most efficient algorithms for a given property pattern).

Another important point is the use of Coloured Petri Nets that better tackle the combinatorial explosion problem intrinsic to the model checking of interactive scenarios of serious games.

We applied our approach to real case studies for assessment purposes.This work is part of a project aiming at designing efficient formal verification based procedures for the design of serious games.

The CPN model of the scenariol, once it is verified, could be a basis for an automated implementation of a serious game execution engine. In the long term, this could decrease the time to implementation as well as to cut a large part of its costs.

Future Work. We mainly focus this paper on the modeling needs and we are currently working on the formal definition of properties of serious games and the extension of CPN tools to enable the verification of these properties. We are also working on a tool to assist designers in building CPN models. We want to construct semi-automatically CPN models from scenario's descriptions more user friendly such as in eAdventure[1] or in LEGADEE[2].

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[2] `http://liris.cnrs.fr/legadee/`

An Automated Assessment of Students' Learning in e-Learning Using Concept Map and Ontology Mapping

V. Senthil Kumaran and A. Sankar

PSG College of Technology, Coimbatore, India
vsk.mca@gapps.psgtech.ac.in

Abstract. E-learning plays vital role in education and its importance is constantly increasing. The key challenge in the teaching learning process of e-learning is assessing the students' learning. Learning means the acquisition of knowledge or skills through experience, practice, or study, or by being taught. Assessing the students learning on the topics being taught is very important in e-learning environment. Based on the student's learning, the system can change / update the pedagogy, recommendations can be made for further study, and the students' performance can be evaluated. Many e-learning systems assess student learning by conducting tests, quizzes or assignments. In this paper, we propose concept map based on assessment from students' learning using ontology mapping. Concept map is an effective tool for determining what a student knows in the topic covered. The concept map created by the student is converted into ontology and is then mapped with the reference ontology created by the expert. The experimental evaluation is presented and discussed.

Keywords: Concept map, ontology mapping, assessment in e-learning, knowledge assessment.

1 Introduction

Teaching-learning process is the heart of any education system. It is the most powerful instrument that helps in achieving the aims and objectives of education. Teaching and learning are related terms. In teaching - learning process, the teacher, the learner, the curriculum and the pedagogy are organized systematically, to attain some predetermined goal. Learning means what the student understands from the subject being taught. Teaching is providing proper direction and management of learning path. It is the process of providing opportunities for students to learn. The teaching-learning process is the backbone for any learning system. The education system can be divided into two based on usage of computers for teaching learning process: i) traditional education (Computers not used) and ii) e-learning, technology enabled education (Using Information and Communication Technology) [1]. In the traditional system, there will be face-to-face communication between student and teacher. The teacher not only teaches but also monitors & assesses the understanding of the student. Due to advancements in internet and communication technology, the education system

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evolved over a considerable period of time. The main element in the evolution is the level at which the computers are used. Fig 1 shows the evolution and it is clear that e-learning is at the higher level.

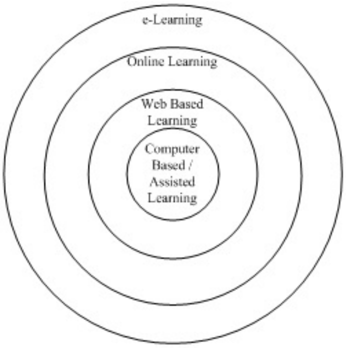

Fig. 1. Evolution of learning system that uses computer

In any education system, it is important that both teacher and learner keep track of learner's progress and to check whether the students have understood the topic. In traditional education system, the teacher and the learner involve in a face-to-face communication with each other at a particular place and at a specific time. So, regular knowledge assessment may be carried out quite naturally and also teachers can easily check the understanding of students. At the same time teachers have to evaluate the assessment of hundreds of students. This may be a biased and time consuming process. In the second form of education system (e-learning), it is very important to automatically assess the student learning. One of the main advantages of e-learning is that it can facilitate adaptive learning such that instructors can dynamically revise and deliver instructional materials in accordance with learners' current progress. In general, adaptive teaching and learning refers to the use of what is known about learners, a priori or through interactions, to alter how a learning experience unfolds, with the aim of improving learners' success and satisfaction [6][9]. In e-learning, a regular knowledge assessment is required to be carried out using different kinds of tests for many reasons. Unfortunately, assessing students' learning by tests, quizzes or assignments assess the students only at the first three levels of Bloom's taxonomy [2][29]. It fails to assess the students in the higher levels of the taxonomy. Students need more understanding and need to give more elaboration when they are assessed at the higher levels of the taxonomy [3][4].

According to Novak and Cañas [16], CMs are represented in a hierarchical fashion with the most general concepts at the top of the map and the more specific concepts below them, but cross-links can be used to indicate relationships between concepts in different domains of a CM in such a way forming some kind of a network. Concept Maps can be effectively used in knowledge assessment for many years. This can be used in assessing knowledge at the beginning or during or at the end of teaching learning process. Concept maps can be used at the beginning of a learning course in order to determine the level of knowledge students already possess, during the learning course to identify changes in students' knowledge and to adjust content and teaching methods of the course, and at the end of the learning course in order to determine the achieved knowledge level. Concept Maps allow evaluation of higher order levels of cognitive development in Bloom's taxonomy, especially when students must choose the most prominent and most useful linking phrases and cross-links [20].

In this paper, we propose a model using concept map and ontology mapping to assess the student learning at the higher level of the bloom's taxonomy.

1.1 Problem Statement

The developments in information and communication technology have moved the education system to a new era called e-learning. E-learning requires efficient and automatic knowledge assessment of students after completing each topic for many reasons like academic purpose, personalization, pedagogy modelling, learning path, recommendation etc.

1.2 Motivation

Assessment is a very important part in the teaching learning process of any learning system. An important aspect of effective teaching learning process is careful assessment of the extent to which students have assimilated the material they were taught. The role of assessment in teaching learning process is not only for assigning grades to learners, but can also be used to direct them to achieve the objectives of the course. But providing flexible and adaptable knowledge assessment, as provided by human teacher in classroom teaching is a key challenge for e-learning designers. There are five levels of assessment approaches suggested in Bloom's taxonomy, in order to provide efficient teaching learning both cognitive and non cognitive. Unfortunately, assessing students' learning by tests, quizzes or assignments assess the students only at the first three levels of Bloom's taxonomy. There are several researches have been performed to assess the students at the first three levels of bloom's taxonomy. One of the main advantages of e-learning technology is that it can facilitate adaptive learning such that instructors can dynamically revise and deliver instructional materials in accordance with learners' current status. Assessing students at the last two levels of bloom's taxonomy is required to provide efficient teaching learning process. This motivated us to propose a model using concept map and ontology mapping to assess the student learning at the higher level of the bloom's taxonomy.

The remainder of this paper is organized as follows. Section 2 outlines some related work. To address the challenge in learning assessment, a new model is proposed in section 3. This proposed approach is evaluated and discussed in section 4. Finally, conclusions and future work are discussed in section 5.

2 Related Work

Assessment is very important in the teaching learning process of any learning system to make sure that the students are progressing towards the course objectives and to adjust teaching learning process. The role assessment in teaching learning is not always used for assigning grades. They are used to improve the quality of instruction in the teaching learning process [15].There are two types of assessment summative and formative assessment. Summative assessment is a periodic assessments used to determine at a particular point in time what students know and do not know. Formative assessment is part of the teaching learning process that provides information needed to adjust teaching and learning while they are happening [7]. Classroom assessment techniques (CATs) are teaching strategies that provide formative assessments of student learning. It has been argued that the use of CATs enhances and improves student learning [13]. Formative assessment can have a powerful impact on student motivation and achievement [8]. Cauley [14] discusses the key practices that teachers can use to gather important information about student understanding, provide feedback to students, and enable students to set and attain meaningful learning goals.

Concept maps are excellent tools to provide instructors with diagnostic pre-assessment prior to beginning a unit and formative assessments during learning activities [17]. Angelo and Cross [5] indicate that concept maps develop student abilities in certain critical areas like, the ability to draw reasonable inferences from observations, the ability to synthesize and integrate information and ideas, the ability to learn concepts and theories in the subject area. Concept Maps (CM) were chosen as a strategy to empower students to be more effective readers and knowledge creators [12]. Concept map can also be used to enhance the interaction of teaching and learning with the goal to foster high order thinking, i.e., analyzing a problem situation, evaluating possible solutions, and creating innovative ideas for problem solving [11]. Concept Map based teaching and learning can motivate and improve student participation in higher order thinking activities [5].

Several ontology mapping systems have been proposed to address the semantic data integration issues in different domains [21]. E-learning systems propose a wide variety of tools and services for content, knowledge and students management to support an effective teaching learning process [22]. In the e-learning several ontologies have been developed and experimentally used to describe the learning contents, model the elements required for the evaluation of interaction between learners [23], teaching learning strategies [25], learner's profile [24], authoring [19], tutoring and for assessing the learners for giving grade to achieve flexibility [26], adaptability [27], knowledge integration and reuse. Fuzzy domain ontology extraction algorithm is used for concept map generation based on the messages posted in online discussion forums [23]. In this paper, a well known assessment tool, concept map is used. The concept map is transformed to ontology for usage in teaching learning process of e-learning and is mapped with reference ontology for effective assessment of learning of the students.

3 Proposed Model

This paper proposes a model that involves the application of ontology mapping technique for the automatic assessment of student learning by comparing the concept maps developed by the students and a reference ontology created by the expert. There are four models in any e-learning system, i) Teacher Model ii) Learner Model iii) Pedagogical Model iv) Assessment Model. The process begins with the Teacher Model, through which the subject expert (teacher) generates the course content and also the "reference ontology" for the content to be learned by the student. After learning the subject, the student generates the concept map on the subject learned. This concept map is given as an input to the Assessment Model, which is the main focus of this paper. There are three phases in this model. First phase is Concept Map processing, which takes CM as input and process the concept map created by the student. Concept map ontology generation phase generates the ontology document for the student's concept map. Ontology mapping phase maps the reference ontology with the concept map ontology and returns the student learning percentages. This learning assessment can be used by Learner Model to learn the learner and in turn Pedagogical Model can decide the learning path. Fig.2 gives the architecture of the proposed model.

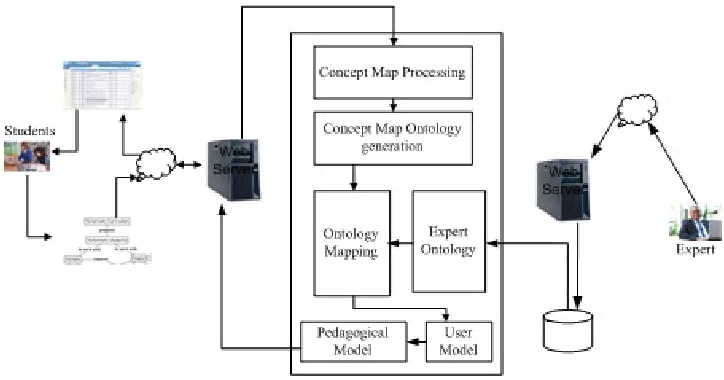

Fig. 2. Architecture of the proposed model

3.1 Concept Map Processing

CMs represent knowledge in the form of a graph which consists of labelled nodes displaying concepts in a knowledge domain and arcs showing relations between pairs of concepts. The main elements of a CM based on [18] are: Concept, relation, cross-link, concept example, prepositions. The various kinds of possible relations between two concepts are: hierarchical, instance, semantic, property, value, and complement. Fig. 3 shows a sample concept map created by student. In concept map processing stage, the main elements of CM are identified. According to Alla Anohina-Naumeca [20], it is possible to determine the seven types of relations in a concept map.

The equivalent OWL coding is written for the main elements of CM. Algorithm for converting CM into ontology is given in Fig. 4.

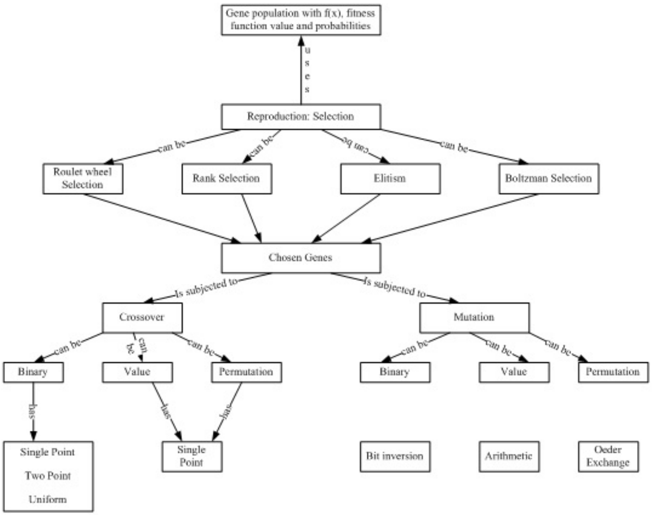

Fig. 3. Sample concept map created by student

```
Algorithm OntoGen (G:Concept)
Mark all concepts in G 'unvisited'
For each concept C directly related with G do
 If not visited (C) then
          Create a OWL class for C
 Else
          It is cross-link.
 Endif
 Find the type of relation (R) between C and G
 If R is hierarchical then
               Make C as the sub class of G
 Endif
 If R is instance relation then
               Make C as the instance of G
 Endif
 If R is whole-part then
               Make C as the part of G
 Endif
 If R is property then
               Make C as the property of G
 Endif
 If R is value then
               Make C as data property of G
 Endif
 If R is Complement then
               Make C as the complement of G
 Endif
 If R is any other then
               Make C as the object property of G
 Endif
 OntoGen(C)
Endfor
Endalg
```

Fig. 4. Algorithm for Ontology learning from Concept Map

3.2 Ontology Mapping Phase (Assessing Learning Level of the Student)

We used ontology instant mapping approach to map the concept map ontology with the reference ontology. The mapping value we get is the score assigned to the student learning. Let H be the reference ontology created by the expert and T be the ontology constructed from concept map created by the student. The edge set of H, E(H) and edge set of T, E(T) is:

$$E(H) = \{h_1, h_2, h_3 \ldots h_n\} \; h_i, i = 1, 2, .. n$$

$$E(T) = \{t_1, t_2, t_3 \ldots t_m\} \; t_j, j = 1, 2, .. m$$

To find the matching between every edges in H with every edges in T, we take the Cartesian product of E(H) and E(T).

$$E(H) \text{ x } E(T) = \{(h_i, t_j) \,/\, i = 1, 2 \ldots n, j = 1, 2 \ldots m\}$$

Let the end vertex of h_i be (v_{i1}, v_{i2}) and the end vertex of t_j be (u_{j1}, u_{j2}).

Let the edge weight of h_i is W_i denotes the weight assigned by the expert in the reference ontology.

The matching between h_i and t_j is as follows:

$$m(hi, tj) = \frac{Sim(vi1, uj1) + Sim(vi2, uj2)}{2} * wi \tag{1}$$

where m(h_i, t_j) is an integer value, Sim(v_{i1},u_{j1}) is the similarity between the two vertices v_{i1} and u_{j1} and Sim(v_{i2}, u_{j2}) is the similarity between the two vertices v_{i2} and u_{j2}. We use the Wikipedia based semantic relatedness similarity measure [10] to find the similarity between two vertices.

The total matching of all edges is:

$$k = \sum_{j=1}^{m} \sum_{i=1}^{n} m(hi, tj) \tag{2}$$

k is the score assigned to the student learning.

4 Experimental Results and Discussion

In this study, a concept map approach with ontology mapping is proposed for supporting teaching learning process in e-learning by assessing knowledge of students. To evaluate the effectiveness of the innovative approach, two experiments were conducted. First experiment was conducted to find the effectiveness of concept map as assessment tool [29]. It is a questionnaire based experiment and prepared two questionnaires one for students and another one for teacher. A total of 73 students belonging to two different classes and 10 faculty members participated in this study.

The average age of the students was 21 years old. All students learned the topic Genetic Algorithm in Soft Computing Course. After completing learning, the students were asked to generate concept map for the topic learned by them. Out of 73, 51 students supported concept map as learning tool. The prime reason given by them is that this learning approach can help learn the contents from a new perspective and this learning system enables better understanding of the learning content. They are happy with the feedback and explanation for each concept given by the system. They are able to understand the concept more clearly. We have analyzed the unexpected results as well. The main challenge faced by the students is that this approach requires thinking differently about the learning content and this makes the current learning activity more challenging. They are not able to link the concepts.

To our surprise all 10 faculty members expressed that they are satisfied with concept map based approach. The main reasons given by them are: i) easiness in assessment ii) easy to add/update concepts iii) easy for quantitative and qualitative analysis.

Second experiment was designed to evaluate the effectiveness of our approach. Six criteria are used to evaluate our approach. The measures we used are: TPRate, TNRate, FPRate, FNRate, F-Measure and Accuracy. Table 1 gives the value of these measures from our experiment.

Table 1. Measures and their values

Measure	***Value***
TPRate	0.93
TNRate	0.87
FPRate	0.13
FNRate	0.07
F-Measure	0.9
Accuracy %	94.14

5 Conclusion

The system discussed in this paper is an ideal environment for automatic knowledge assessment of students. This paper focuses on how concept map and ontology mapping can be used for assessment of learners in e-learning system. The effectiveness of teaching learning process in e-learning system depends on the appropriate teaching and knowledge assessment methods [28]. Concept map provides valuable information for teaching learning process. Since, concept maps have structural similarity with ontology, it is possible to convert concept map into ontology efficiently [18] and applying ontology mapping technique. Experimental results show that our proposed model can assess the learning of students effectively. In future we are planning to compare our model with some existing model for knowledge assessment. We plan to extend this work using fuzzy ontology.

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Community Learning Analytics – Challenges and Opportunities

Ralf Klamma

RWTH Aachen University
Advanced Community Information Systems (ACIS)
Informatik 5, Ahornstr. 55, 52056 Aachen, Germany
klamma@dbis.rwth-aachen.de

Abstract. Learning Analytics has become a major research area recently. In particular learning institutions seek ways to collect, manage, analyze and exploit data from learners and instructors for the facilitation of formal learning processes. However, in the world of informal learning at the workplace, knowledge gained from formal learning analytics is only applicable on a commodity level. Since professional communities need learning support beyond this level, we need a deep understanding of interactions between learners and other entities in community-regulated learning processes - a conceptual extension of self-regulated learning processes. In this paper, we discuss scaling challenges for community learning analytics, give both conceptual and technical solutions, and report experiences from ongoing research in this area.

Keywords: learning analytics, community learning analytics, visual analytics, community of practice, expert identification, overlapping community detection.

