Program and Proceedings of
2012 The 1st International Symposium on
Smart Learning Environment

February 2-7, 2012,
AU Edmonton Learning Centre, Edmonton, AB, Canada

Hosted by
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Edited by
Dr. Maiga Chang and Dr. Rita Kuo
School of Computing Information and Systems
Athabasca University
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Organization

Hosting Organizations

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Beijing Normal University, China

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Ronghuai Huang, Beijing Normal University

Program Co-Chair:

Maiga Chang, Athabasca University
Yanyan Li, Beijing Normal University

Publication Chair:

Rita Kuo, Knowledge Square, Ltd.
Biographies of Contributing Authors (in alphabetical order)

**Frederick Ako-Nai** is a graduate student in the Master of Science – Information Systems (MsIS) program at Athabasca University. I received my Bachelor’s degree in Computing Science from Augustana University College (now a faculty of the University of Alberta). I am taking the project route for the final course in the MsIS program. My project topic will be Cross platform mobile application development. The applications developed will be used to access location-based learning contents, one of its many uses.

**Maiga Chang** is Assistant Professor in the School of Computing Information and Systems, Athabasca University (AU), Athabasca, Alberta, Canada. His researches mainly focus on mobile learning and ubiquitous learning, museum e-learning, game-based learning, educational robots, learning behavior analysis, data mining, intelligent agent technology, computational intelligence in e-learning, and mobile healthcare. He is guest associate editor of IEEE Multidisciplinary Engineering Education Magazine, the local chair of IEEE DIGITELE 2008, general co-chair of Edutainment 2009, and program co-chair of Edutainment 2011. He has participated in 156 international conferences/workshops as a Program Committee Member and has (co-)authored more than 147 book chapters, journal and international conference papers. In September 2004, he received the 2004 Young Researcher Award in Advanced Learning Technologies from the IEEE Technical Committee on Learning Technology (IEEE TCLT). He is a valued IEEE member for seventeen years since 1996 and also a member of ACM (since 2001), AAAI (since 2001), INNS (since 2004), and Phi Tau Phi Scholastic Honor Society.

**Guang Chen** (Ph.D.) is lecturer in the School of Educational Technology, Beijing Normal University. His current research interest is cognitive development in information age. Specifically, he is interested in studying digital textbook in K-12 education. He has been taking part in several projects of digital textbook in K-12 education in the past 12 months. Pilot studies will be carried out in some schools in 2012.
Andrew F. Chiarella joined the Centre for Psychology (now the Centre for Social Sciences) at Athabasca University in July, 2009. He received a doctorate in educational psychology in May of that year from McGill University. His research focus is on the empirical study of learning and instruction in traditional school subjects, and in particular the development of educational technologies. His current research focuses on the study of social software for education, specifically social annotation systems. He has designed and programmed a software application – called CoREAD – which aggregates the annotations (at the moment simple highlighting) of a community of readers and adds text signals (using font colour) to the text based on this community consensus. As the community of readers grows, these social text signals evolve in a self-organizing fashion. Essentially, these social text signals indicate which sections of the text were highlighted most often by the community of readers. It may be inferred that these sections of text are important to the community. Principles and characteristics of complex, self-organizing systems were used to design CoREAD.

Dr. Jon Dron is currently an associate professor in the School of Computing and Information Systems and member of the Technology Enhanced Knowledge Research Institute (TEKRI) at Athabasca University, Canada. Until 2007 he was a principal lecturer at the University of Brighton, UK. Straddling the technology/education divide, his research interests broadly centre around social aspects of learning technologies, with a particular emphasis on discovering, designing and employing methods and technologies to enable learners to help each other to learn. He is the author of the book Control & Constraint in E-Learning: Choosing When to Choose. He has been a keynote speaker at many international workshops and conferences, is author of scores of papers in journals, books and conference proceedings, several of which have received top paper awards at international conferences. He is a National Teaching Fellow of the Higher Education Academy in the UK.