1 Introduction

Learning Analytics (LA) [1] and Educational Data Mining (EDM) [2] have become major research areas in technology enhanced learning recently. LA is concentrating on assessment of formal learning processes in blended or online environments. Following [3] it has its roots in business intelligence (BI) and data mining (DM). The Horizon Report 2013 writes: ***Learning analytics, in many ways, is "big data," applied to education*** [4]. Consequently, research concentrates on predicting and steering the learning progress of individual learners under the premise that an institutional learning management system (LMS) is deployed. Support is facilitated by recommendations of learning content or learning activities. In contrast, **Community Learning Analytics (CLA)** comprises the identification, analysis, visualization and support of informal community-regulated learning processes. Professional **communities of practice (CoP)** are learning informally. CoP are groups of people who share a concern or a passion for something they do and who interact regularly to learn how to do it better [5]. In CoP formal learning or training management systems' use is insignificant. Instead, an ecosystem of learning tools and resources

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is used which is called **community information system (CIS)** in the following. Training or learning often takes place at the workplace or in informal learning situations like commuting. Traditional LA often does not include mobile learning aspects like consideration of the context. Moreover, numbers in one professional community are often too small to draw statistical conclusions or to apply educational data mining algorithms in a standardized way. For deeper LA, domain knowledge is needed to understand the practice, usually this is accompanied by a passion for the community under study and a sense of belonging. Usually, expert members in communities are taking informal responsibility for learners since they have enough domain knowledge about the practice.

A major purpose of this paper is to clarify the distinction between LA and CLA. Therefore, we reconstruct the argumentation in three perspectives in the next section. First, we give the main distinctive characteristics between individual and social learning in a community. Second, we distinguish between formal and informal learning. Third, we add a mobile dimension to the argumentation. Then comes a section with concrete use cases for the challenges from an ongoing project. The paper ends with conclusions and an outlook.

2 Challenges for Community Learning Analytics

In this section, we want to sketch three major challenges for CLA, together with some opportunities from recent developments in computer science. First, the challenge is to build CLA solutions which are able to assess the learning progress of learners in informal learning situations. Second, the challenge is to bridge the gap between individual learning processes and community-regulated learning processes. The third challenge is the trend to mobilize learning, especially in informal learning.

2.1 From Formal to Informal Learning

Formal learning processes implemented in LMS contain a lot of information which is already *biased* by the way the information was collected having certain institutional norms and practices in mind. Moreover, the collection of data for LA is following certain pedagogic practices in the learning institution recording the data. Information may be also biased by the demographics of the learners. There may be many other factors not mentioned here. On one side, this is very convenient, since the data gathering process is usually aligned with the data processing and analysis processes; only necessary information is recorded. *Privacy* and *authenticity* of the recorded information is not that problematic when the recording and processing steps stay within the borders of the institutions. On the other hand, this kind of information is completely useless for informal analysis, regardless if it takes places on an individual or a community level, because in informal learning neither the use of a LMS as a *learning tool* or of any *learning content* is determined. The *learning goals* and *learning activities* as well as their sequencing are not fixed in informal learning processes. Challenges here are to detect the learners and the learning communities, to find out about their learning goals, the content and tools they are utilizing and the learning activities they perform. In professional communities the learning goals of the learners may be more short-term and more dynamic than in learning institutions where the goals are often fixed in the curricula. Also, the nature of learning materials and tools may differ significantly, since for many CoP no canonical training materials or LMS are available. CoP may follow stereotypical patterns, which may be used as guidelines when recording the information [6] but in many cases, the information to be recorded has to be analyzed in any particular case, e.g. for identifying *self-regulated learning processes* in social software [7]. At present, the most prominent solution to an unbiased processing of LA data seems to be the recording of low level activities, e.g. interactions of learners or learning tools via HTTP. However, HTTP-based analysis is limited to learner-tool or learner-resource interaction. To record learner-learner interactions, the records of more advanced Internet protocols like XMPP [8] records are needed. However, with such low level recording no meaningful learning activities or learning processes can be traced. Therefore, the aggregation of such information is needed. Learner-learner interactions can be reconstructed again by the application of **social network analysis (SNA)**, e.g. by assuming that digital traces of interactions in a forum software can be traced as the interaction between members of a community.

However, the ubiquitous use of SNA in organizations has also started only very recently [9], in particular in the context of open innovation [10]. Social capital is a measure for the reputation in a community but also for the strategic position of a member in a community. The notion of social capital can be connected to the social network [11]. Methods of measuring social capital on basis of SNA are therefore ideally suited to assess the social capital for learning processes [12]. The idea of SNA enabled CLA has been introduced by [13] and successfully applied in large European teacher communities [1]. Additionally, a lot of DM techniques as sentiment or opinion mining, topic mining, and natural language processing techniques are important to gain results in the analysis process [14,15].

Visual Analytics (VA) [16] is facilitating the understanding of LA results in general. In the following, a number of learning dashboards have been developed similar to solutions provided by Google Analytics for Web analytics [17,18]. This concentration on EDM and visual feedback have led to a growing inventory of LA methods for formal learning. However, most of the LA methods are not directly transferable between institutions and LMS, even if data from LMS are available at least on a institutional level. VA is the most promising way to combine the cognitive capabilities of humans with the data processing means of computers in LA. Because of the underlying formal learning processes, LA is often focused on the individual learner or instructor, respectively on the learning institution. CLA should be integrated in a CIS like VA dashboards in LMS.

2.2 From Self-regulated to Community-Regulated Learning

Very heterogeneous individual informal learning processes are addressed by self-regulated learning (SRL) [19,20]. SRL is a multi-stage process where the learners plan, learn and reflect in interaction with learning resources. To support such interaction processes within a learning environment, it needs models of learners, learning resources and the learning process itself. Personal learning environments (PLE) have been built lately to support SRL [21,22]. However, LA for PLE or responsive open learning environments (ROLE) is in its infancy. We will introduce the ROLE sandbox as a LA test-bed later.

In professional communities LA is complemented by peer or CLA methods. Again, we have to distinguish between CLA for individual members and the CLA for the whole community. Community-regulated learning (CRL) [6,23] is addressing the needs of a professional community in the following ways. First, the lack of institutional rules and roles induces negotiation of roles in CoP based on reputation and expertise. Since expertise and roles are highly dynamic and complex concepts in CoP, peer assessment is an ongoing process in the CoP which needs to be supported by the CIS. Second, recommendations are not limited to learning goals, resources, activities and tools but also include *learning peers* on the community level. For learners outside a community, learning communities can be recommended. Therefore, we need to identify experts in a community. CLA is not only concerned with identifying the expertise of community members as an indicator of learning progress but also to determine the expertise of a whole community to make it comparable to others. **Expert identification** [14] and **expert recommender algorithms** [24] have been researched in the last years, in particular in the context of collaborative work over the Web [25,26]. Experts are recognized as peer instructors in CoP since they are assumed to have an advanced knowledge about the practice. It is extremely important, e.g. for learning recommender services [27], to identify the experts and the novices in a CoP as well as to distinguish them from each other. Novices may need access to different services than experts. Within the CoP, there is an ongoing process of experts assigning themselves, e.g. as mentors for novices. Also, novices may seek for experts in the CoP to learn from them. Since CoP are using social software and are in a constant flux, these processes should be supported by the social software. Many recommender algorithms have been successfully deployed in CIS. However, as CoP are transforming their practices into social software to increase their agency, the knowledge of the established practice and the knowledge of digital media are falling apart in many cases. Therefore, expertise has become a multi-faceted property in communities. This has led to an increased need for communication among different experts in the CoP and to a much more differentiated view on expertise in CoP. Roles in the community-regulated learning process are not static but dynamic, not institutionally fixed, but negotiated within the community or earned by peer assessment. As a consequence, expertise has to be mined constantly by a CIS as it may change for the members of the CoP as well as for the community as a whole. Moreover, we want to assign an expert value to a whole community, again for recommending learning communities to individual learners. Here, the problem is that on the Web there may be a lot of communities which seem to be appropriate for a learning goal stated by the learner. In comparison to search engines, the ranking of communities for the learner may be as important as the identification of the CoP [28]. Finding expertise in CoP is therefore a problem related to (overlapping) community detection [29,30]. **Overlapping Community Detection Algorithms (OCDA)** are key to expertise recommender systems, since they use methods of SNA which are able to distinguish between the core and the periphery of the community as well as to handle the overlapping roles of expertise. Since the actual number of communities, e.g. on social network platforms like facebook and google+ is very large, machine learning algorithms have to be combined with OCDA for automatic classification of community expertise.

A threat in CoP using CIS is the vulnerability of social software against attacks. These attacks try to compromise expertise in different ways. Since attackers know the value of expertise for a CoP, they can try to get the desired expertise level by knowing details of the SNA methods, e.g. they can create fake accounts which are referring to each other to increase the reputation among faked experts. These attacks are commonly called *Sybil attacks*. Consequently, more **robust** expert identification and expert recommender algorithms are needed [31].

2.3 Mobile Community Learning Analytics

Due to the widespread availability of mobile devices and trends like urbanization the use of mobile devices for learning has also increased. While mobile learning is a very active research area, a visit in a typical mobile app store is sobering. This has been addressed by micro-learning research [32]. In most educational systems the length of courses and classes is comparable and prescribes a certain rhythm for the learning process of the formal learner. Even in a LMS the learner is expected to work on course units with an attention span comparable to class hours. In mobile learning situations this rhythm is different and extremely context-dependent. In an almost classic learning situation while commuting, there is a certain rhythm given by the commuting schedule but, here the external context may change drastically, e.g. by the kind and number of fellow passengers. What is the pedagogy of context-aware mobile learning and how to support mobile LA here?

Similar to the learner attention drilled to the class or course length, learning content is produced for standardized course duration. Mobile learning content is different [33]. Mobile standard descriptions of learning materials are not existing yet and the available standards for content description are not applicable. Even more, LA regardless for individual or communities is limited to non-mobile LMS. Data gathering from the plethora of available apps is inherently complex and costly. However, if such learning tools are exchanging information, based on standardized and scaling protocols like HTTP, e.g. using Web services, the situation may improve. Since there are no available solutions, approaches from community analytics may be adapted to CLA. We will introduce also a test-bed for mobile applications later. Before doing this, we present an use case from ongoing project about informal mobile learning in professional communities, the Learning Layers Project.

3 Community Learning Analytics for Mobile Informal Learning

In the Learning Layers Project (Scaling up Technologies for Informal Learning in SME Clusters) the goal is to develop informal learning support for workplaces in particular in small and medium sized companies (SME). All challenges mentioned above are essentially scaling challenges, i.e. there may be solutions available which work for a distinct learning management system (LMS) or in a certain context. It would be not fair to totally ignore all these approaches. However, such solutions have been not successful to address a large number of communities, yet. Scaling here is connected to the idea of clusters [34] and the assumption that clusters can be traced back to substructures in complex networks [35]. The idea is that those SMEs belong to a cluster and that inter-organizational clustering facilitates network effects like we know from complex networks.

One important use case for CLA is the *peer production and semantic annotation of video materials* in the construction industry. Although the use of mobile camera technologies is still limited on construction sites, there is an emerging practice among the craftsmen and engineers to produce, share and annotate video materials, e.g. when an urgent problem must be solved and involved people are not available on the site. However, after the problem solving phase is over, these materials are often discarded or not used for learning purposes, e.g. they are hard to find again because they have not been stored for later use. Annotations, in particular semantic annotations, may be useful to find such digital materials again. Moreover, the annotations can be used as input for community detection algorithms, i.e. to identify common practices, or even as input for recommender systems, e.g. recommending learning materials or for *scaffolding* learning processes. The experts within a CoP can be identified by analyzing their annotation and sharing practices. SNA measures will identify their social capital in the community. CLA will determine the expertise levels of different CoP in the same area and making transfer of practices from more experienced CoP to less experienced CoP possible, thus using the idea of scaling and clustering. Again, dynamic SNA and OCDA can help facilitating such CLA processes. Since the Learning Layers project is still in its initial phase, we present in the following some results from recently finished projects which can be utilized for addressing the CLA challenges in general and the challenges of the Learning Layers project in particular.

The **ROLE Sandbox** (`http://www.role-sandbox.eu`) is a hosting environment for PLEs which has been recently demonstrated to enable such CLA processes [36]. While the ROLE Sandbox is collecting traces from PLE, learner-learner interactions are based on the careful analysis of digital traces in communities. Data management, privacy and aggregation of data from the individual level to the community level are major challenges here.

Unlike in a hosting environment, such as the ROLE Sandbox, communities use a plethora of learning tools which are not storing information in a single repository. In the case, that Web-based tools are used for learning we can get access to server logs in an ideal case. Normally, we get access only to digital traces left in social software. A **MediaBase** [13] is a post-mortem collection of social software artifacts from an ecosystem of Web-based learning tools. The artifacts are collected from blogs, wikis, mail, forums and other media over a long time with parametric scripts. They are stored in relational databases for further processing with data warehousing techniques and analytic procedures. Since a MediaBase has a fixed data model which is based only on communities with their members and artifacts stored on digital media, the processing allows cross-community as well as cross-media analytics. Therefore, a MediaBase overcomes the statistical problems occurring from small numbers and also scales from the individual to the community. Combining test-beds and port-mortem CLA would allow to handle arbitrary collections of learning tools within CoPs.

MobSOS ([37]) is a model and a scaling test-bed for mobile community success based on the Success Model from DeLone and McLean [38] enhanced for mobile communities. One fundamental idea of the success model is the combination of quantitative and qualitative factors determining the success of a CIS. The MobSOS test-bed implements this idea for mobile applications by allowing the targeted creation and utilization of qualitative research tools as a service [39]. Designers of mobile services can make use of the MobSOS test-bed to design and implement surveys together with the orchestration of services for direct interaction with users or in our case learners. Since the system is not addressing learning activities or learning resources yet, this is an open research challenge. But, the possibility to include the mobile context of learners is giving a competitive advantage over traditional LA solutions in LMS.

The **SeViAnno** video annotation platform [40] is integrating the previous solutions for CLA purposes. Currently it is evaluated within the Learning Layers project in different scenarios for its usefulness in the use cases.

4 Conclusions and Outlook

In this paper, two of the most important learning theories, communities of practice and self-regulated learning have been combined to a community-regulated learning approach. The consequences for LA have been sketched. In particular, latest development in algorithm design for community detection and related data mining tasks have been analyzed for their usefulness in leveraging LA information to CLA. Some challenges involved and first attempts to address those challenges have been shortly explained. Due to the space restrictions only some pointers to further reading have been given. In table 1 a summary of the main distinctions between LA and CLA are characterized according to the concepts of learning environments, learning tools, learning activities, and learning goals. Additionally, two different use cases were sketched. An ongoing research project on scaling informal learning by the idea of clustering and an example of semantic video annotation as an emerging collaborative learning practice have been introduced.

Table 1. Main Differences between Learning Analytics and Community Learning Analytics

âĂć	**Formal Learning**	**Learning Analytics**	**Community-regulated Learning**	**Community Learning Analytics**
Environment	LMS	EDM/VA	CIS/ROLE	DM/VA/SNA/ Role Mining
Tools	Fixed	LMS Specific	Ecosystem	Tool Recommender
Activities	Fixed	Content Recommender	Dynamic	Content Recommender/ Expert Recommender
Goals	Fixed	Progress	Dynamic	Progress / Goal Mining / Refinement
Communities	Fixed	Not applicable	Dynamic	(Overlapping) Community Detection
Use Cases	Courses	Learning Paths	Peer Production/Scaffolding	Semantic Networks of Learners / Annotations

In future work, we will design and implement a series of mobile learning tools utilizing the underlying infrastructure of CLA by allowing direct visual feedback and by scaffolding learning processes, e.g. by recommender technologies.

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Harnessing the Potential of Accessibility Standards and Responsive Web Design Practices to Achieve Learning Interoperability on the Level of the User Interface

Mohammad AL-Smadi and Vladimir Tomberg

Institute of Informatics, Tallinn University, Estonia
{Msmadi,vtomberg}@tlu.ee

Abstract. The emergence of information and communication technologies (ICT) and web 2.0 has fostered the domain of learning platforms with a variety of learning tools. As a result, many open-source and commercial learning management systems (LMS) were developed. The variety of platforms and approaches provided by these LMSs makes it difficult to deliver learning content to end users in a consistent manner. Learning tools interoperability, content reusability, learner's information accessibility and share ability are main matters of quality for any LMS. However, learning interoperability standards lack to some extent common semantics on the level of the user interface. This paper discusses this problem in more details and proposes an enhanced approach based on semantics, accessibility standards, and responsive web design practices.

Keywords: Interoperability, Accessibility, WAI ARIA, User Interface, Responsive Web Design.

1 Introduction

Different learning standards and specifications have been developed to design and develop e-learning content and components. Shepherd [1] argues that conforming to standards during the design and development of e-learning tools may foster them with the following abilities: (a) *Durability:* no need for further redesigns or redevelopments even with new versions of the system, (b) *Scalability:* can it grow from small to large?, (c) *Affordability:* is it affordable?, (d) *Interoperability:* are information and services sharable with other systems?, (e) *Reusability:* can it be used within multiple contexts?, (f) *Manageability:* is it manageable?, and (g) *Accessibility*: are the contents accessible and deliverable from anywhere and anytime?.

Interoperability has been always a challenge for e-learning software designers and developers. LMSs have been designed as centralized environments where educational activities are organized and provided to students. Nevertheless, the variance of e-learning application domains has increased the limitation of LMSs to cover those different application domains. For instance, higher education universities and institu-

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tions provide a variety of disciplines where students are required to learn and interact with contents, perform experiments, and collaborate with other students. Therefore, more activity-specific or application-domain specific tools have been developed. As a result, a variety of educational and learning tools and content are available as standalone, apart from the centralized LMSs. This has caused people in the domain to think how to reuse and share content among those tools, how to integrate those tools within the centralized LMSs in a way to extend the LMS services by third-party tools and services. As a result, interoperability has been decided to be a major requirement for any e-learning content, tool, service, or LMSs [2].

This paper discusses the problem of interoperability at the user interface level. It sheds the light of some limitations in the field of learning interoperability and proposes an approach of how to achieve learning interoperability in general and on user interfaces in particular as an emerging problem. Therefore, we propose a comprehensive framework for designing and developing interoperable learning tools that are not only reusable and sharable but also have a consistent behaviour on rendering media.