Chaohua Gong is currently a graduate student in the R@D Center for Knowledge Engineering, at Beijing Normal University. She was graduated from the School of Teacher Education at Zhejiang Normal University with a master’s degree in 2006. Her research interests include e-Textbooks design, educational software design and open education resource distribution.
Sabine Graf has a PhD from Vienna University of Technology, Austria, and is presently an Assistant Professor at Athabasca University, School of Computing and Information Systems, in Canada. Her research expertise and interests include adaptivity and personalization, student modeling, ubiquitous and mobile learning, artificial intelligence, and learning analytics. She has published more than 70 peer-reviewed journal papers, book chapters, and conference papers in these areas, of which three conference papers were awarded with a best paper award. Dr Graf is Executive Board Member of the IEEE Technical Committee on Learning Technologies, Editor of the Learning Technology Newsletter, a publication of the IEEE Computer Society’s Technical Committee on Learning Technology (TCLT), and Associate Editor of the International Journal of Interaction Design and Architectures. She is an active member of the research community, serving as editorial board member of three international journals, workshop chair and organizer of ten international workshops, doctoral consortium chair at four international conferences, and guest editor of three special issues. Dr. Graf has been invited to given keynote/invited talks at universities/companies/conferences in Austria, Canada, Colombia, New Zealand, Taiwan, and UK.

Ronghuai Huang is a professor and deputy dean of Faculty of Education in Beijing Normal University (BNU). He is visionary and active in the field of exploring how to improve human learning by developing new tools and utilizing new methods innovatively, especially collaboratively learning and its supporting software. He has been engaged in the research on educational technology as well as knowledge engineering since 1997. He has accomplished or is working on over 60 projects, including those of key science and technology projects to be tackled in the national “Ninth Five-year Plan”, “Tenth Five-year Plan” and “Eleventh Five-year Plan” and the projects in the national 863 plan as well as others financed by the government. His ideas have been widely published, with more than 160 academic papers and over 20 books published both nationally and internationally.

Prof. Huang has been very active in academic organizations both at home and abroad. He was Co-chairs of the Program Committee of the 6th and 8th Global Chinese Conference on Computers in Education, and chairs of the Organizing Committee of the International Conference on Computers in Education (ICCE2006), the 10th IASTED International Conference on Computers and Advanced Technology in Education (CATE2007) and the 5th International Conference on Wireless, Mobile and Ubiquitous Technologies in Education (WMUTE2008). He was the General Co-Chairs of the 5th International Conference on Advanced Data Mining and Applications (ADMA2009) and the International Conference on Hybrid Learning (ICHL2010). He is editor-in-chief of Global Chinese Journal for Computers in Education (GCJCE). In addition, he is currently serving on the Executive Committee of Asia-Pacific Society for Computers in Education (2008-2011).
Dr. Kinshuk is Associate Dean of Faculty of Science and Technology, and Full Professor in the School of Computing and Information Systems at Athabasca University, Canada. He also holds the NSERC/ICORE/Xerox/Markin Industrial Research Chair for Adaptivity and Personalization in Informatics, funded by the federal and provincial governments of Canada and by industries. His work has been dedicated to advancing research on the innovative paradigms, architectures and implementations of online and distance learning systems for individualized and adaptive learning in increasingly global environments. Areas of his research interests include learning technologies, mobile, ubiquitous and location aware learning systems, cognitive profiling and interactive technologies. With more than 300 research publications in refereed journals, international refereed conferences and book chapters, he is frequently invited as keynote or principal speaker in international conferences and visiting professor around the world. He also has a successful record of procuring external funding over 11 million Canadian dollars as principal and co-principal investigator. He is Founding Chair of IEEE Technical Committee on Learning Technologies, and Founding Editor of the Educational Technology & Society Journal (SSCI indexed with Impact Factor of 1.066 according to Thomson Scientific 2010 Journal Citations Report).

Vive Kumar was born and raised in the south Indian state of Tamil Nadu. He attended 10 different institutions across the state to complete his 12 years of schooling prior to successfully completing his bachelor's degree in physics with distinction. Switching from physics to computer science proved to be a good move when he graduated his masters with top rank honours in 1990 that also launched his professional career as a scientist at the Centre for Development of Advanced Computing (CDAC) in Mumbai, India. During this tenure, he won a fellowship of the United Nations to work with Prof Alan Lesgold at the Learning Research and Development Centre (LRDC), University of Pittsburgh, USA. His research on 'model tracing' at LRDC won him a full PhD scholarship at the University of Saskatchewan, Saskatoon, Canada, where he worked with Prof Gordon McCalla and Prof Jim Greer. He graduated his PhD as the Best Graduating Student of 2001 and launched his academic career with Simon Fraser University as Assistant Professor. In 2006, he consulted for the Asian Development Bank and worked with the Open University of Sri Lanka in Colombo to develop an online learning infrastructure and a masters programme in educational technology. He then moved to New Zealand to take up an academic position with Massey University in Wellington. In August 2008, he came back to Canada as an Associate Professor in the School of Computing and Information Systems at Athabasca University to continue his beloved research in online learning technologies.

Vive(k)'s research centers around Technology-Enhanced Teaching, Learning, and Research that extends to mixed-initiative human-computer interaction, causal modelling, model tracing, automated instructional design, lifelong learning, cognitive modelling of self-regulated and co-regulated learning, semantics of online learning interactions, and competency modelling in portfolios. Vive(k) has been successful in attracting major research funds from NSERC, SSHRC, and BCKDF. He is active in the research community with quality publications, service contributions to journals and conferences, funding proposal reviews for NSERC, and establishing Indo-Canadian collaborative research. His personal interests include social impact of science fiction, empowerment of women through information and communication technologies, and comparative analyses of native cultures.
Yanyan Li is an associate professor in the Department of Educational Technology at Beijing Normal University. She received her PhD degree in computer software and theory from Institute of Computing Technology, Chinese Academy of Sciences. Her research interests include e-learning, semantic Web, computer supported collaborative learning, and text mining. She has published more than 50 academic papers in Internal Journals and conferences. Two of her papers have been awarded as the best paper in the IEEE International Conference on Advanced Learning Technologies (ICALT).

Fuhua (Oscar) Lin is a Full Professor and the Chair of School of Computing and Information Systems, Faculty of Science and Technology, of Athabasca University, Canada. Dr. Lin obtained his PhD in Virtual Reality from Hong Kong University of Science and Technology (HKUST) in 1998. Prior to working in Athabasca University, Dr. Lin was an Assistant Research Officer of Institute for Information Technology (IIT) of National Research Council (NRC) of Canada. Dr. Lin did post-doc research at University of Calgary in 1998-1999. He is conducting research in Intelligent Systems, Multi-Agent Systems, Virtual Reality, and their applications. Dr. Lin has more than 80 publications, including edited books, journal papers, book chapters, conference papers, and reviews. Dr. Lin is the Editor-in-Chief of International Journal of Distance Education Technologies. For details, please visit http://oscar.athabascau.ca.

Dr. Tan’s background is in aviation navigation, control engineering, computer science, and computer information systems. As a Northwest Polytechnic University undergraduate (Xi’an, China), he majored in Gyroscopic and Inertial Navigation. Dr. Tan conducted his PhD research at the Norwegian Institute of Technology in Trondheim, Norway on Robotics and Anthropomorphic Robot Teleoperation. He then performed a senior research fellow at the Japan Atom Energy Research Institute in Tokai. After he came to Canada, Dr. Tan worked in the IT industry for over ten years. He developed many software applications and provided system integration services to a wide range of companies and industries. Dr. Tan joined Athabasca University in 2007. His research interests include Location-Based Technologies, Mobile Computing and Technologies, Mobile Learning, Adaptive Mobile Learning and Commerce, Wireless Sensor Networks, Computer Network and Cyber Security, Cloud Computing, Enterprise Modeling and Information Management Systems, and Telepresence Robots. Since his return to the academic career, Dr. Tan has been program committee member, reviewer, and guest editor of international conferences and journals and has been invited to give research talks at various universities. He has also published and presented his research on location-aware technologies for mobile learning in wide range of international conferences and journals.
Dr. Dunwei Wen is an Associate Professor in the School of Computing and Information Systems at Athabasca University (AU), Alberta, Canada. He received the PhD degree in pattern recognition and intelligent from Central South University (CSU), Hunan, China, in 2001, and the MSc and BEng degrees from Tianjin University, Tianjin, China, in 1988, and Hunan University, Hunan, China, in 1985, respectively. Prior to his current position at AU, he was a visiting scholar in the Department of Computing Science at the University of Alberta, Alberta, Canada, from 2003 to 2004, and a faculty at Central South University from 1988 to 2007, where he became Lecture, Associate Professor, and Full Professor in 1991, 1997 and 2003 respectively. His research interests include artificial intelligence, natural language processing, machine learning and inference, data mining, intelligent agents and information systems. He has published more than fifty journal and conference papers, supervised thirty graduate students and research assistants, and taken part in eighteen research and development projects. He is a Member of IEEE, ACM, and AAAI.