The rest of this paper is organized as follows: Section 2 explores learning interoperability in general and sheds the light on the problem of interoperability at the UI level – i.e. presentation interoperability. Section 3 proposes a comprehensive framework for designing and developing interoperable learning tools. Section 4 proposes the use of an accessibility initiative to foster semantics provision on the UI level in order to deliver standard-conform content in a consistent way, whereas Section 5 provides the overview of the Responsive Web Design as a promising approach to tailor the provision and delivery of learning content and tools to device type and specifications. Section 6 discusses the arguments behind this research paper and sheds the light on some limitations in the learning interoperability field.

2 Interoperability in Web-Based Learning

Several definitions have been provided to the term interoperability. The Oxford English Dictionary defines the word "interoperable" as "(of computer systems or software) able to exchange and make use of information". The IEEE defines interoperability as "the ability of two or more systems or components to exchange information and to use the information that has been exchanged". Taking into consideration the integration point of view, Merriman [3] defines interoperability as "the measure of ease of integration between two systems or software components to achieve a functional goal. A highly interoperable integration is one that can be easily achieved by the individual who requires the result". Merriman discussed the aforementioned two definitions and argued that both of them do not consider integration. Moreover, Merriman stresses on the level of integration achievement as a main measure for interoperability. Based on that interoperability is not only the ability of sharing information, rather than it goes deeper to cover the ability of sharing functions and services in flexible way of integration. Bull and McKenna [4] argue that "interoperability describes the capacity for different systems to share information and services such that two or more networks can communicate with each other to exchange data in a common file format". Similar to Bull and McKenna definition, Crisp [5] defines interoperability as "the ability of a system, content or activity to be exchanged or used in a variety of situations with the confidence that it will function in a predictable manner. Interoperability allows efficient use of resources and avoids the necessity to design a system, content or activity de novo for every context".

Based on these definitions interoperability can occur on three main levels [2], [6] of information (content, user data) level, workflow (learning and information workflow) level and on tools level (tools interoperability) as follows:

- Content and Information interoperability: has been a major research area for years. Several specifications and standards have been published. For content examples are IEEE Learning Object Metadata (LOM), IMS Meta-data, SCORM, and IMS Content Packaging. For learner information examples are IMS LIP (Learner Information Package) and PAPI Learner (Public and Private Information).
- Learning Workflow Interoperability: refers to the automation of the provision of learning activities controlled by a set of rules that define the pre-requisite, sequence, and consequence of each learning activity. Learning workflow – which is object of learning design – is known to the educational community through two main initiatives, the IMS Global Learning Consortium (GLC) Learning Design (LD)[1] and the Learning Activity Management System (LAMS)[2].
- Tools interoperability: is an emerging research where limited examples of specifications are available. Among these specifications we can mention the Open Knowledge Initiatives (OKI)[3] and its Open Service Interface Definition (OSID), and CopperCore Service Integration (CCSI) [7]. A more recent and promising research is the IMS Learning Tools Interoperability[4] specifications by which tools and LMSs are provided by guidelines of how they can be designed to flexibly be integrated with each other.

According to Haag [8], providing standard-conform learning content is not enough to make the content interoperable. The authors argue that launching the learning content on the end-user devices causes different behaviors based on the properties of the device and the web browser specifications such as width, height of the browser window, resizing, and area of launching within the browser [9]. Moreover, learning content standards lack standardized end-user players, which make it not applicable on different devices such as Mobile devices. For instance, some learning content players utilize browser applets such as Java Applets, Silverlight, or Flash interfaces to represent content to the end-user. However, some mobile devices or even web browsers lack support of these applets. This problem can be referred to as presentation interoperability and applies to the user interface (UI).

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[1] http://www.imsglobal.org/learningdesign/

[2] http://www.lamsinternational.com/

[3] http://www.okiproject.org

[4] http://www.imsglobal.org/lti/

3 Proposal for Interoperability Framework

In Fig. 1 we propose a conceptual map which shows several concepts related to learning interoperability. As depicted in the concept map, we propose that achieving learning interoperability on the abstract level requires the following:

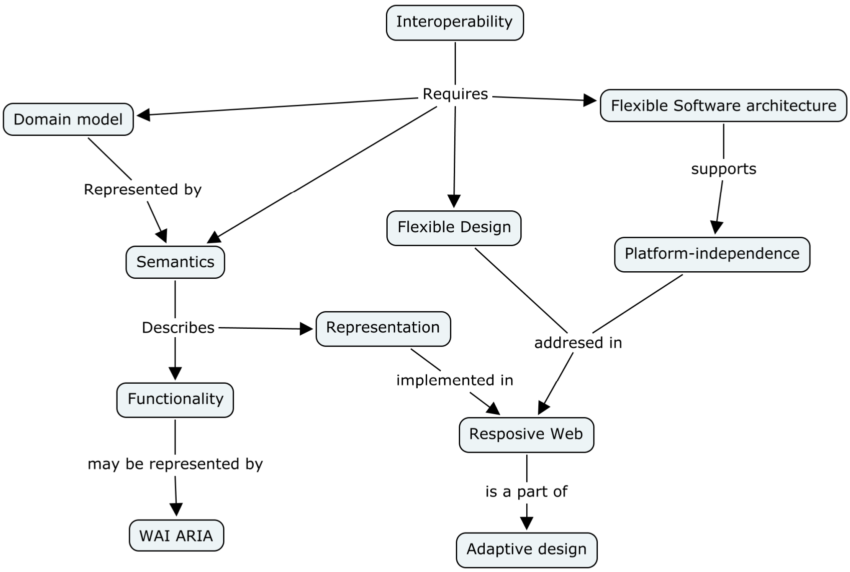

Fig. 1. Conceptual Map illustrates main concepts of learning interoperability in general and interoperability at the level of the UI in particular

1. Common understanding through which learning content, tools, and services are provided based on a shared description of the functionalities and dependencies [10]. For this, we propose first modeling the *application domain* and representing the relations within it in terms of *semantics*.
2. Provided learning content, tools and services based on the common understanding requires *flexible software architectures* that facilitate platform independent delivery [2].
3. *Adaptive and flexible design* of front-end, learning content, tools, and services through which different devices can be supported and consistent learning delivery can be achieved.
4. In addition to learning content and information specifications, learning design specifications, and learning tools interoperability specifications we propose a layer of accessibility specifications enriched with semantics on the *presentation* level.
5. Embedding standard-conform technologies – e.g. accessibility specifications enriched with semantics - into UI design is useful to achieve consistent presentation of elements and to maintain consistent behavior of content at the UI level. Moreover, we recommend the adoption of good practices such as *Adaptive Design* and *Responsive Web Design* for designing interoperable UIs for learning tools.

Regarding the first two points, different learning content standards have emerged – as discussed before – and they are widely adopted in LMSs. Additionally; Learning solutions based on service-oriented architecture (SOA) have attracted research community in the last years. The SOA paradigm aims at providing distributed systems with high transparency with respect to platform and the communication heterogeneity.

A major problem with the services is that their technical interfaces definition lacks semantics of the service and information on non-functional features. For instance, aspects related to performance and dependability only covered by the programmer documentation and this is represented by natural language. Using natural language may lead to misunderstanding and thus facing problems in services development and deployment. There is a clear requirement in specifying the semantics for the services. A promising solution is to use an ontology-based description. Ontologies provide a standardized way to share terminologies and concepts as well as their relationships. Thus, ontologies can be used to explain specific concepts used in the description of the service. The Semantic Markup for Web Services (OWL-S[5]) is an example of ontology-based language to describe web services. The OWL-S - which based on Ontology Web Language (OWL) - consists of three main parts: (i) the service *profile* for registering and discovering services, (ii) the *process model*, which gives a detailed description of a service's operation, and (iii) the *grounding*, which provides details on how to interoperate with a service using messages.

Despite the variety in learning standards and specifications and the richness in related research, learning tools developers are still facing the challenge of providing learning tools and content to be presented with consistent behaviour and representation at the end-user devices. Therefore, we propose using accessibility specifications enriched with semantics to represent the content on the end-user interfaces and utilizing practices form Adaptive Design and Responsive Web Design (RWD) as a useful way to adapt an existing content to different rendering media – see points 3, 4, and 5.

Fig. 2 represents our proposal of a layered and comprehensive framework for learning interoperability. The framework summarizes our understanding of the learning interoperability problem and focuses on the presentation interoperability problem of how to deliver learning content and tools that behave consistently at the UI level. Two dimensions are highlighted in the framework, the interoperability levels and their available or possible specifications and standards.

In this interoperability framework, we have placed the presentation layer on top of the application domain, content, workflow, and tools & services layers. We believe that achieving interoperability at the UI level requires a common understanding of the application domain which is represented with common terminology and well-defined semantics. This understanding is then mapped into required learning content, tools and services which are delivered based on a clear workflow. During the design of these learning content and tools the user should be the main focus and an adaptive design approach should be followed.

[5] `http://www.w3.org/Submission/OWL-S`

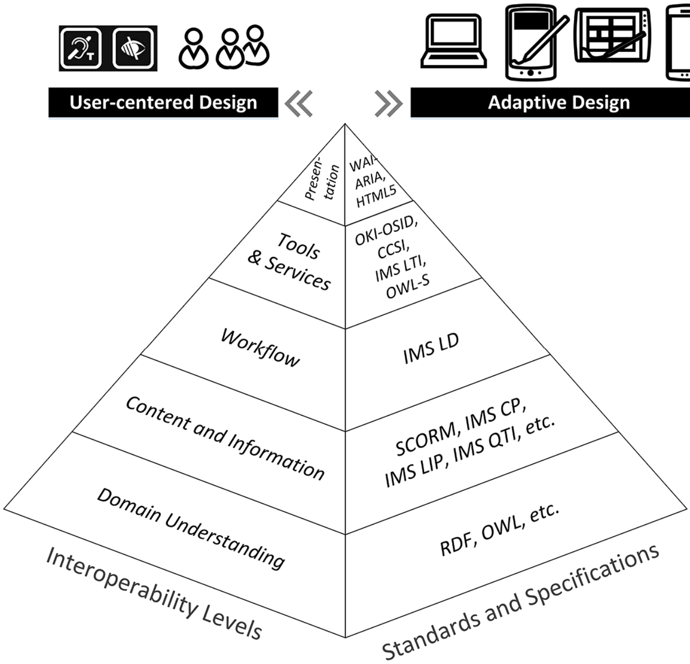

Fig. 2. Layered learning interoperability framework with focus on presentation interoperability

By focusing on the presentation interoperability layer, we recommend using a user-centered and adaptive design. Moreover, we propose providing semantics for UI by using WAI-ARIA specification. The next sections explain in more details the accessibility specifications WAI ARIA (Web Accessibility Initiative - Accessible Rich Internet Applications) as promising accessibility specifications with semantics and the RWD approach as possible solutions to achieve learning interoperability at the UI level.

4 Supporting Semantics for Web User Interface

HTML5 proposes a semantic-level markup language and associated semantic-level scripting APIs for authoring accessible pages on the web ranging from static documents to dynamic applications [11]. There are many new tags that can be treated as ones that describe of a user interface, like <nav>, <footer>, or <audio> and <video>.

By producing rich web applications developers often use JavaScript to create unique user interface elements, which are not accessible by software that uses screen-reading technologies. To overcome this and many other limitations W3C's Web Accessibility Initiative (WAI) introduced in 2006 WAI ARIA specification.

WAI ARIA is intended to improve as the accessibility, as well as the interoperability of web content and applications. It provides ontology for roles, states, and properties that define accessible user interface elements and can be used to improve the accessibility and interoperability of web content and applications. The vocabulary is designed to allow authors to properly convey user interface behaviors and structural information to assistive technologies in document-level markup [12].

There are still many issues around the ways, how user agents can join WAI ARIA and HTML5 together [11]. There are also some claims that all accessibility issues should be solved using clean HTML5 code only [13]. Advocates of retention semantics on the layer of HTML also argue that semantics are universal and intended not only for disabled people who can access it with accessible technologies, but also for everyone. Therefore, they said, semantics must be expressed at the presentation layer (in HTML) [14]. However quick look into a list of ARIA roles and properties that are not available in HTML5 [15] can show that WAI ARIA proposes a high diversity of terms. This leads to an issue of parallel use of HTML5 and WAI ARIA tags with the similar functionality. Obviously in case where the browser supports an HTML5 tag that also exists in ARIA, the ARIA roles and states can be omitted. However, they can be used when HTML5 has no similar roles, states, and properties. The instructions for using WAI ARIA in HTML are provided by W3C[6].

The fact that WAI ARIA still has a draft status means that any document with WAI ARIA markup will be considered by HTML validation service as not valid. However, this is true also for many emergent W3C technologies including HTML5 itself. In fact, the main prerequisite for success of a new web technology depends to a level of supporting that technology by web browsers. The situation with supporting WAI ARIA by most popular web browser is constantly monitored and it shows continual improvement. For April 2013 42.35% of popular browsers for desktop and mobile devices fully supported WAI ARIA, while 47.51% of the browsers support WAI ARIA partially [16].

Today the accessible technologies are considered not as technologies for disabled people only. Improvement of the data accessibility is aimed to have a positive effect for all groups of information consumers. By following the universal design definition "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" [17] we consider the WAI ARIA properties as potentially useful for much wider audience than disabled people. The prominent property of WAI ARIA is added semantics for description user interfaces. Describing plenty of user interface elements and properties this technology is on the one side universal, and on the other side it is adapted for the web — the most popular media today. The WAI ARIA vocabulary can bring a new level of interoperability on the level of the user interface, which can break down not only the barriers related to the disabled people, but also overcome the limits of hardware and software platforms.

5 Best Practices in Responsive Web Design

The first mobile applications at the end of 90s had very limited web browsing functionalities. Users had to work with one-color textual displays that were barely able to fit a couple of words into one row. At that time besides limitations of the

[6] https://dvcs.w3.org/hg/aria-unofficial/raw-file/tip/index.html

hardware, an amount of bandwidth provided by mobile operators was also limited. A compact two-byte monochrome file format for graphics WBMP was introduced to avoid excessive consumption of traffic. Using dedicated formats like WBMP and protocols for the mobile platform like Wireless Access Protocol led to appearance of separate versions of web sites for the mobile devices, which usually represented a limited subset of data existing in the desktop version of website (Fig. 3). By designing separate versions of websites, developers usually used different media, formats and ways for navigation for each target platform. Some of them used a summarization approach [18] [19], where only part of the original HTML was displayed in WAP browser, other proposed separate dedicated design of content for different media [20].

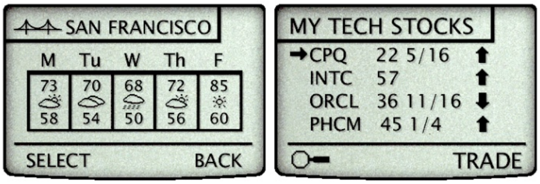

Fig. 3. Screens of the textual WAP browsers (Image courtesy of Openwave Systems Inc.)

Even later, when the speed capabilities of mobile operators, processing power, amount of colors and screen resolutions of mobile devices were increased, the tendency of making a separate mobile version of websites was preserved. Even by switching from WML to HTML and XHTML developers continued to implement specially tailored mobile versions that were different to their desktop siblings (Fig. 4). The important reason for that were limited possibilities of the mobile browsers to interact with the content designed for desktop.

a) b)

Fig. 4. Separate desktop (a) and mobile (b) versions of a web site in the mobile browser [21]

With the introduction of iPhone mobile device at 2007, Apple initiated a market for browsing web content using dedicated small web applications. For each application the developers provided its own user interface. The approach proposed by Apple increased a gap between mobile and desktop versions for the same web content.

While previous mobile web pages were still accessible from the desktop applications, iPhone applications were platform-dependent and provided in their own ecosystem.

In 2010, Apple introduced the tablet computer (tablet PC) iPad, which quickly became very popular. By using similar ways of interaction to mobile devices of stylus and fingers, tablet PCs at the same time had a display with much higher resolution, which was more preferable than screen resolution of desktops. Growing diversity of screen sizes and different hardware characteristics made parallel development of several versions of websites labor-intensive and expensive. Developers started to look for other solutions. The solution was close to them as part of their daily web developments, several products based on CSS and JavaScript technologies like *flexible images*, *media queries* and *fluid grids* were extensively used already in web design practices. Combined use of these technologies with the aim to adapt an existing content to different screen resolutions was labeled as Responsive Web Design (RWD). RWD was at first time defined by Ethan Marcotte [22]:

> *Rather than tailoring disconnected designs to each of an ever-increasing number of web devices, we can treat them as facets of the same experience. We can design for an optimal viewing experience, but embed standards-based technologies into our designs to make them not only more flexible, but more adaptive to the media that renders them.*

The mechanism of responsive web design is simple; by using a special typographic grid a fluid layout is filled in with content in different ways for different screen resolutions [23]. For each layout, the designer creates a specific set of CSS rules. These sets can be called using media queries, which can distinguish between different types of media (screen, print), sizes, orientation, aspect ratio, color capabilities etc. [24]. The fluid layout is enhanced with using flexible images, which instead of having fixed size can scale within a containing element. Using this set of techniques one can adapt the same web content to different platforms. There is no more need to prepare a separate content, or think about special conversion for each possible platform. Responsive design ensures content uniqueness and integrity and makes it accessible for different platforms.

The ideas of responsive design were extended by Gustafson [25], who proposed to extend this approach and labeled it as adaptive design. Gustafson proposed to use in designing web pages *progressive enhancement* instead of *adaptive degradation*. This means that the designer should start from the mobile version of website and by extending it with a new content and features gradually move to the most reach, desktop version (Fig. 5).

In adaptive design, not only format and visualization of content can be changed, but also some part of content can be hidden in the smaller versions of screens. This approach changes the way that information architects use to think about content. Being labeled as *"Mobile first"*, this approach emphasizes at the early phases of design the most prominent parts of web pages allowing them to be included into mobile versions of websites.

Fig. 5. Adaptive versions of TIME website for screen resolutions of mobile, small and big tablet PCs, and desktop

6 Discussion

Dagger et al. [26] discuss the evolution of e-learning platforms and they distinguish between three main generations. The first generation is stand-alone monolithic systems for specific learning activities with support of content-only inter-operation. The second generation builds on web-based modular systems with more interest on users and their associated profiles. Whereas, the third generation highly depends on service-oriented architectures (SOA) through which federated exchange of information and control, various levels of interoperability (intra-domain and inter-domain), and service composition (orchestration and choreography) have been considered. Nevertheless, the third generation is more directed towards having interoperable learning services and tools within more personalized and adaptive e-learning platforms. However, as discussed earlier in this paper providing standard-conform learning content is not enough to achieve interoperability. Moreover, nor flexible software architectures neither standard-conform learning content is enough to achieve interoperability at the UI level.

Achieving learning interoperability in general requires the learning services to exchange semantic representation of learning domain in addition to standard-conform learning content and services [10]. Nevertheless, focusing on learning interoperability on the level of the UI, in addition to having standard-conform learning content and tools, common understanding of the application domain represented as domain model with well-defined semantics, flexible software architectures, and a flexible approach to deliver consistent and compatible learning content and services are required – see Fig. 2. Therefore, we propose representing the functionalities behind the standard-conform learning content using accessibility specifications enriched with semantics and adopting good design practices that embeds standard-conform technologies into the designs.

As depicted in Fig. 2. Achieving presentation interoperability at the UI level requires the standard-conform content and tools to be delivered based on well-defined semantics that describes UI elements and their interrelations and behavior. As an example of a promising technology that embeds semantics to UI design is the WAI ARIA accessibility initiatives. WAI ARIA accessibility initiatives aim at improving the accessibility, as well as the interoperability of web content and applications.

It provides an ontological approach of representing UI semantics – i.e. roles, states, and properties - that define accessible user interface elements. These semantics enable an author to properly convey user interface behaviors and structural information to assistive technologies in document-level markup [12].

In order to provide adaptive delivery of content tailored towards different devices, we propose using the responsive web design approach and to design content for mobiles first and progressively extend the design for other devices such as tablet PCs and desktop. Responsive web design ensures content uniqueness and integrity and makes it accessible for different platforms. Therefore, delivered learning content and tools will eventually comply with different devices and properly and consistently behave on varied platforms.

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Exploring the Effectiveness of Adopting the ASR-Based System to Facilitate Adults' English Speaking Proficiency

Yi-Hsuan Wang and Shelley Shwu-Ching Young

Institute of Information Systems and Applications,
National TsingHua University, Taiwan, R.O.C.
annywang12345@hotmail.com, scy@mx.nthu.edu.tw

Abstract. The study constructs and evaluates an automatic speech recognition (ASR)-based system with multiple levels of corrective feedback to support adult learners with opportunities of practicing English speaking with immediate diagnosis. The corrective feedback includes three levels: the first level shows the learner's pronunciation score and audio waveform, the second level provides learners with a comment, a list of words that are pronounced accurately and inaccurately, and an audio toolbar for replaying the learner's utterance, and the third level shows a demonstration of the accurate utterances with both full sentence and single-word form at normal and slow speed. A total of 38 adults from Taiwan participated in this experiment, divided into an experimental and a control group. The control group practiced English speaking using the single-level-feedback system while the experimental group was given the three-level-feedback system. The results of the study indicate that the ASR-based system serves as a helpful tool for Taiwanese learners and the learners were satisfied with the system for self-paced learning. Besides, the learners in the experimental group with three-level feedback made significant progress in English speaking. Some research issues and suggestions are also presented for future reference.

Keywords: Automatic speech recognition system, English speaking, Adults.

1 Introduction

The automatic speech recognition (ASR) based CALL systems provide learners with an integrated environment in which they obtain immediate evaluation of their English utterances, and allow them to practice at any time to enhance their speaking (Chiu, Liou, & Yeh, 2007; Chen, 2011). However, many issues in the feedback design of ASR-based CALL programs require further research. In this study, the researchers formed an interdisciplinary research team, and constructed an intelligent computer-assisted speaking learning system in which the ASR web-service technique and pedagogical corrective feedback are integrated to provide learners, especially adults who are not English majors and have less chance to keep learning English after graduating

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from school, with extended opportunities for practicing English speaking. The research questions of this study are as follows:

1. How do the adult learners perceive the system embedded with ASR technology for English speaking?
2. Can the designed three-level feedback in the system promote learning effectiveness than the waveform feedback?

2 Literature Review

The advanced CALL systems that involve the application of state-of-the-art computing technology such as natural language processing (NLP), artificial intelligence (AI), and automatic speech recognition technology (ASR) for language learning are referred to as intelligent computer assisted language learning (ICALL). The ASR-based iCALL systems have been attracting an increasing amount of interest from researchers and English instructors alike (Hincks, 2002; Chen & Chiu, 2005). The timely speaking evaluation of learners' utterances is especially beneficial for acquiring listening and oral skills. On the other hand, the importance of providing learners with corrective feedback according to their learning performance rather than only giving them learning opportunities while using a CALL system for speaking learning has been recognized by several studies (Precoda, Halverson, & Franco, 2000; Chen, 2011). The system designers and teachers should consider pedagogical purposes and students' responses to various types of feedback while designing language feedback, and help them improve through self-repairing their language errors with an integration of both explicit and implicit feedback. Some studies had explored the usability of integrating different approaches into designing feedback, and it suggested that digital waveforms or short feedback have not proved to be effective tools in helping learners recognize their pronunciation errors, and the specific feedback on their utterances to improve their speaking errors such as more pictures, videos and games could be added into the program to attract learners and facilitate learning (Neri, Micha, Gerosaa, & Giuliani, 2008; Chen,2011).

3 The Developed System

Based on the reviewed literature, we summarize a general ASR-based CALL model (Figure 1a) and then propose the system integrating ASR techniques and multiple levels of corrective feedback for English speaking (Figure 1b). The system could be regarded as a web-based speaking learning management system that assists learners in arranging their English study progress and trace their speaking performance. The motivation for proposing the system is to provide Taiwanese learners, especially those who have already graduated from formal education, with flexible opportunities to practice speaking English at home. Furthermore, we aimed to explore the effectiveness of the corrective feedback in the system for addressing the actual needs of learners in Taiwan. The system applied a self-developed speech application programming interface (API) for speaking evaluation. The API adopts the Carnegie Mellon University (CMU) machine-readable pronunciation dictionary for mapping from words to their pronunciation in the given phoneme sets. A statistical process (Hidden Markov Model) graduates the textual code according to the factors of tone, speed, volume and timbre (Chen, Lo, & Jang; 2004), and the API generates a score and feedback based on the statistical results. The researchers designed the corrective feedback of the system as three levels. The first level focuses on providing implicit feedback, showing the learner's pronunciation score and audio waveform. At the second level, which aims to provide explicit feedback, there is a comment, an emoticon (a smiley face or crying face depending on the score), a list of words that are pronounced accurately and inaccurately, and an audio toolbar for replaying the learner's utterance. At the third level, demonstration of the accurate utterances with both full sentence and single-word form at normal and slow speed are available. The slow button is particularly useful for pronouncing multi-syllabic vocabulary (Engwall, Balter, Oster, & Kjellstrom, 2006).

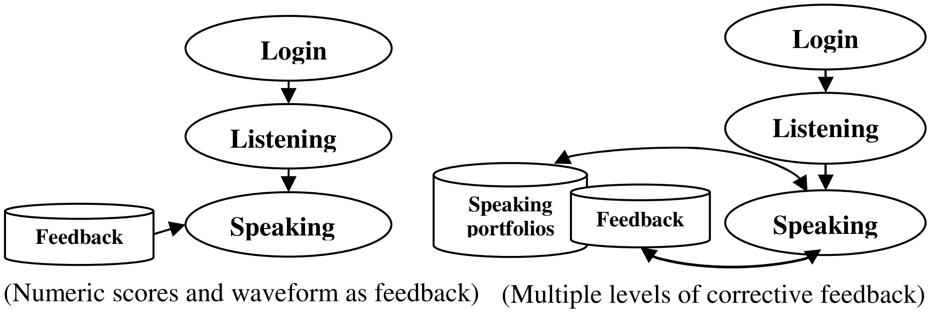

Fig. 1. A general ASR-based CALL model and iCALS system model

4 Methodology

The study uses comparative test data and empirical experiments to report on the performance of learning English in the iCASL system with different levels of learning feedback. The control group practiced English speaking using the single-level-feedback system in which only a waveform diagram was presented as feedback to evaluate the learners' speaking, while the experimental group was given the three-level-feedback iCASL system integrating implicit and explicit elements in the feedback presentation. The multiple-choice pre-test and post-test, and speaking pre-test and post-test were collected, and an independent samples t-test was applied for statistical analysis. The multiple-choice pre-test and post-test consisted of five multiple-choice questions for which the learners had to read the proverbs in Chinese and choose the matching English proverbs. The speaking pre-test and post-test consisted of eight proverbs where each correct utterance was awarded one hundred points, giving a total score of eight hundred. The participants had to listen to the pronunciation in the system and then repeat it. In addition, the questionnaire, based on a five-point Likert scale (from 5 to 1: strongly agree, agree, neutral, disagree, strongly disagree) were administered to the students. Furthermore, intensive observations of the learners' learning processes through system records and analysis of the raw audio data in the system were carried out for further analysis. A total of 38 adult learners from different backgrounds and aged from 23 to 40 were invited to participate in the study. They were divided into two groups (Table 2). The experimental group consisted of 18 learners and the control group consisted of the other 20 learners. The duration of the data collection was eight weeks, and the participants were encouraged to arrange their schedule to practice English speaking using the system at least two times a week, and to complete all of the learning units.

5 Data Analysis

5.1 Participants' Feedback and Perceptions of the Use of the System

We can infer from the system login records that the participants learned English with the system during two specific time periods, from 2 to 4 o'clock in the afternoon and from 9 to 12 o'clock at night, and those who were working often used the system from 10pm to 11pm (Figure 2). The system record shows that the average number of times each learner accessed the system was about 2.5 times per week, and the average login time was from 30 to 40 minutes.

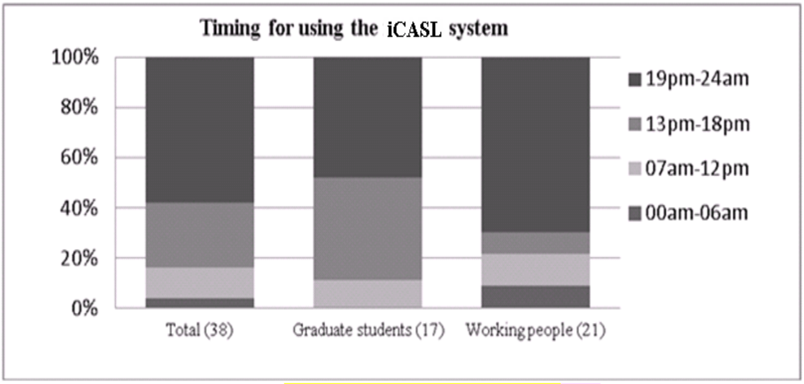

Fig. 2. System login records indicating login times

The data from the questionnaire related to the learning and operational aspect of the system shown that 72% of the learners were initially embarrassed and were afraid of making mistakes when practicing English with teachers and classmates due to their prior learning experiences. In contrast, they indicated that they felt relaxed when practicing English speaking with the system. As many as 94% of the learners reflected that the flexibility of using the system enhanced their motivation to practice English speaking. Moreover, most of them found that the system was helpful and they had positive reflections on the system operation, 72% agreed that they were more confident in speaking English after the eight weeks of on-line practice.

5.2 Evaluation of the Multi-level Feedback of the System

The data from the questionnaires regarding the learners' reflections on the multiple-level feedback were analyzed. It shows that the three-level-feedback system is helpful for improving pronunciation. One learner in the experimental group (E.G.) pointed out that she could improve her inaccurate pronunciation by reading the immediate feedback, commenting, "What a surprise that the score improved after I modified the utterances according to the system feedback!" Learners in the E.G. also claimed that they were more willing to have repeated practice with the system in order to achieve positive learning reinforcement such as the smiley face. Moreover, among the second and third level feedback given to the E.G learners, the model pronunciation of the sentence, the model pronunciation of the individual vocabulary and the audio file of learner utterances were more useful in helping the students to pronounce the target language. On the contrary, the students in the control group (C.G.) were confused about the audio waveform diagram. More than 94% reflected that they did not know how to adjust their pronunciation just by using the first-level feedback, and they suggested the need for details from the system. Besides, the results from the open-ended feedback also indicated that the learners in the C.G. had problems understanding the feedback only with numeric scores and audio waveform diagrams.

On the other hands, the average scores of the post-test were improved than the scores of the pre-test for the two groups. The researchers further compared the improvement rates between the pre-test and post-test for the two groups to understand learners' learning performance. The independent sample t-test shows that there were no significant differences in the improvement rates of the multiple-choice questions between two groups (Table 1), but, noticeably, there were significant differences in the improvement rates between the pre-test and post-test of the speaking part and the learners in the E.G. achieved better improvement rates in the speaking test than those in the C.G. This indicates that learners in both groups can read the proverbs in Chinese and choose the matching English proverbs correctly in the multiple-choice questions after eight weeks of on-line learning. However, only the learners in the E.G. achieved significant improvement rates in pronunciation with the help of the three-level feedback.

Table 1. The results of improvement rates between pre-test and post-test for the two group

(a) Improvement rates between pre-test and post-test

	Groups	Mean	S.D	F	T	P
Writing part	E.G.	57.74	64.42	3.60	1.01	0.33
	C.G.	33.90	44.84			

(b) Improvement rates between pre-test and post-test

	Groups	Mean	S.D	F	T	P
Speaking part	E.G.	10.84	7.80	0.80	2.17	0.04
	C.G.	2.56	9.88			

6 Discussion and Conclusion

The results of the study indicate that the iCASL system, based on three-level feedback principles for enhancing English speaking, jointly designed and implemented by a multi-discipline research team has received learners' positive feedback. The empirical evaluations reveal that the system could support self-paced learning, and that the learners made significant progress after several weeks of practice. The participants used their free time, during lunch or at night, to practice speaking English. Despite the fragmented time, the accumulated short periods of the informal learning opportunities made it possible for the learners to achieve great improvement in their spoken language. It serves as a helpful tool for Taiwanese learners, especially for those who have already graduated from formal education and could not afford the time to learn in fixed educational settings to achieve the goal of lifelong language learning. We conclude from the current study that the use of ASR technology in CALL programs has great potential to provide Taiwanese with more flexible learning opportunities to satisfy their learning needs.In the future, we tend to extend the uses of the system for learners of different ages to address the actual needs of learners in Taiwan. It is our aim to get students to devote their own time to lifelong English practice.

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Applying Skype in English as a Foreign Language Instruction: Effect on Students' Speaking Errors

Y.C. Yen[1], H.T. Hou[2,*], and K.E. Chang[1]

[1] National Taiwan Normal University, Taiwan
lornayen@gmail.com, kchang@ntnu.edu.tw
[2] National Taiwan University of Science and Technology, Taiwan
hthou@mail.ntust.edu.tw

Abstract. Social networking services (SNS) have gained its popularity and utility in the past years, and there is an increasing interest in using SNS as an educational tool. Skype in particular provides teachers with a suitable platform to enhance students' language abilities and it is ideal for role-playing based learning activities. Role-playing has been proved to be an effective English as a foreign language (EFL) teaching tool. This pilot study was conducted on 42 students attending an English conversation course. Students' speaking errors during a role-playing Skype-based activity were being investigated with both quantitative and qualitative analysis. The findings of this pilot study indicated that Skype in combination with role-playing activities could gradually reduce the number of speaking errors and help improve speaking skills of EFL learners.

Keywords: Social networking service, role-playing, computer-assisted language learning.

1 Introduction

A good practical environment is essential for EFL learners to improve oral communication (Yang & Chang, 2007). It has been shown that social and cultural interactions are essential for learners to develop meaningful strategies. In Taiwan, EFL learners traditionally face particular challenges in learning. It appears that speaking English in public becomes a stressful task for Asians because of their fear of being looked down upon by other peers. The lack of a proper learning environment affects opportunities for cultural exchange, language acquisition and motivation (Kormos & Csizer, 2007). Language, as a social mechanism of communication, is closely related to cultural and social dynamics of communication. Those dynamics play a key role in learning experience and create a "foreign language anxiety". Horwitz, Horwitz and Cope (1986) identified three foreign language anxiety components: communication apprehension, test anxiety and fear of negative evaluation. The test anxiety is related to cultural and academic factors, which reward test-taking ability rather than language skills. This emphasis on test-taking ability creates a negative impact through stress in

* Corresponding author.

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an English learning environment focusing on scores, result measures and peer competition. This anxiety is widely observed in Asian cultures.

Many researchers have developed different approaches to describe language error types. Lyster (1998) presented four error types, including grammatical error, lexical error (inaccurate imprecise choices of lexical items), phonological error (mis-decoding and addition of wrong elements lead to mispronunciation), and unsolicited used of L1 (errors are not related to the content). In addition, Yang (2010) divided misspellings into punctuation, typographic and dyslexic errors. Otoshi (2005) focused on five major error categories in linguistic taxonomy of grammar errors: verb errors, noun ending errors, article errors, wrong word and sentence structures. Garett (1975) and Hamrouni (2010) categorized speech errors into nine error types: deletion, anticipation, shift, exchange, stranding, substitution, blend, and accommodation errors. Therefore, to identify learners' speaking error types is crucial for further suggestions to specific teaching development.

Many technologies can be used in training foreign language speaking skills such as real-time communication tools nowadays. Indeed, Skype receives much attention as a SNS application for interpersonal communication. Thus, we explored if integration of Skype into instructional activities can be useful for interactive learning when students are familiar with SNS environment. One advantage of Skype, a computer mediated synchronized communication platform (CMC), is that it connects people from different places. The key features are the instantaneous transmission of voice messages for the group members, and they can observe each other's behavior through video connection. These two features can be incorporated with two important EFL activities: listening and speaking tasks. Besides these supporting features, Skype is a popular tool with roughly 600 million users. The popularity of Skype is within the learning process an important factor. It creates a fairly familiar and relaxing SNS environment for learners, where students feel less anxious and pressure as they often do in classroom (Kern, 1995). The use of SNS's may increase learners' motivation and make learning refreshing and interesting.

In addition to the advantages Skype offers, a proper instructional strategy is critical to the learners' experiences and performances. Role-playing is used to develop learners' speaking and communication abilities. The use of role-playing increases students' attention (Hou, 2011) by allowing learners to assume a role in a particular simulated situation and training learners to concentrate on the task itself, rather than on the language used to complete the task. This strategy creates real-world situations and puts learners into a topic related position. In groups, learners can improve their oral language abilities in three ways: by testing how the language works, by reflecting and discussing the language, and by comparing their own production to the target language (Satar & Ozdener, 2008; Gánem Gutiérrez, 2003; Swain, 1997). During the role-play interaction, learners might experience peer-to-peer correction and realize self-correction processes.

Research Objective

1. To use Skype to design a role-playing instructional activity to train students' speaking abilities and observe students' interactive discussions.