Junfeng Yang received his Master degree from the School of Meida at Northeast Normal University in 2006, and have been working in Hangzhou Normal University since then. He is currently a Ph.D students in the R&D Center for Knowledge Engineering in BNU, whose supervisor is Professor Ronghuai Huang. His research interests include cross-cultural online collaborative learning, smart learning environment, and technology enhanced learning.

Yonghe Zhang is a PhD student from Beijing Normal University. I am interested in educational data mining and personalization learning. Recently, I am working on topic modeling approaches to extract interpretable topics from asynchronous discussion discourse. One application of such research is to help students and teacher understand the progress of discussion efficiently, and provide adaptive feedback to promot the disucssion.
Proceeding Abstracts

Reusable Intelligent Pedagogical Agents: a novel research direction in the making

Ireti Fakinlede, Vive Kumar
School of Computing and Information Systems, Athabasca University, Canada

Abstract: The benefits of embodied pedagogical agents have been well documented. In spite of the many advantages that they offer, their deployment into online learning management systems has been impeded by the high cost to develop them. Emerging technologies support the rapid development of reusable platform-independent digital assets including digital characters commonly referred to as avatars. This paper discusses our ongoing research that intends to apply the techniques used to create these interoperable avatars to embodied intelligent pedagogical agents that may be repurposed across various platforms and tasks by exploiting platform-independent concepts such as social intelligence and learning. The intelligent pedagogical agents, thus created, will be implemented and tested within a virtual world that provides real-time mixed initiative feedback to students in an undergraduate course in Java3D. The agents will be used to perform various tasks and then transported into other virtual environments to test their reusability.

Keywords: pedagogical agents, reusable agents, mixed-initiative feedback

Soft technology design - Building cyborg social spaces

Jon Dron
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Abstract: This is a paper about the design of systems that are part human, part machine. It uses a framework for understanding the nature of technology that builds on W. Brian Arthur’s notion of technology as the orchestration of phenomena to some use and the nature of technologies as assemblies. Technologies are treated as existing on a continuum between soft and hard, with soft technologies orchestrated by humans and hard ones embedding that orchestration within the technology. The concept is explored in relation to Athabasca Landing, a deliberately soft social system that attempts to avoid predetermined purpose and design so that its inhabitants actively create the technology as they use it. The paper describes some issues that arise and steps being taken to address them.

Keywords: social media, technology, soft systems, hard systems, social software
Student Clustering based on Their Online Annotation Behaviors

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Abstract: Students often annotate texts they are reading using highlighting, underlining, and written comments and marks in the margins of the text. These may serve various functions and will reflect each student’s goals and understanding of the text. This research proposes a simple biology-inspired approach to represent the patterns of student annotations and to cluster students based on the similarity between their annotations; the annotations produced were simple highlighting. To verify the effectiveness of the proposed approaches, the research compared the processing speed of the approach with generic hierarchical clustering algorithm implemented in Matlab and compared the accuracy of the clusters with the clusters created by human raters. The results show that the proposed approach is more efficient and accurate than the generic hierarchical clustering algorithm.

Keywords: Annotation, Biology-inspired, Chromosome, Patterns, Clustering.