2. To explore learners' speaking errors in the activity mentioned above and determine whether errors will be reduced.

2 Method

2.1 Participants

Participants in this pilot study were 42 students from a university in Northern Taiwan. The course they attended is “English Conversation.” Demographically, the group was composed of 10 males and 32 females with an average age of 16 year old. They set expectations for the language program and the goal they might achieve. They also had sufficient familiarity with Skype, including its functions, and usage.

2.2 Procedure

The process involved three phases: the classroom lecture, the formation of groups with strategic discussions, and Skype negotiations with opposing groups. The Skype meetings were recorded as the main research tool to assess the meaningfulness of this strategy on EFL learners. The entire process lasted for three weeks.

Phase 1:
In the first week, the entire class (42 participants) was given a classroom lecture. The teacher focused on the preparation for role-playing scenarios (business-to-business buyer/seller scenarios) in the target language. The learners practiced their conversing and speaking abilities in classroom sessions. Speaking was also trained with one-on-one practices.

Phase 2:
In the second week, the students were divided into two teams of buyers and sellers. The buyer team represented a publishing company about to set a new department, while the seller team worked for an office equipment retail company. Each team was divided into four groups of 5-6 people responsible for buying/selling the items belonging to a particular product category. The four product categories included desktop computers, printers, cameras and laptops. Each group was assigned a leader to coordinate the buying/selling process.

The two groups were assigned challenges and objectives before negotiation. The objectives were explained in terms of the overall scenario for the role-playing: the buying side represented a publishing company, which has a strategic interest in establishing a new marketing department. The task for its employee (buying team) is therefore to buy office equipment from an equipment company. The selling team on the other side faced the challenge to unload its surplus of products before a new product line will be launched. Both teams had to create their selling/buying strategy and had to make sure to follow their budget plans. Once all participants were set up, the teams started a negotiation.

Phase 3:
In the third week, the actual one-on-one negotiation role-play was conducted. Each confrontation included one buyer and one seller for the trade of one product. The meetings were set up online by using Skype. The choice of using Skype in a computer lab instead of direct negotiations in the classroom was motivated by the fact that

Skype reduces learning anxiety. The total negotiation time was limited to 10 minutes and the learners were asked to keep up the discussions for this period. The instant messaging function was not allowed to use. The goal of the bargain was to reach the best performance for buying or selling procedures and to reach the acceptable price for both sides. The participants were allowed to converse in English language only.

2.3 Data Analysis

In order to determine whether the use of role-playing in combination with Skype in an EFL course achieved the objectives, both quantitative and qualitative analyses were applied. In the quantitative analysis, conversations of the participants were recorded and divided into three segments. The three segments included a pre-analysis, mid-analysis and post-analysis, which were from a third of the conversation content at the beginning, in the middle and at the end of the whole negotiation. Errors made in each segment were calculated to see whether Skype could help reduce their numbers. Qualitatively, the recorded content on Skype was employed to analyze participants' discussions. The recorded content revealed how much of learned knowledge was retained and used in their role-playing activities. Content analysis was thus used to support the quantitative results.

2.3.1 Speaking Error Analysis

The content and common errors of the three stages, pre-, mid- and post-analysis part, were compared to determine if any improvement can be observed. Skype message was selected as a unit of analysis. Two expert EFL instructors conducted the coding of messages for each group to determine whether the messages contained errors. Inter-rater kappa value was 0.982. In particular it is of interest to analyze whether the learners reached a peer-to-peer correction mechanism in order to reduce their speaking errors. To explain the significance level of a possible improvement, a paired t-test was applied.

2.3.2 Qualitative Content Analysis

For data triangulation, two independent EFL experts analyzed the message content by the participants during the Skype conversations qualitatively. Every single phrase during the negotiation was taken into consideration. Besides, participant' peer-to-peer corrections in English language were noted.

3 Results and Discussion

3.1 Speaking Error Analysis

To analyze the results from the Skype negotiation, a paired t-test was used to compare learner's performance on the pre-, mid- and post-stage. The differences in the performance from pre- to mid-stage, mid- to post-stage, and pre- to post-stage were taken into consideration.

The results of speaking errors from the pre, mid, and post stage were analyzed by using a paired *t*-test, as shown in Table 1. It showed that in the first period, pre-stage to mid-stage, no significant improvement was found in the use of English language. The reduction of speaking errors in this phase is insignificant (t=0.34). With the reduction of speaking errors from the mid-stage to post-stage, it revealed a significant improvement (t=3.02, p<0.01). The final results showed a significant improvement in the overall process, which was demonstrated from the pre-stage to post-stage (t=4.05, p<0.01).

Table 1. Paired t-test of pre, mid and post stages of speaking errors

	M	N	SD	t
Pre-stage – Mid-stage	17.38	42	8.35	0.34
Mid-stage – Post-stage	17.05	42	7.10	3.02**
Post-stage – Pre-stage	15.00	42	7.29	4.05**

**p<.01

As shown in figure 1, the number of average errors in each stage was decreasing during the Skype conversation. From the pre- to mid-stage, the reduction of errors was 0.33 on average. The main decrease was observed in the mid- to post-stage phase, where the reduction of errors was 2.05 on average. This overall analysis showed a meaningful development in the use of role-playing activity.

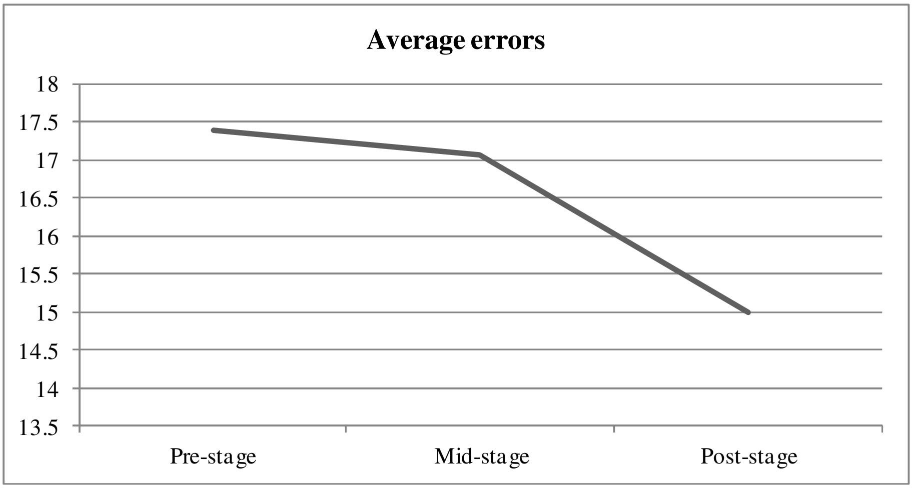

Fig. 1. Average error reduction during pre-, mid-, post-stage

These significant improvements might be influenced by a supporting SNS environment and the application of Skype. One noticeable difference between the Skype conversations and the class lectures was that the learners seemed to express themselves more freely (Nadzrah & Mickan, 2003) and with less hesitation in the Skype environment. This observation might be supported by the absence of the pressure when students were expected to express in English. This absence of pressure improved the learners' willingness to communicate and decreased their fears of making speaking errors. Another account may be due to learners' less anxiety when communicating with peers rather than teachers. The role-play interaction may therefore reduce learners' fear of making errors and motivate them at the same time to contribute to the task.

3.2 Qualitative Content Analysis

In the qualitative speaking analysis, all conversations on Skype were noted and observed. This data contributed to our better understanding of students' speaking performance when Skype negotiation was incorporated. Through this analysis, it was found that peer-to-peer correction technique was applied by the learners. Some of those peer-to-peer correction examples were extracted and elaborated in the following section.

Content Analysis of Speaking Process: Peer-to-Peer Correction

While the learners carried out the role-playing on Skype, they seemed to apply peer-to-peer correction technique in diverse negotiations (see Table 2). For example, in table 2, Case I, student #29 said "uh..we purchase so many machines this time so could we get more dis-gone". Student #29 couldn't use the word "discount" correctly. Student #34 tried to figure out what his fellow student tried to tell him with "dis-gone? What is that mean? Umm…..you mean "discount"?" While he understood what student #29 tried to say he applied the peer-to-peer correction strategy. Case II is another example for a peer-to-peer pronunciation correction. Student #33 said "yeah…I want mo chi." Student #43 couldn't understand the word. So, student #33 tried to explain but said "very chi" instead. Student #43 realized and said "Ohh...i can give you cheaper price." Then student #33 repeated "Ah..yeah..“cheaper.“

Students improved their speaking abilities better when they were allowed to focus on their goal of their discussion rather than language mechanics (Wenger, 1998). Learners showed more willingness to communicate in the Skype environment. This does not necessarily proof that it improved their English abilities, but it was recognized by the learners as a tool, providing a comfortable English learning environment.

Application of Skype in the instruction process resulted in the reduced numbers of speaking errors. Such an outcome could also be conducive to the observed peer-to-peer correction.

Table 2. Qualitative content analysis – Examples of learners' peer-to-peer correction in Skype discussion

Case	Student ID	Content
I	29	uh..we purchase so many machines this time so could we get more dis-gone
	34	dis-gone? What is that mean? Umm…..you mean "discount"?
	29	Yes, yes…..I mean discount
II	33	yeah…I want mo chi.
	43	Huh?…mo-chi?
	33	Yeah, very chi.
	43	Ohh...i can give you cheaper price.
	33	Ah..yeah..“cheaper“

4 Conclusion and Suggestions

From this pilot study it can be concluded that the use of role-playing instructional strategies in combination with Skype, as a communication platform for learning activities, is in fact meaningful to EFL learners' experience and the quality of learning. The applied strategy encourages "learning by doing", a method shown to be effective in language acquisition. On the one hand, the students were able to learn through trials and errors. On the other hand, students could focus on their task rather than worry too much about grammar and making mistakes. This combination of role-playing and Skype provided learners a less-pressure environment where they could express their thoughts and use language without feeling stressful, which comes often along with the fear of making errors.

From the quantitative and qualitative results, it showed significant improvement in learners' speaking abilities within the chosen topic. Implementing Skype as a tool improves EFL teaching and learning. The two elements in this study, Skype and role-playing strategies, offered the learners to use language actively rather than passively in a classroom lecture. There were positive effects on the learning environment by implementing Skype, such as higher learner's motivation, reduced anxiety levels, peer-to-peer correction mechanism. Jauregi and Bañadoes (2008) explained that role-playing activity forces learners to learn to cope with information gaps and the unpredictability of communication and to share the responsibility to construct a meaningful exchange of ideas.

The use of Skype and role-playing strategies improved the learners speaking and listening abilities. In this pilot study, it showed that one-on-one interactions in a buying-selling situation motivated the learners to apply their English abilities more freely and they were benefited from peer-to-peer correction mechanism. These situations were illustrated in several examples within this study. Overall, the use of Skype and role-playing instructional activity is a very effective EFL instructional strategy. Therefore, it is suggested that teachers incorporate this strategy in future

EFL courses as a supplement for speaking practice. Besides, we suggest that other error types be analyzed in the future to better understand characteristics and limitations of Skype application in the EFL instructional process. As it was a pilot study, a control group can be included in the future research to confirm the decrease in speaking errors was due to the use of Skype.

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Analysis of E-Learning Logs to Estimate Students' Phonemic Perception Confusion in English Word Recognition

Min Kang[1,*], Yaheng Zou[1], Harumi Kashiwagi[2], Kazuhiro Ohtsuki[1], and Makoto Kaburagi[3]

[1] Graduate School of Intercultural Studies, Kobe University, Kobe, Japan
{kang,ohtsuki}@kobe-u.ac.jp, akyou.suu@stu.kobe-u.ac.jp
[2] School of Languages and Communication, Kobe University, Kobe, Japan
kasiwagi@kobe-u.ac.jp
[3] Institute for Promotion of Higher Education, Kobe University, Kobe, Japan
kabu@kobe-u.ac.jp

Abstract. In the paper, we analyzed students' learning log data obtained in a word listening learning system to estimate phonemic perception confusion of students. We had two student groups take a word dictation test and a word choice test. English words in the word dictation test were resolved into phonemes and the abilities of both groups on phonemic perception were inferred by Bayes' rule. By comparing the results estimated by Bayes' rule with those obtained in the word choice test, we suggested that the estimation is valid and helpful to build adaptive word recognition training systems.

Keywords: Learning log data, CALL system, Word Recognition, Data mining, Listening Comprehension.

1 Introduction

As web-based instructions are increasingly adopted in higher education, a lot of studies have indicated the importance of analyzing learning log data or tracking data [1,2]. An early indicator of student academic performance is possibly detected by the use of data on student online activity in a Learning Management System (LMS) [3]. Karen et al. investigated a learning log over a five week period and suggested that the learning log data did stimulate student reflection [4]. Tselios et al. argued that an adaptive help system could be built by taking advantage of log files and Lee indicated that the ability of students can be estimated from the log files of a Web-based learning environment [5, 6]. In analysis of learning log data, statistical approaches and data mining technologies such as association rule, Bayesian network and clustering etc. are widely used [6, 7].

On the other hand, web-based instructions have been popular in foreign language education in the past few decades. Unlike in second language environment, students have less opportunity to receive input of the target language in foreign language

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environment [8] so that computer assisted language learning (CALL) has been become one of effective methods to improve the situation of foreign language learning. After classroom learning, students could access language materials whenever and wherever they like. Besides text-based CALL materials, a large number of materials with audios or videos have been developed. Recently, most of CALL materials are commonly created by teachers with LMS [9]. As CALL materials are frequently utilized in instructions of universities, a large amount of student's learning log data can be recorded.

However, there are few research reports on how to analyze the language learning log data with data mining technologies. An LMS generally provides functions that statistically deal with log files, but are limited to sums, means or percentages et al. [10]. It has been noted that one of the main problems of an LMS is the lack of exploitation of the acquired information [2]. In the literature, Item Response Theory (IRT) is a frequently used method to infer the ability of students. The famous exploitation of IRT is in estimating reliable scores of TOEFL [11, 12]. Chen et al. have implemented a personalized e-learning system based on IRT, though the utilization of IRT is not only aimed to mine the data in language courses [13]. The theory also has been adopted to measure the ability level of students in order to recommend appropriate vocabulary words in a personalized mobile English vocabulary learning system [14]. It is notable that one of important purposes of mining log data is to develop personalized learning systems.

In this paper, we aim to analyze student's learning log data obtained in a word listening learning system to estimate phonemic perception confusion of students. English words that have been learned by an individual or a group are resolved into phonemes and the ability of an individual or a group on phonemic perception is inferred by Bayes' rule. We consider that identifying learner's ability on phonemic perception is an indispensable process in building personalized learning system to support adaptive listening learning.

In English listening comprehension, word recognition is the basic step while phonemic perception plays an important role in the step [15]. The process of identification of words includes understanding of words in speech and meaning. With respect to speech perception, there has been a variety of models proposed to explain how recognition takes place [16-18]. In spite of different explanation on the process of recognition in the models, perception of phonemes is emphasized to be an important factor. Additionally, it has been well-known that Japanese listeners of English have problems to perceive some phonemic contrasts such as the phonemes /r/ and /l/ because some phonetic categories are not used in their native language [19]. Thus, listening tasks such as identification training and discrimination training are general approaches in classroom learning in order to decrease phonemic confusion and enhance listening comprehension skill. On the other hand, it has been claimed that teaching listening strategies such as listening for gist have tended to be emphasized while word recognition has generally been neglected in recent EFL [20]. It would be a crucial issue to propose a method for identifying individual phonemic perception ability and building personalized learning system to support adaptive listening activities of students in word recognition. In this paper, we consider that the ability level of students in phonemic perception is in inverse proportion to their phonemic perception confusion.

In the next section, we will first describe the word listening learning system and the learning log data stored in the database of the system. Then we will explain how to apply Bayes' rule for estimating students' phonetic confusion. The data analysis procedure is shown in Section 2. The data of two student groups are analyzed according to the procedure and students' phonemic confusion is clarified in Section 3. The conclusion will be given in Section 4.

2 Mining Log Data in Word Dictation with Bayes' Rule

2.1 Log Data in Word Dictation

The target log data are stored in the learning log database of a web-based word listening learning system that was implemented in our previous work [21]. The system mainly consists of three functions: material generation, material learning as well as feedback. For creating materials, we implemented three kinds of listening test templates to support the generation of word diction questions, word choice questions and fill-in-the-blank questions. The system was designed to evaluate students' progress and reflect weak points in word listening comprehension. Fig. 1 is a screenshot of the word diction test. For each question, students are required to press the button to listen to the audio and enter the spelling what they heard into the text box on the left as their answers in English. During taking a test, students are also required to enter the Japanese translation what they heard into the text box on the right. The translation answers are used to differentiate listening comprehension errors from spelling errors.

Once a student completes a test and submits his/her answers to the system, the data such as personal information of the student, the number of the test, answers in English, answers in Japanese etc. will be saved into the learning log database. Meanwhile, the system will compare each answer in English to the correct spelling and insert "0" or "1" into the column "Results" where "1" means that the spelling is the same as the correct one, and vice versa. Table 1 draws an example of the data in the database. Here, the correct word spellings are saved in the column "Word spelling". Because we focus on estimating phonemic confusion in this paper, we manually modified the values on the column "Results" to "1" to eliminate the influence of spelling problem when the answers in Japanese were correct.

2.2 Phonemic Confusion

As mentioned in the introduction, phoneme perception plays an important role in word recognition. If a student gives an incorrect answer in word listening, he/she is highly probably confused with perceiving one phoneme or several phonemes that comprise the word. For example, if a student frequently makes mistake when he/she listens to the English word "look" while there is no mistake in the log file related to the word "book", you may suppose that the student is confused with the phoneme /l/. We assume that students' confusion in phoneme perception can be estimated based on the log data in word diction by the use of Bayes' rule. Hence, the data used in the analysis are those stored in the column "Results" (See Table 1).

Fig. 1. A screenshot of word diction test

Table 1. A sample of the log data collected in the tasks of word diction

ID	Name	No. of test	Results	Answer in English	Answer in Japanese	Word spelling
1	Student 1	1	1	thick	厚みのある	thick
2	Student 2	1	0	sick	病気の	thick
:	:	:	:	:	:	:
37	Student 1	2	1	book	書籍	book

2.3 Application of Bayes' Rule

Consider two sample space $\Omega_1 = \{A_1, A_2, \ldots, A_I\}$, $\Omega_2 = \{B_1, B_2, \ldots, B_J\}$, and each pair in each sample space is mutually exclusive. According to Bayes' rule, for two events A and B that $A \subseteq \Omega_1$ and $B \subseteq \Omega_2$, the posterior probability P(A|B) can be calculated as

$$\mathrm{P(A|B)} = \frac{P(B|A)P(A)}{\sum_{i=1}^{I} P(B|A_i)P(A_i)} \tag{1}$$

where P(A) is the prior probability [22].

In our analysis, we consider two sample spaces $\Omega_1 = \{A_1, A_2\}$, $\Omega_2 = \{B_1, B_2, \ldots, B_J\}$. A_1 and A_2 denote acquired word and word that has not been acquired, respectively. Each B_j in the set Ω_2 notes an event that a phoneme appears in a word. So when we define $A = A_2$, and B_j is related to an English word including a particular phoneme, the posterior probability P(A|B) in Eq. (1) means the probability that an English word has not been acquired by an individual or a group in listening if the word includes the particular phoneme. In other words, Bayes' rule provides us with a method for estimating the probability that a word cannot be recognized and the cause is that a phoneme appearing in the word has not been perceived. We propose that the probability gives a quantitative factor on the ability level of phoneme perception. If we use the notation Ph_j to represent an arbitrary phoneme, Eq. (1) can be rewritten as

$$\mathrm{P}\left(A_2 \middle| B_j = Ph_j\right) = \frac{P\left(B_j = Ph_j \middle| A_2\right)P(A_2)}{P\left(B_j = Ph_j \middle| A_1\right)P(A_1) + P\left(B_j = Ph_j \middle| A_2\right)P(A_2)} \tag{2}$$

so that we can estimate how bad/good a student or a group perceive the phoneme Ph_j if we know the prior probability $P(A_1)$, $P(A_2)$ and the likelihood of A_1 given B_j, $P(B_j = Ph_j | A_1)$, the likelihood of A_2 given B_j, $P(B_j = Ph_j | A_2)$ as well.

3 Estimating Students' Confusion in Phoneme Perception

For estimating students' phonemic confusion, and meanwhile evaluating the validity of Bayes' rule in the estimation, we used Eq. (2) to analyze the log data that we collected in several experiments in our previous work.

Table 2. English words and corresponding phonemes used in Test I and Test II

Test I Words	Phonemes	Test II Words	Phoneme Pairs	Words	Phoneme Pairs
rent	/r/, /e/, /n/, /t/	sole/ thole*	/θ/:/s/	cheep*/keep	/ʧ/:/k/
thick	/θ/, /ɪ/, /k/	saw/thaw*	/θ/:/s/	juice/goose*	/ʤ/:/g/
wrong	/r/, /ɔ:/, /ŋ/	zee*/ thee	/ð/:/z/	jab/gab*	/ʤ/:/g/
thumb	/θ/, /ʌ/, /m/	sank/thank*	/θ/:/s/	jaws*/gauze	/ʤ/:/g/
arrow	/æ/, /r/, /oʊ/	jest*/guest	/ʤ/:/g/	jot*/got	/ʤ/:/g/
bath	/b/, /æ/, /θ/	sing/thing*	/θ/:/s/	chop*/cop	/ʧ/:/k/
rough	/r/, /ʌ/, /f/	jilt*/gilt	/ʤ/:/g/		
sing	/s/, /ɪ/, /ŋ/	chew*/coo	/ʧ/:/k/		
lock	/l/, /ɑ:/, /k/	joe/go*	/ʤ/:/g/		
sank	/s/, /æ/, /ŋ/, /k/	chair*/care	/ʧ/:/k/		

3.1 Experiments for the Collection of the Log Data

We prepared two kinds of tests with word diction questions and word choice questions. The test level was set on the primary level [23]. In the test with word diction questions (Test I), we intentionally chose the words with the phonemes that are difficult for Japanese learners of English to perceive [19]. In the test with word choice questions (Test II), one minimal pair was shown in each question and the students were required to choose one answer after they heard the voice in the question. The words and the phonemes included are drawn in Table 2 in order of question. The choices in Test II are symbolized with "*".

As we can see in Table 2, the intersectional phonemes in the answers of the two tests are /θ/, /s/ and /k/. Because the result in Test II directly gives us the phonemic confusion of students, we aim to analyze the data collected in Test I and confirm the validity of the analysis result by using the result in Test II.

We had two student groups take the tests. All students were freshmen and there were 16 students in Group I and 19 students in Group II, respectively. The voices in the tests were generated in American English with AT&T Natural Voice TTS software. We consider that the use of synthetic speech does not influence the validity of the analysis, though the result may not completely represent students' confusion because of the naturalness of the voices.

3.2 Calculation of P ($B_l = Ph_1$ |A_1) and P($B_l = Ph_1$ |A_2)

The log data in Test I can give us the likelihood in Eq. (2). According to the log data, we obtained the set A_1 with all of the correct words and the set A_2 including all of the incorrect words. The CMU Pronouncing Dictionary [24] were adopted to resolve the words into phonemes and the set B was obtained. For an arbitrary phoneme Ph_j, the occurring frequency in the set A_1 is equal to the number of the words that contain the phoneme. Clearly, the occurring frequency in the set A_2 can be counted in the same way. For example, if the occurring frequency of Ph_j in the set A_1 is K and there are L elements in the set A_1, then the likelihood $P(B_j = Ph_j \mid A_1)$ equals to K/L. Similarly, if the occurring frequency of Ph_j in the set A_2 is M and there are N elements in the set A_2, then the likelihood $P(B_j = Ph_j \mid A_2)$ equals to M/N. We have assumed that the occurring frequency of a phoneme included in a word does not depend on the position that the phoneme appears in the word.

3.3 Decision of P(A_1) and P(A_2)

The decision of $P(A_1)$ and $P(A_2)$ is a critical step in the application of Bayes' rule and strongly affects the values of the estimation on students' phonemic confusion. Because the probabilities are the prior probabilities, we cannot use the log data in Test I to calculate them. Here, we suggest several possible methods to determine the probabilities.

One possible method is to use the learning log data of Group I and Group II obtained before the experiment. If we have collected a large amount of log data about an individual or a group in word diction learning, the correct rate and incorrect rate on word recognition are easily inferred by the law of large numbers. $P(A_1)$ and $P(A_2)$ correspond the two rates. The second possible method is to use the log data collected in other learning patterns. The correct rates in Test II may provide us a rough measurement of the prior probabilities. Empirically inferring by teachers may a possible method and finally the probabilities can be set to 0.5 if there is no reliable data to support the decision. In this paper, we used the data obtained in Test II.

3.4 Incorrect Rates in Test I and Test II

Because we attempted to estimated students' confusion, we focused on the calculation of incorrect rates. The results are shown in Table 3. For comparing the results with a view to evaluating students' phoneme perception, we only presented the phonemes of the minimal pairs in the table. The numbers in front of the phonemes correspond to the question number in Test II. G1 and G2 denote Group I and Group II, respectively.

Table 3. Incorrect rates of Group I and Group II in Test I and Test II

Words	*G1*	*Words*	*G2*	*Phoneme pairs*	*G1*	*Phoneme pairs*	*G2*
thick	88%	wrong	89%	(1) /θ/:/s/	50%	(1) /θ/:/s/	53%
thumb	81%	thumb	89%	(2) /θ/:/s/	44%	(2) /θ/:/s/	53%
bath	75%	lock	79%	(6) /θ/:/s/	19%	(3) /ð/:/z/	21%
sank	75%	sank	79%	(7) /ʤ/:/g/	13%	(4) /θ/:/s/	16%
wrong	69%	thick	74%	(5) /ʤ/:/g/	6%	(5) /ʤ/:/g/	16%
lock	69%	arrow	74%	(3) /ð/:/z/	0%	(6) /θ/:/s/	16%
sing	56%	sing	74%	(4) /θ/:/s/	0%	(7) /ʤ/:/g/	11%
arrow	44%	rough	68%	(8) /ʧ/:/k/	0%	(8) /ʧ/:/k/	5%
rough	38%	bath	63%	(9) /ʤ/:/g/	0%	(9) /ʤ/:/g/	0%
rent	25%	rent	32%	(10) /ʧ/:/k/	0%	(10) /ʧ/:/k/	0%
				(11) /ʧ/:/k/	0%	(11) /ʧ/:/k/	0%
				(12) /ʤ/:/g/	0%	(12) /ʤ/:/g/	0%
				(13) /ʤ/:/g/	0%	(13) /ʤ/:/g/	0%
				(14) /ʤ/:/g/	0%	(14) /ʤ/:/g/	0%
				(15) /ʤ/:/g/	0%	(15) /ʤ/:/g/	0%
				(16) /ʧ/:/k/	0%	(16) /ʧ/:/k/	0%

As shown in the table, there is explicit difference on word recognition between Group I and Group II. The ability of Group I is better than that of Group II. There are 6 words that more than 60% of students in Group I cannot recognize while more than 60% of students in Group II cannot give correct answers for almost all words in the test. Students in Group I can completely discriminate around 70% of phoneme pairs in Test II while the percentage in Group II is around 50. For students in Group I, the word that is most difficult to recognize is "thick" and the phonemic perception confusion mainly corresponds to the phoneme pair /θ/:/s/. On the other hand, the most difficult word to recognize for students in Group II is "wrong" and the perception confusion is seemly related either to the pair /θ/:/s/ or to /ð/:/z/.

3.5 Results by Bayes' Rule

Based on the log data in Test I, we estimated the probabilities that students in Group I and Group II may make mistakes when they listen to English words because of perception confusion on phonemes included in the words. The results are drawn in Table 4 in converse order of the values of the posterior probabilities. We have divided all phonemes in Test I into two categories, e.g. the consonants and the vowels. The values of $P(A_1)$ and $P(A_2)$ used to calculate the posterior probabilities are given in the title rows.

We adopted the second possible method mentioned in Section 3.3 to determine the prior probabilities. According to the values related to the phoneme pairs in Table 3, we assumed that students in Group I can perceive around 70% of words at the test level while only 50% of words at the same level can be comprehended by students in Group II. Therefore, we assumed that the prior probabilities on word recognition of

Group I and Group II are equal to 0.7 and 0.5, respectively. To discuss the validity of the estimation with Bayes' rule, we also calculated the posterior probabilities for the case in that the prior probabilities were set to 0.5.

Table 4. Probabilities on phonemic confusion by Bayes' rule

	G1	$P(A_1)$: $P(A_2)$ =0.7:0.3	$P(A_1)$: $P(A_2)$ =0.5:0.5	*G2*	$P(A_1)$: $P(A_2)$ =0.5:0.5
Consonant	/m/	53%	73%	/m/	77%
	/θ/	53%	73%	/ŋ/	62%
	/k/	47%	67%	/l/	59%
	/b/	44%	65%	/k/	57%
	/l/	37%	58%	/s/	55%
	/ŋ/	35%	55%	/θ/	54%
	/s/	34%	54%	/f/	46%
	/r/	17%	32%	/r/	43%
	/f/	14%	27%	/b/	40%
	/n/	8%	17%	/n/	15%
	/t/	8%	17%	/t/	15%
Vowel	/ɪ/	40%	61%	/ɔ:/	77%
	/ɔ:/	37%	58%	/ʌ/	59%
	/ɑ:/	37%	58%	/ɑ:/	59%
	/æ/	33%	53%	/ɪ/	52%
	/ʌ/	28%	47%	/oʊ/	52%
	/oʊ/	17%	32%	/æ/	50%
	/e/	8%	17%	/e/	15%

As shown in Table 4, there are over 50% of students in Group I have perception confusion on the words with the phonemes /m/ and /θ/. On the other hand, the perception confusion of Group II concentrates at the phonemes /m/, /ŋ/, /l/, /s/ and /θ/. 40% of students in Group I are seemly not able to perceive the word with the vowel /ɪ/ while most of students in Group II cannot recognize the words with the vowel /ɔ:/. Thus, the estimation on the ability of phonemic perception gives different results for different student groups. Based on the estimation, a personalized word recognition training systems is possibly built.

3.6 Discussion

For comparing the results on phonemic confusion with those obtained in Test II, we focus the discussion on the consonants /θ/, /s/ and /k/. We notice that the results estimated on the phoneme /θ/ for both groups are approximately consistent to those in Test II (See Table 3). From the values of Question (1) and Question (2) in Test II, around 50% 0f students in both groups have confusion on the phoneme /θ/. Although the questions were used to examine if students can discriminate the two utterances with /θ/:/s/, the incorrect rates actually denote that students have confusion on perceiving /θ/ because only the utterances with the phoneme were pronounced in the test. Obviously, the incorrect rates of Question (4) and Question (6) are far lower than 50%. This may originated from the effect of word familiarity. Consequently, according to the estimation with Bayes' rule, there are around 50% of students in both groups who have not acquired the words with the phoneme /θ/ in listening learning. As shown in the table, if the prior probabilities are set to 50%, the values of the posterior probabilities become larger. This may cause overestimation of students' confusion.

As mentioned above, the result about the phoneme pair /θ/:/s/ in Test II mainly explains students' confusion on the phoneme /θ/ so that with respect to the phoneme /s/, it is difficult to compare directly the results from Test I with those from Test II. Furthermore, the results in Test II have indicated that most of students can discriminate the phoneme pair /ʧ/:/k/ very well while approximately, 50% of students in both groups cannot recognize precisely the words with /k/. We noted that the words are "thick", "sank" and "lock". Because the phonemes /θ/, /s/ and /l/ are difficult to discriminate with /s/, /θ/ and /r/ for Japanese learners of English, the low incorrect rates of the three words may originate from the confusion on the three phonemes. However, the low incorrect rates cause the overestimation of students' confusion on the phoneme /k/ when Bayes' rule is used. The reason is that there is the same occurring frequency counted for each phoneme included in a same word and there is a sample bias of words with the phoneme /k/. Conversely, if we have lots of data about the words with the phoneme /k/, it is possible to obtain an unbiased result on the phoneme.

4 Conclusion

In this paper, we analyzed student's learning log data obtained in a word listening learning system to estimate phonemic perception confusion of students. English words were resolved into phonemes and the abilities of students on phonemic perception were inferred by Bayes' rule. We suggested that the estimation is helpful to build adaptive word recognition training system. Meanwhile, in this work, the overfitting problem related to Bayes' rule has not been considered because we have not collected enough data to evaluate the problem. It will be dealt with in our future work.

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COLLEAP – COntextual Language LEArning Pipeline

Bartholomäus Wloka[1,2] and Werner Winiwarter[1]

[1] University of Vienna, Research Group Data Analytics and Computing
[2] Austrian Academy of Sciences,
Institute for Corpus Linguistics and Text Technology

Abstract. In this paper we present a concept as well as a prototype of a tool pipeline to utilize the abundant information available on the World Wide Web for contextual, user driven creation and display of language learning material. The approach is to capture Wikipedia articles of the user's choice by crawling, to analyze the linguistic aspects of the text via natural language processing and to compile the gathered information into a visually appealing presentation of enriched language information. The tool is designed to address the Japanese language, with a focus on kanji, the pictographic characters used in Japanese scripture.

Keywords: Web crawling, natural language processing, language learning.

1 Introduction

Foreign language learning plays an important role in today's society all over the world. While there is more and more communication and collaboration between different countries and cultures, the English language often serves the purpose of the *lingua franca* to overcome the language barrier. However, it is often essential to learn a foreign language, rather than relying on an intermediate solution, since a language includes much information about the culture, attitude and thinking of a particular nation. Subtle hidden meanings and connotations are often impossible to convey through a third language, especially when considering languages of countries which greatly differ in culture, history, everyday interaction, and sociolinguistic factors, such as English vs. Japanese.

The importance of learning foreign languages spawned a great effort in creating learning environments for personal computers and hand-held devices, such as smartphones. Most of these environments rely on previously prepared learning material. However, many students want to learn by studying real everyday material. We propose a pipeline of several state-of-the-art tools which turn an article from the Web into a language learning experience. The World Wide Web presents abundant resources of multilingual texts, one of these vast resources is Wikipedia, a collection of articles for virtually any topic in multiple languages, which is one of the reasons we chose it as a starting point to obtain textual data. In the following sections we describe how we obtain and process the data to

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create a learning experience from Wikipedia articles, which students can choose according to their interest. We present the process for the Japanese/English language pair, since Japanese poses a series of intricacies, due to its radically different surface structure and the complex writing system, compared to English. However, the pipeline concept can be adjusted to virtually any other language pair and the system is applicable in the settings of individual study as well as in the class room, supported by a language instructor.

2 Related Work

Although there are many other resources for harvesting textual information from the World Wide Web, Wikipedia is a valuable source for Web crawling, due to its vast amount of different topics and its well organized and documented HTML structure (see `http://www.mediawiki.org/wiki/API`). A good overview of that structure in the context of multilingual Web crawling for information extraction can be found in [1]. Research effort to exploit this well organized vast data collection is very active, as can be seen in [2], where a concept network is built within a certain domain, or clustering of Wikipedia content in [3].

Amongst many different Web crawling tools we chose *Scrapy* (`www.scrapy.org`). It is an open-source Python based Web crawler. Scrapy is efficient and well documented and proved to be a good choice to obtain high level textual data for our purposes. We plan to extend the data acquisition in a topic focused fashion, following the approach of [4]. The addition of semantic links with the help of WordNet [5], or finding links even in the crawling process, as presented in [6] offers the possibility of compiling coherent word and text collections from multiple sources.

We have chosen Japanese as the target language. While learning the language the writing system in particular poses the biggest intricacy. The Japanese scripture consists of two syllabaries *katakana* and *hiragana*, and pictographic characters called *kanji*, originating in China and adopted in Japan around the 5^{th} century. Each kanji has usually several readings and can have different meanings, depending on the context and combination with other kanji. Each reading of a kanji can be transcribed into each of the two syllabaries as well as into Roman alphabet (romaji). Hiragana is predominantly used for pre- and suffixes which are crucial for the grammatical structure. Katakana is mostly used to express words and names from foreign languages for which there are no kanji [7]. The knowledge of roughly 2000 kanji is necessary for basic reading and writing, although there are larger collections like the *Japanese Industrial Standards for kanji* consisting of over 6000 kanji, which in turn is still a subset of all existing characters. This sheer number and the fact that each kanji conveys various meanings and has several readings, is by far the greatest hurdle for a student of the Japanese language.

Following the understanding and being able to pronounce a kanji, the next difficulty for the learner is to be able to draw it. Each kanji has a specific order of strokes which needs to be followed so that the result is a correctly written character. The most common way to depict the right sequence of strokes is to put a number next to the beginning of each stroke in the kanji, as can be seen in Fig. 1 (font available at `www.nihilist.org.uk`).