Multiagent Virtual Learning Environments

Fuhua Lin, Sandeep Virwaney, Grant McClure, Jeanne Blair, Andrew J. Armstrong
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Abstract: Incorporating intelligence into virtual worlds for e-learning is becoming more desirable in making them smart, adaptive, personalized, and therefore, more effective and engaging. Work has been done with software agents in the context of multi-agent systems, and it makes sense to try to leverage that work when it comes to modeling functional modules, controlling realistic non-player characters, and maintaining student models in a virtual learning environment. There are challenges to integrating a multi-agent system into a virtual world including concerns with synchronization, communication, monitoring, efficiency, and control. In this paper we discuss these concerns while creating a framework that acts as an interface between a multi-agent system JADE/Jason and a 3D virtual world engine Open Wonderland.

Keywords: virtual learning environments, multiagent systems
The 5R Adaptive Learning Content Generation Platform for Adaptive Mobile Learning

Frederick Ako-Nai, Qing Tan
School of Computing and Information Systems, Athabasca University, Canada

Abstract: Ubiquitous mobile computing and the advancement in mobile networks have encouraged the growth of mobile learning. Since learning can take place at anytime and anywhere, there is an advantage to integrate the real world objects into learning contents, which creates a learning management system with time and location sensitive learning contents. Mobile devices have characteristics that include location awareness and heterogeneous. Thus, there are the possibilities and needs to provide mobile learners with location, time and device adaptation in addition to personalized learning. To implement the adaptive mobile learning, it is essential that the learning contents be of the sensitivities to be retrieved through the adaptation mechanism built in the learning management system. In this paper, an adaptive learning content generation platform is presented. The 5R adaptation framework is adopted in this content generation platform, which enables the mobile learning system to have the capability to provide right contents to right learner through right device at right location and right time. We will also provide an example to demonstrate how to use the platform to create adaptive learning contents.

Keywords: Adaptive learning, mobile learning, location-based learning, ubiquitous learning, learning content creation.

Online Variational HDP for Topic Modeling of News Articles

Jonathan Esterhazy, Dunwei Wen
School of Computing and Information Systems, Athabasca University, Canada

Abstract: The online version of the hierarchical dirichlet process (HDP) represents the current state of the art in probabilistic topic modeling research, because it allows for automated topic discovery in large, open-ended corpora. This paper demonstrates the application of the algorithm to a corpus of New York Times articles. It confirms previously reported results that show an advantage over online LDA in terms of model fit, and identifies the optimal HDP parameter settings to use for the target corpus.

Keywords: Text analysis, Hierarchical Dirichlet Process, Latent Dirichlet Allocation, Topic modeling, Variational inference, Probabilistic graphical models.
Adaptivity and Personalization in Learning Systems based on Students' Characteristics and Context

Sabine Graf, Kinshuk, Keri Baumstark, Farman Ali Khan¹, Paul Maguire, Ahmed Mahmoud, Tricia Rambharose², Victoria Shtern, Richard Tortorella, Qingsheng Zhang

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Abstract: Providing learners with personalized recommendations and/or adaptive courses that fit their characteristics and situation has high potential to make online and mobile learning easier and more effective for learners. However, most of the learning systems that are currently used by educational institutions do not provide adaptivity based on learners’ characteristics, needs or situation. In this paper, we introduce our research on considering different learner characteristics and their context in learning systems and therefore provide learners with personalized learning experiences.

Keywords: adaptivity and personalization, learning styles, affective states, cognitive traits, motivational aspects, context and environment

Expertise Network Discovery via Topic and Link Analysis in Online Communities

Yanyan Li, Shaoqian Ma, Yonghe Zhang, Ronghuai Huang

Knowledge Science & Engineering Institute, School of Educational Technology, Beijing Normal University, China

Abstract: Online communities have become important places for people to seek and share expertise. Yet with the increasing number of members and produced artifacts within the communities, it is challenging to find the influential experts who post topic-specific high-quality content. This paper presents an approach to discover expertise network in online communities based on textual information and social links. In addition to computing documents’ topic-focus degree, the approach measures the quality of documents according to users’ feedback behaviors and topic-specific influence of users who give feedback. In this way, user’s expertise rank and social links are both considered to constitute expertise network. Experiments on real dataset have shown that our approach is effective to discover the meaningful expertise networks.