Natural Language Processing (NLP) for Japanese is quite different from English, due to the properties mentioned in the previous paragraph. To process the text and acquire an analysis of the individual words of the text we used *MeCab* [8]. MeCab tokenizes the text, a non-trivial process, since there are no space delimiters between words in Japanese and the correct kanji sequences have to be often implied from the context. For each word MeCab generates the katakana transcription, as well as the morphological information. This results in a presentation of annotated language learning material. An interesting approach is examined in [9] with the integration of semantic annotation and a serious game component.

Additionally to the multiple meanings of kanji, there is the problem of word sense disambiguation, depending on the context, as it is e.g. addressed in combination with Wikipedia crawling by [10]. The aim is to approach disambiguation by creating an ontology in certain domains, or as in [11] investigating cross-lingual links in multilingual texts. These approaches do not include the Japanese language and we plan to investigate whether this concept is also applicable to the English/Japanese language pair. Translating individual kanji and kanji compounds poses another layer of ambiguity due to their numerous ways of representation. The *JMdict* project aims to compile a comprehensive dictionary to remedy this problem [12]. The content of the dictionary includes Japanese words, their various written representations, their readings and translations into various languages, and additional information.

Another active research area is the named entity recognition problem. [13] addresses this issue using co-occurrence pattern measures. We will explore this approach in future work, as named entity recognition can greatly benefit not only the disambiguation issue, but also the collection of useful learning material.

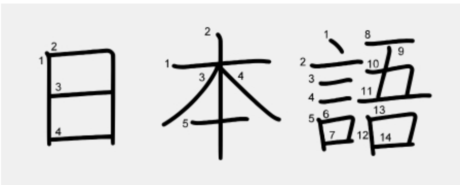

Fig. 1. The word *nihongo*, meaning Japanese language, with stroke-order annotation

3 Pipeline Concept

In the following paragraphs we describe the concept of our approach. Each step in the pipeline utilizes state-of-the-art tools, which are mentioned in detail in Sect. 4. The entire process is semi-automatic. The user picks a Wikipedia site describing a certain topic and starts the pipeline to extract the information.

The first process harvests textual data from Wikipedia pages. Once the article is obtained in raw text format, i.e. the selected part of the HTML page, it is cleaned from noise, and the textual structure is analyzed via NLP. Individual words are compared with dictionary entries and translational candidates are added. These results are then compiled for presentation to the language student in an appealing and organized fashion. This representation format is useful for individual study as well as applicable in a classroom setting.

3.1 Crawling – First Iteration

Crawling Wikipedia articles is a fairly straight-forward process, since the HTML content is well organized and commented in the Wikipedia API. Analyzing the content with tools such as *Firebug* gives a quick insight in the structure and organization. The articles, their format, and any links associated with them, such as further HTML content, pictures and files are extracted. In this fashion a preselected article from Wikipedia is obtained according to the crawler's parameters.

3.2 Text Analysis and Translation

The NLP analysis of the text results in basic linguistic information. The Japanese sentences are tokenized, i.e. split into individual words and the reading for each kanji is determined and annotated with katakana and romaji. The translation of the individual words is done via dictionary lookups. If the particular word is a kanji, it can have many different meanings, therefore a list of translation candidates is attached as annotation.

3.3 Crawling – Second Iteration

Depending on which meaning was assigned to the particular word, the crawler starts another iteration in which Wikipedia is searched for a link to a picture or graphic, which depicts the concept.

3.4 Visualization

After the crawling process, translation, and NLP analysis we have the textual information in UTF-8 format. This annotated raw text is fairly hard to read, hence not very appealing to a language student. The last step of the pipeline wraps the collected information in a graphical application, which represents the text in easy to read font and color. Additionally the stroke-order is added to the output. The student can navigate between chunks of information and is presented with pictures and figures associated with the topic of the Wikipedia article, whenever possible. Pictures, colorful appearance and reasonably sized chunks of information make the visualization an efficient as well as enjoyable way to study the content of the Japanese Wikipedia entry, following the principle of *cognitive load theory*, which states that the learner should not be overwhelmed with information at any given time, but on the other hand being presented with associations, in this case the graphical representations of the word semantics, so that cognitive links are created while studying the material [14].

4 COLLEAP – Architecture

The architecture of COLLEAP consists of a Web crawler, NLP analysis, and a program for visualization. The pipeline of the work steps and tools is shown in Fig. 2. The Wikipedia content is crawled for textual data with Scrapy (http://scrapy.org), the Web crawler we chose for this task. Being based on the Python programming language it is straight-forward to use and easy to maintain, due to the nicely readable source code. Additionally it is platform independent and can be used on Linux, Windows, and Mac systems. This spider, i.e. the module which defines the scope and details of the target content, is very simple, yet sufficient for retrieving the articles of a Wikipedia page, including text and figures. It can be easily extended with more detailed crawling attributes and regular expressions to perform first selective formatting even before starting to obtain the data.

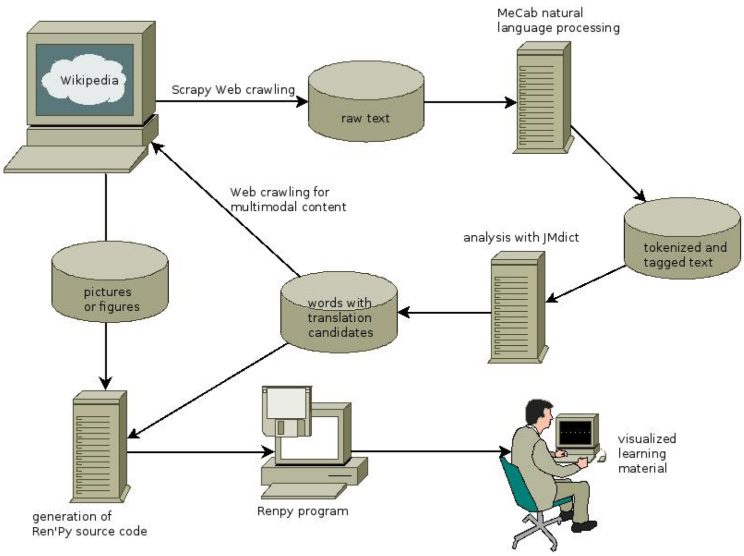

Fig. 2. Path from Wikipedia article to the learning environment

Crawling Japanese Wikipedia content poses another difficulty. In fact it is an issue which arises with any language containing special characters, which need to be encoded in UTF-8, rather than the small ASCII set of characters, which is sufficient for the English language. This problem is solved particularly easy with Scrapy, since it is based on the Python programming language, which in turn deals nicely with UTF-8 content. It opens the output file with UTF-8 encoding support and as long as the file is processed with UNICODE support throughout the entire process, further handling is straight-forward.

The result from the crawling is analyzed via NLP. *Part of Speech* (PoS) tagging of the Japanese text input results in a list of tokenized individual words and their phonetic spelling in katakana. This is done with MeCab, a PoS tagger and morphological analyzer for Japanese. We use a module of MeCab which we have integrated into our program. Further we import the content of the JMdict database and use its information to identify translation candidates for the individual words and the romaji transcription. All steps in the sequence are coded in the Python programming language, avoiding a mix of different programming languages, which allows for a clean and transparent implementation without the need of cross-language coding; this makes the program very well readable and easy to maintain.

Depending on the meaning of the word, which is now identified, a semantic search is started with the second iteration of the crawler. A picture or figure from Wikipedia is obtained and added to the collection of data.

The final step visualizes the processed, translated, and annotated textual data. For this purpose we found Ren'Py to be a good solution (http://www.renpy.org). The Ren'Py environment comes with a pre-coded structure for displaying text, pictures, and sounds. The scripts processed by the Ren'Py engine require only a few keywords to create a graphical story out of the raw textual data. An example of the final output within the Ren'Py application is shown in Sect. 5, Fig. 6. The visualization is a sequential presentation of the Wikipedia data. At first a sentence is displayed, as it was obtained originally, then, each word in the sentence, its katakana and romaji transcription as well as the translation candidates. This is particularly interesting in a class room environment, where the instructor has the chance of explaining each kanji or word in the context of the specific word in the article, but also pointing out other meanings and ways of using a certain character. Each kanji is displayed with its stroke-order information.

In order to further improve the learning potential, a multimodal component is added, i.e. a figure, picture, or photograph is displayed together with the textual information. This picture is obtained in the second iteration of the crawling process, as described above.

5 Showcase

In this section we present the sequence of steps from choosing a Wikipedia article to the finished visual representation of learning content. We have focused on tourism related topics in our test runs and present the pipeline sequence of the Japanese Wikipedia entry for the city of Vienna. The output of the crawler is the raw text data and the link to the first representative picture associated with the article. This data is processed with MeCab, which tokenizes the sentences into individual words and their katakana transcription, shown in Fig. 3. These words are then searched in the JMdict XML database and the corresponding translation candidates are associated with the tokens, shown in Fig. 4. In the next step this output is processed into a format readable by Ren'Py, the visual representation engine. Now, all the user has to do is to start Ren'Py and load the created file.

ウィーン	ウィーン	ウィーン	名詞-固有名詞-地域-一般
[	[	[	名詞-サ変接続
1	1	1	名詞-数
] (	] (	] (	名詞-サ変接続
標準	ヒョウジュン	標準	名詞-一般
独	ドク	独	名詞-固有名詞-地域-国
:	:	:	名詞-サ変接続
Wien	Wien	Wien	名詞-一般
（	（	（	記号-括弧開
ヴィーン	ヴィーン	ヴィーン	名詞-固有名詞-一般
）	）	）	記号-括弧閉
、	、	、	記号-読点
巴	トモエ	巴	名詞-一般
:	:	:	名詞-サ変接続
Wean	Wean	Wean	名詞-一般
（	（	（	記号-括弧開
ヴェアン	ヴェアン	ヴェアン	名詞-固有名詞-一般
）	）	）	記号-括弧閉
、	、	、	記号-読点
仏	フツ	仏	名詞-固有名詞-地域-国
:	:	:	名詞-サ変接続
Vienne	Vienne	Vienne	名詞-一般
（	（	（	記号-括弧開

Fig. 3. The output from MeCab, tokenized text with reading information of the individual words

As seen in Fig. 5 each sentence from the paragraph is displayed. Navigating through the content, the student or instructor advances through the words of the sentence, to display stroke-order information, the reading of the word in katakana, romaji as well as meanings, i.e. the translation candidates, as shown in the example in Fig. 6.

Following this procedure the language student can analyze the text, token by token; or if the program is used in a class room setting, the instructor can narrate each part of the paragraph. The progress can be halted and bookmarked and continued at any time.

```
1 標準 ヒョウジュン ひょうじゅん standard level norm
2 独 ドク どく Germany
3 仏 フツ ふつ France
4 仏 フツ ぶつ Buddha Buddhism
5 仏 フツ ほとけ Buddha merciful person Buddhist image the dead
6 英 エイ えい Britain British
7 首都 シュト しゅと capital city metropolis
8 人口 ジンコウ じんこう population common talk
9 万 マン ばん many all
10 人 ニン じん -ian (e.g. Italian, etc.) (attaches to name of country to denote nationality) -er
   (e.g. performer, etc.) (attaches to name of occupation) (usu. in compound words) man person
   people
11 人 ニン と person
12 人 ニン ヒト man person human being mankind people human (Homo sapiens) humans as a species
   character personality man of talent true man another person other people others adult
13 人 ニン り counter for people (usu. in compound words) person
14 年 ネン ねん year (e.g. AD) counter for years
15 月 ツキ つき moon month
16 月 ツキ がつ month (of the year) used after number or question word (e.g. nan or nani)
17 月 ツキ げつ Monday
18 日 ニチ にち Sunday day (of the month) counter for days Japan
19 日 ニチ か day of month counter for days
20 都市 トシ とし town city municipal urban
21 単独 タンドク たんどく sole single solo independence singleness singularity
22 有数 ユウスウ ゆうすう prominent leading foremost distinguished
23 世界 セカイ せかい the world society the universe sphere circle world renowned world-famous well-
   known outside of Japan realm governed by one Buddha space
24 都市 トシ とし town city municipal urban
25 北緯 ホクイ ほくい north latitude
26 度 ド たんび time (three times, each time, etc.) times
27 度 ド ど degree (angle, temperature, scale, etc.) counter for occurrences and times strength
   (of alcohol)
28 度 ド ド precisely exactly plumb totally very much damn stupid cursed
29 分 フン ふん minute fun (one tenth of a monme, 5.787 grains)
30 分 フン ぶ one-tenth one percent (one-tenth of a wari) 3 mm (one-tenth of a sun) 2.4 mm (one-
   tenth of a mon, a traditional unit used to measure shoe sizes) 0.1 degree (one-tenth of a do,
   used to measure body temperature on any temperature scale) one-quarter of a ryou (obsolete
   unit of currency) thickness advantageous circumstances one-tenth of a monme of silver
31 分 フン ぶん part segment share ration rate degree one's lot one's status relation duty kind lot
```

Fig. 4. The output from postprocessing with the JMdict dictionary

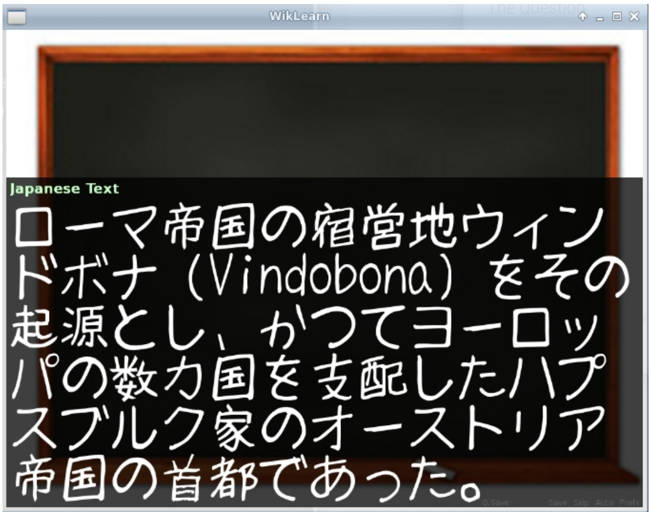

Fig. 5. The beginning of the sentence analysis. The entire sentence is displayed.

Fig. 6. The word *house* with kanji stroke-order information, katakana, romaji transcription, and translation candidates

6 Conclusion

In this paper we have presented a pipeline of state-of-the-art tools wrapped in a framework implemented with the Python programming language, to create a language learning experience with Wikipedia content. It includes the use of efficient Web crawling, natural language processing, dictionary lookups, and learning content visualization, including stroke-order-diagrams for Japanese characters and multimodal presentation of the articles. We described the architecture of the individual components and presented a showcase to illustrate our prototype.

While the concept is focused on the Japanese/English language pair, it is applicable to any other language pair with adjusted NLP analysis. The resulting program is usable on Linux, Mac, and Windows systems, as well as on portable device architectures, such as Android.

The program pipeline aims to be a learning supplement for the single student as well as a basis for class room instruction. We plan to distribute our prototype to the Department of Japanese Studies at the University of Vienna to receive valuable feedback in the near future.

Further we plan to integrate word sense disambiguation to propose an accurate translation of the content and enrich the text presentation with synonyms and other information in conjunction with sources like the Japanese WordNet [5], as well as the possibility to choose kanji according to the proficiency of the language student, using the kanji difficulty level information included in the kanji database. We plan to make the environment interactive and persistent and usable for collaborative learning with a constantly growing knowledge base, combining the user-driven collection of data with an extended acquisition of data from the crawler comparable to other current ongoing efforts [15].

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Development of Material Automatic Generation System Based on the Analysis of Phonemic Errors in English Vocabulary Listening

Yaheng Zou[1,*], Kashiwagi Harumi[2], Kazuhiro Ohtsuki[1], and Min Kang[1]

[1] Graduate School of Intercultural Studies, Kobe University, Tsurukabuto, Nada, Kobe, Japan
[2] School of Languages and Communication, Kobe University, Tsurukabuto, Nada, Kobe, Japan
zouqqing@gmail.com

Abstract. With analyzing the learning log-data, personalized learning patterns of different students could be detected, and the personalized materials could be automatically created and offered to learners for guiding their specific learning processes and solving weak points. In this paper, we propose a new approach to develop a CALL system including an error-detecting algorithm and a material-creating module. And in our approach, we pay much of our attention on the detection of phonemic errors. The system can detect the phonemic errors of Japanese learners' in English vocabulary listening by analyzing the relative learning log data, and automatically create multiple-choice question materials to help students take practices to enhance perception on the phonemes that they distinguish difficultly.

Keywords: CALL System, Data Analysis, Listening Learning, Data Mining.

1 Introduction

As the training of communication skills becomes more and more important in foreign language education, Computer Assisted Language Learning (CALL) systems have been widely used in English education in Japan. More importantly, in terms of efficiency, it is effective for listening learning to use a CALL system because students would have more opportunity to be exposed to English sound inputs. Another benefit of using CALL system is that students' learning log-data can be easily saved in database. Therefore the saved log-data gives us the possibility to automatically create and offer contents to students to guild their own learning processes or improve their weak points [1].

On the other hand, adaptive learning has become considerable and there is a trend to develop the applications to generate adaptable materials. In order to automatically select information to meet individual needs, students' characteristics such as

[*] Corresponding author.

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preferences, previous knowledge and profiles are first captured and analyzed [2][3]. Moreover, mining learning data obtained in learning process is also an effective approach to estimate students' ability for providing adaptable materials [4]. However, there are few reports in the literature about how to analyze the log-data in listening learning, essentially, how to build a system that automatically finds out students' weak points according to the analysis of the log-data and creates personalized material for students to solve their weak points. For building a personalized material generation system to support overcoming weak points in English listening learning, we should first find out the misinterpreted pronunciation and what the misinterpretation is supposed to be.

In this paper, we propose an approach in developing a CALL system that centers on analyzing Japanese learners' error patterns in their English vocabulary listening learning at the phonemic level, and automatically generating personalized materials that can help students to solve the weak points based on the analysis.

It has been indicated that word recognition is the core process in listening however there is no clear conclusion on what is the key factors in recognizing words [5]. In the cohort model, phonemes are considered as the key factors. In addition, it is well-known that Japanese learners have difficulties in distinguishing some special phonemes that cause difficulty of word recognition so that the phoneme discrimination training is emphasized in listening learning [6][7][8]. Therefore, we focus on the detection of phonemic errors at first, and then the automatic generation of phoneme discrimination training materials. In our previous works, we have developed a listening learning system, and collected the English answers and Japanese translations from students[9]. In this work, the error answers and their corresponding right words are extracted and decomposed to phonemes. And then an algorithm is presented to compare the right phoneme and wrong phoneme pairs, in order to find out weak points of aural perception in listening learning for an individual student or a student group. Section 4 explains how to develop a material generation module that can automatically generate multi-choice materials to help students take exercises to overcome their mistakes on the phonemes.