Keywords: Expertise finding, online community, social link, textual information, topic-specific.
Note-taking Markings in Pupil's Textbook: Features and Influence Factors

Guang Chen, Chaohua Gong, Ronghuai Huang
Faculty of Education, Beijing Normal University, China

Abstract: As an important learning strategy, note-taking has been long drawing researchers’ attention. This paper analyzes features and influence factors of note-taking markings in Chinese and mathematics textbooks for primary schools through content analysis and interviews leading to the following results. Firstly, the features of note-taking markings in the textbooks embody in three aspects of the forms, locations and contents of note-taking. Secondly, the important note-taking influence factors contain individual initiatives, teachers’ lecturing speed and the level of contents. Thirdly, the note-taking contents have obvious diversities in the subjects and grade sections. Fourthly, the textbook is an important cognitive tool for pupils’ study and an important intermediary tool for home-school communication. Fifthly, teachers have to guide pupils to develop good habits of note-taking. Sixthly, the design of note-taking function for eTextbook should take the features of note-taking markings in printed textbooks into consideration with the enrichment of note-taking forms and providing different note-taking tools, etc.

Keywords: note-taking markings, textbooks, behavior features, influence factors, the design of note-taking function for eTextbooks

Research on the Feasibility Investigation of e-Textbooks in China's K-12 Schools

Chaohua Gong, Guang Chen, Ronghuai Huang
R&D Center for Knowledge Engineering, Beijing Normal University, China

Abstract: e-Textbook refers to a type of e-books with special functions that meet specific content standards. Our goal is to fully understand the feasibility of applying e-Textbooks in China's K-12 schools. Our methodology for addressing this issue involved interviewing and sending questionnaire to five groups of people: teachers, students, parents, publishers and school administrators. The interviewing and questionnaire surveyed these individuals about their views regarding the disadvantages of printed textbooks, and the function, advantages and drawbacks of e-Textbooks in the digital age. The respondents believe that the advantages of e-Textbooks outweigh their potential disadvantages and they should be used to supplement printed textbooks. They also felt that in the digital age, the use of e-textbooks is a trend and that such books do not just duplicate printed textbooks; they found that the usefulness of e-textbooks, as a teaching tool, has exceeded their expectations. However, the respondents also expressed concerns about the negative impact of e-textbooks on the physical health of students and their studies and reading skills. Many schools in China have yet to use e-textbooks, so our findings suggest that such schools should make use of them, they also a useful starting point for further make detailed investigation of the problem.

Keywords: K-12 schools, e-Textbooks, Feasibility investigation, interviews, questionnaires, target groups of users.
Automatically extract interpretable topics from online discussion

Yonghe Zhang, Yanyan Li, Ronghuai Huang
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Abstract: Teachers adopting CSCL often face the challenge of handling massive textual information, and finding it difficult to have a clear grasp of the topics being addressed in the discourse. Topic modeling, an emerging field in machine learning, has the potential to solve this problem by automatically extracting from text collections formal representations of latent topics. However, the interpretation of latent topics is still a challenge, which hinders the use of this state-of-the-art technology from wider use in CSCL contexts. In a recent paper, we put forward a novel topic discovery method, the fLDA model, based on Minsky’s Frame theory. This method has the advantage of providing outputs that are potentially more easily interpretable for generating the topic of each thematic cluster. In this paper, we show how fLDA can be used in extracting and visualizing the topics of asynchronous online discourse from two classrooms.

Keywords: topic modeling, frame theory, CSCL, interaction analysis.

Cross-Cultural Web-based Collaborative Learning

Junfeng Yang, Ronghuai Huang
R&D Center for Knowledge Engineering, Beijing Normal University, China

Abstract: The purpose of the study was to identify the characteristic of cross-cultural web-based collaborative learning (WebCL), and to find out ways to facilitate cross-cultural WebCL. The study was carried out between the third year students of Hangzhou Normal University China and the postgraduate students of University of North Carolina Willmington U.S.. A web-based learning environment (WBLE) was developed and students from both sides collaborate for learning through WBLE. The research is based on a questionnaire as a mean of data collection method to find out characteristics of cross-cultural web-based collaborative learning, and the study progressed through finding relationships between the variables used in the data collection instrument. The findings of the analysis reveal that social interaction plays an important role and students prefers to have more prior knowledge of each other’s cultures and backgrounds and to have more in-depth conversations individually. Based on the results, three methods to facilitate cross-cultural WebCL are put forward.