2 English Vocabulary Listening Learning System

2.1 System Overview

In our previous work [9], we have built an English vocabulary listening test system in AMP (Apache, MySQL, and PHP) environment. Three listening test templates, e.g. "dictation question", "alternate choice question" and "blank filling question" were implemented. Figure 1 shows the overview of the system. Teachers create listening test materials based on the templates through browsers. They can use Text-To-Speech (TTS) engine to generate sound files for the materials when they have not recorded sound files to update. The materials created by teachers will be saved in the content database and provided for students through browsers. Figure 2 shows a part of a snapshot of a listening material with dictation questions. For dictation questions, learners are requested to input the spellings of English words as English answers and Japanese translations corresponding to the words as the Japanese answers after they heard the voices of words in the tests with dictation questions. For alternative questions, learners are requested to choose one of the prepared candidate answers. For blank filling questions, filling correct and corresponding Japanese translations are required. Learners' answers are then saved into the database as the log-data. In this paper, we purpose to discuss how to analyze the log-data, how to detect the students' listening weak point appropriately as well as how to automatically generate training materials for students to enhance the listening skills on the weak points(See red arrow in Figure 1).

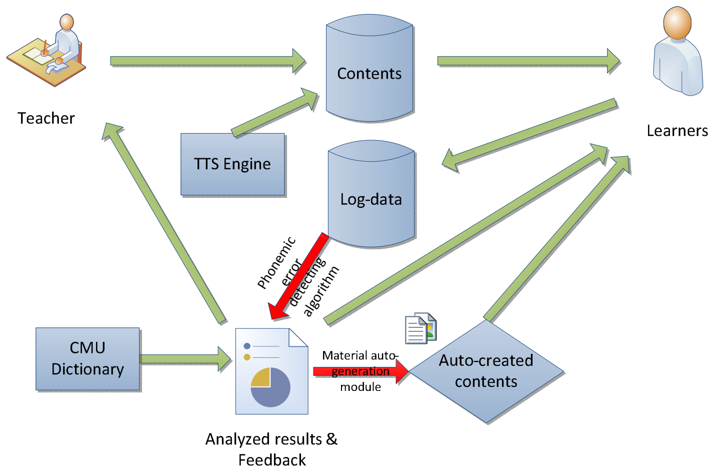

Fig. 1. Main functions and database of the test system

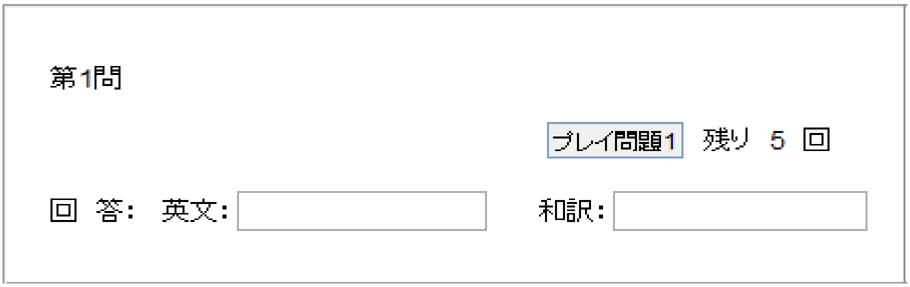

Fig. 2. A part of test page with dictation questions

2.2 About the Data from the Tests with Dictation Questions

As shown in Table 1, the answers are saved as "English answer" and "Japanese answer". The "User ID", "Test ID" and "Question Index" are the primary keys in the table. When an answer is saved into database, the system would automatically compare the "English answer" with its paired right word to determine the TF (true or false) of the answer. In the "TF" field, "1" stands for true, and "0" stands for false.

Table 1. Example of the log-data concerned to dictation questions

User ID	Test ID	Question Index	English Answer	Japanese Answer	TF
1	1	1	look	見る	1
1	1	2	right	正しい	1
2	1	1	root	ルート	0
3	…	…	…	…	…

3 Phonemic Error Detecting Algorithm

For detecting phonemic errors, we basically used the data in the "English answer" field and the "TF" field. Each English answer is paired with a right English word. We have manually checked the wrong spellings and the corresponding right spellings in the past log-data and found that almost no English answer is wrong as it's all phonemes are wrong. Most of the wrong answers were given as different English words that there is only one or two phoneme misunderstood. We aim to extract the right phonemes and corresponding misunderstanding phonemes pairs from the wrong answers at the word level. Here, we call the pairs phonemic errors and describe as "Right-Phoneme → Wrong Phoneme". The "Right-Phoneme → Wrong Phoneme" pairs may represent learners' aural perception difficulties in listening. Furthermore, we count the pairs that appear in the log-data by the Apriori-like method in sequence data mining and find out the error patterns at the phonemic level [10]. Hence, it is a key step to extract the "Right-Phoneme → Wrong Phoneme" pairs. We present an algorithm to find out the pairs as follows. Figure 3 shows the flow chart of the algorithm. Before starting the flow, we use "CMU Pronunciation Dictionary" to decompose English words into phonemes [11]. A wrong spelling is decomposed into a phoneme set W $\{w_1, w_2, w_3\ldots w_n\}$ and its corresponding right spelling is decomposed into a phoneme set R $\{r_1, r_2, r_3\ldots r_n\}$.

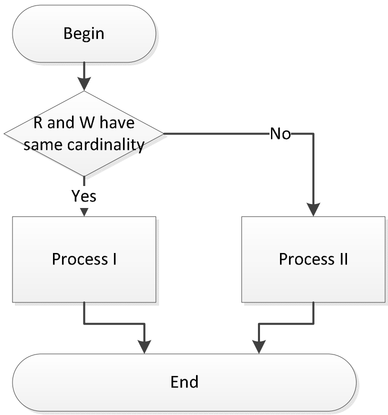

Fig. 3. Flow chart diagram of phonemic error detecting algorithm

In this algorithm, the elements in the sets R and W are first counted. If the set R has the same cardinality as the set W, Process I would be executed in that an injective mapping is performed and the "Right-Phoneme → Wrong-Phoneme" pair is detected if two phonemes in an ordered pair are different each other. For example, the word LIP{/l/, /ɪ/, /p/} and a wrong answer RIP{/r/, /ɪ/, /p/} are paired to the "Right-Phoneme → Wrong-Phoneme" pair "/l/ → /r/". We show the pairing process in Figure 4.

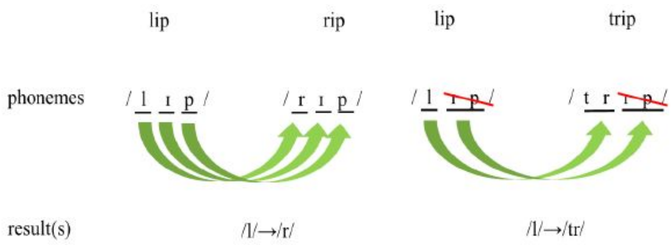

Fig. 4. Example of detecting the phonemic error pairs when R and W have same cardinality

For the case in that the sets R and W have different number of elements, Process II would be executed in that a data-base of common errors of Japanese learners would be used to conjecture the pairs.

Other studies have concluded that the phoneme pairs such as /r/ and /l/, /θ/ and /s/, /ð/and/z/ are difficult for most English learners of Japanese to distinguish [5]. We call the aural perception difficulties the common errors. In the algorithm, the adopted pairs are shown in table 2.

Table 2. Common errors in English learners of Japanese

Vowels	Consonants
/ɑ/⇔/ʌ/,/ʌ/⇔/ɔ:/,/u/⇔/u:/,/æ/⇔ /ʌ/,/æ/⇔/ɛ/,/æ/⇔/ɑ/,/ɪ/⇔/ɛ/,/ɪ/⇔/i:/	/r/⇔/l/, /f/⇔/h/, /v/⇔/b/, /θ/⇔/s/ /ð/⇔/z/, /dʒ/⇔/ʒ/,/g/⇔/ŋ/, /n/⇔/ŋ/ /m/⇔/ŋ/, /r/⇔/d/, /t/⇔/tʃ/, /s/⇔/ʃ/ /d/⇔/dʒ,z/, /z/⇔/dʒ/

We compare r_k $\{r_k \in R\}$ and w_k $\{w_k \in W\}$, where k means the index in the set R or W. If $r_k \Leftrightarrow w_k$ is not matched with the pairs in Table 2, then r_k and w_{k+1} or w_{k-1} is compared and checked if $r_k \Leftrightarrow w_{k+1}$ or $r_k \Leftrightarrow w_{k-1}$ is matched the pairs in Table 2. This process is repeat until the final elements in the sets R and W. the "(Right-Phoneme → Wrong-Phoneme)/2x" pairs are returned where x stands for an absolute value of the difference between the element index of the "Wrong-Phoneme" and the element index of the "Right-Phoneme". For example, for the word LIP{/l/, /ɪ/, /p/} and its wrong answer TRIP{/t/, /r/, /ɪ/, /p/}, the result by Process II is "0.5(/l/ → /r/)" as shown in Figure 5.

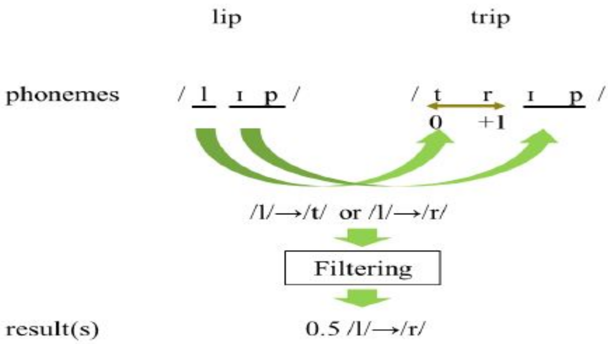

Fig. 5. Example of detecting phoneme pairs by common errors when R and W have different cardinality

4 Material Auto-generation Module

Based on the algorithm mentioned in Section 3, the difference of right words and wrong words could be detected in phonemic level. We consider the phonemic errors as students' aural perception difficulties, and develop the module to automatically generate training materials to help students distinguish the phonemes they mistaken.

According to the results that detected by the phonemic error detecting algorithm, the Right-Phoneme → Wrong-Phoneme pairs are counted, and it is considered that the more a pair occurred in the results, the pair is more difficult for students to distinguish. In this paper, the top five error pairs occurred in the results are selected to be the training targets that appear in the automatically generated materials.

The automatically generated materials are designed as the tests with alternate-choice questions. Every question includes two words that are minimal pair and correspond to an error pair detected. The words are automatically and randomly picked out from the database table that consists of the CMU Pronouncing Dictionary. In our previous case studies, we have noticed that students feel stresses if there are more than fifteen words at one time, and the first five or six words are easy to be remembered[12]. Therefore, in this module, we designed that each error pair appears in a material three times and corresponds to three minimal pairs. The questions concerning the most frequently occurred two errors pairs are placed at the question index one to six and the other questions are in random order. For example, for the phoneme pair /r/ → /l/, the words include /r/ and the words include /l/ are selected from the CMU Pronouncing Dictionary, and the words such as LICH{/l/, /ɪ/, /tʃ/} and RICH{/r/, /ɪ/, /tʃ/} that only /r/ and /l/ are different at the same position would be generated to question. Meanwhile, the sounds corresponding to the minimal pair words would be generated by the use of AT&T Natural Voice Engine that is incorporated into our system. At last, alternate-choice questions of words would be created as shown in Figure 6.

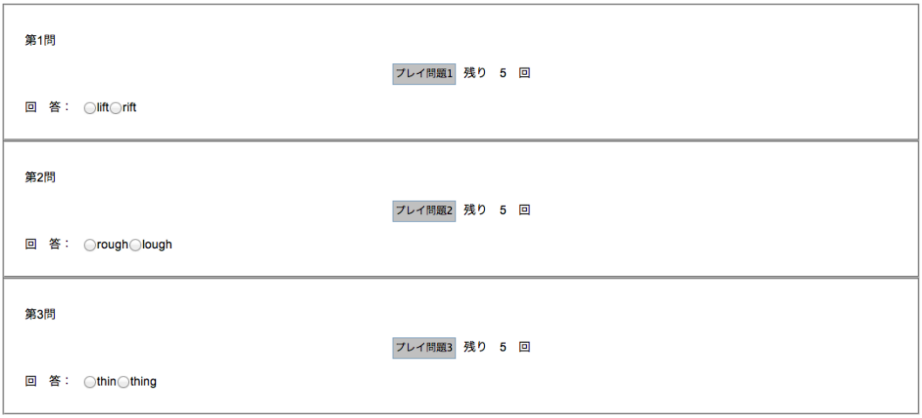

Fig. 6. An example of auto-generated alternate-choice material

5 Results and Discussion

The freshmen in two classes of our university were asked to take a listening test with dictation questions. There were 23 students in Class I and 20 students in Class II. English words in the test are listed in Table 3. We calculated the incorrect answer rates of the words and manually picked up the wrong answers with higher frequencies.

We performed the algorithm suggested above for each student to detect the "Right-Phoneme → Wrong-Phoneme" pairs, and then put the pairs into a sequence. Figure 7 and Figure 8 show the results. A percentage corresponds to a ratio of the number of an error pattern to the number of all wrong answers by a class in the test. For identifying the accuracy of the detecting approach, we also gave the results that are manually counted in the figures.

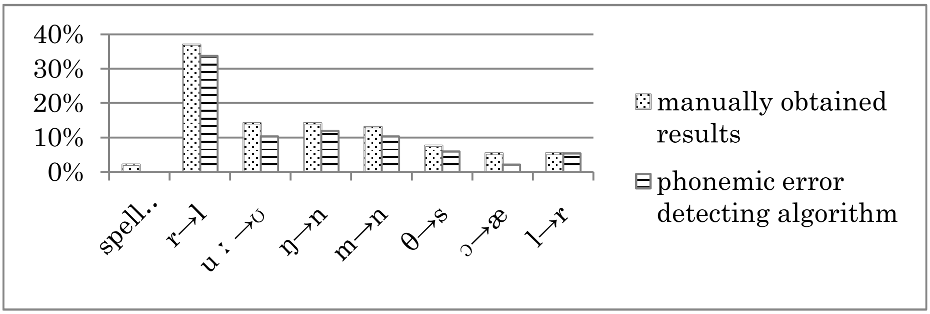

Fig. 7. Ratios of error patterns in Class I

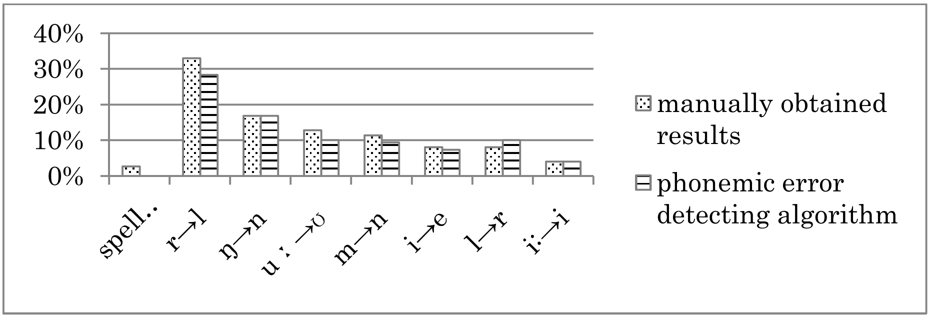

Fig. 8. Ratios of error patterns in Class II

As drawn in Figure 7 and Figure 8, it is clarified that the error detecting algorithm can show us the different error patterns for the two classes and help us to grasp the personalized weak points in different student groups. The "spell missing" in the figures represents the log-data that "Japanese answer" are right but the "English answer" are wrong. The data occupy around 5% in the log-data of one class. We will remove the data from the wrong answer database in our next work because the data cannot explicate the weak points of students in listening.

The top five frequently occurred phoneme pairs in each class are selected to be the training targets so that the materials with 15 English minimal pairs for the two classes would be automatically generated. Table 3 and Table 4 give the detail examples of the materials. The minimal pairs and their question indexes in the materials are described in the columns of “Words” and “Index”.

Table 3. Phoneme error pairs, incorrect rates words and indexes in the material for Class I

Error pairs	Incorrect rates	Words	Indexes
r→l	33.70%	read, lead	1
		rough, lough	3
		rift, lift	4
ŋ→n	11.96%	thing, thin	2
		sing, sin	5
		bring, brin	6
u:→ʊ	10.33%	kook, cook	8
		boock, book	10
		pool, pull	12
m→n	10.33%	moon, noon	11
		farmer, farner	9
		cream, crean	7
θ→s	5.98%	thick, sick	13
		thing, sing	15
		think, sink	14

Table 4. Phoneme error pairs, incorrect rates words and indexes in the material for Class II

Error pairs	Incorrect rates	Words	Index
r→l	33.11%	read, lead	1
		rough, lough	2
		rift, lift	5
u:→ʊ	16.89%	pool, pull	3
		boock, book	6
		kook, cook	4
ŋ→n	12.84%	thing, thin	9
		sing, sin	10
		bring, brin	12
m→n	11.49%	moon, noon	11
		farmer, farner	8
		cream, crean	7
i→e	8.11%	fist, fest	14
		tin, ten	15
		frisch, fresh	13

As shown in Table 3 and Table 4, the two classes have different questions to fit their specific error patterns, and the most frequently occurred two pairs, /r/→/l/, /ŋ/→/n/ for class I and /r/→/l/, /u:/→/ʊ/ for class II, are placed at the first six questions in order that students can remember easily.

6 Conclusions

In this paper, we proposed an approach in developing a CALL system to detect Japanese learners' error patterns in English listening learning by analyzing the learning log data, and developing a material auto-generation module that automatically creates alternate-choice questions to help students practice the phoneme difficulties.

It is confirmed that the algorithm can detect different phonemic errors for different student groups and personalized training materials can be automatically generated based on the detecting results. We suggested that the system is helpful for teachers and students to grasp the weak points of students and enhance the perception skills on the weak points. Although we have not collected enough data to make practice analysis for personal students in the paper, we consider that the approach is similarly effective for the data of personal students. As the limitation of this work, there are about 18% of answers that are not exist in CMU pronouncing dictionary can not be analyzed, because they can not be decomposed to phonemes. We remain the problems in our near future work.

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