Keywords: WebCL, CSCL, Cross-culture, Collaborative Learning
Proceedings of
2012 The 1st International Symposium on
Smart Learning Environment
Reusable Intelligent Pedagogical Agents
a novel research direction in the making

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Abstract—The benefits of embodied pedagogical agents have been well documented. In spite of the many advantages that they offer, their deployment into online learning management systems has been impeded by the high cost to develop them. Emerging technologies support the rapid development of reusable platform-independent digital assets including digital characters commonly referred to as avatars. This paper discusses our ongoing research that intends to apply the techniques used to create these interoperable avatars to embodied intelligent pedagogical agents that may be repurposed across various platforms and tasks by exploiting platform independent concepts such as social intelligence and learning. The intelligent pedagogical agents, thus created, will be implemented and tested within a virtual world that provides real-time mixed initiative feedback to students in an undergraduate course in Java3D. The agents will be used to perform various tasks and then transported into other virtual environments to test their reusability.

Keywords—pedagogical agents; reusable agents; mixed-initiative feedback

I. INTRODUCTION

Empirical studies show that social interaction and collaboration are useful tools for successful and effective instruction often resulting “in learning that outperforms the ability of the best individuals in the group, produces knowledge that none of its members would have produced by themselves, and leads to the generation of new ideas” [1]. Yet, peers and learning companions are generally missing in conventional online learning environments. With the focus geared towards personalization, to meet individual needs and preferences, it is difficult to match optimal peers, coordinate schedules or avoid off-task distractions [2]. In addition, the spatial and temporal separation between teaching and learning processes takes its toll on student morale and motivation [3], [4].

Embodied pedagogical agents are animated life-like characters embedded in instructional applications [2] aimed to positively impact learner motivation (e.g., self-efficacy, attitude, and interest), affective outcomes (e.g., feelings of connection, relief of frustration) and engagement in learning tasks [2], [5], [6]. Pedagogical agents assume instructional roles as well as roles that facilitate collaboration and competition through digital characters where human peers are unavailable. Seminal works by Vygotsky, Paget & Bandura have indicated that teaching and learning are essentially social activities and that social interaction is a key mechanism in the process of learning development [2]. Empirical studies also demonstrate the benefits of social interaction to the motivation to learn as well as the learning process itself known as the social-cognitive aspect of learning [2]. Social-cognitive learning theories recommend a paradigm shift from viewing software modules (e.g. AI techniques that facilitate personalization and adaptation services) as tools to viewing them as social actors playing various instructional roles so as to emphasize their implicit social relationship with the learner [2], [6], [7]. Examples of roles assumed by pedagogical agents include roles traditionally attributed to humans such as [2], [7], [8]:

- Expert agents provide adaptive feedback and demonstrate expertise in the domain. Examples include: Steve and Adele [9]
- Tutor agents identify student misconceptions and employ corrective measures that encourage deeper reasoning. These can be seen in intelligent tutoring systems (ITS).
- Motivator agents provide verbal persuasion, affirmative feedback and encouragement by emphasizing affective affiliation with the learner. Examples include MIMIC [8]
- Mentor agents simulate the ideal instructor by combining the roles of expert, tutor and motivator into one single agent. Examples can be found in [8]
- Peers or pedagogical agents acting as learning-companions (PALS) simulate and reflect the social interaction that exists naturally between peers in traditional classrooms. PALS can take on several peer roles such as collaborator, competitor, as well as that of the equally or less competent peer. Their design is based on learning theories and studies that show that peer-to-peer learning can be more effective than expert-to-learner because learners get a stronger sense of personal efficacy from the peers.
• Other teaching assistant roles which are programmed to provide information and/or encouragement, and to share menial tasks with the learner. Examples of non-traditional pedagogical agents include teachable agents [10] which facilitate the teaching theory of “learning by teaching”. With teachable agents, the roles of learner and teacher are reversed with the learner taking the responsibility of ensuring that the pedagogical agent understands the required concepts. It is proposed that in the processing of educating the pedagogical agent the learners perform tasks that indirectly ensure that they in turn adequately learn the concepts.

In other to be believable and effective it is recommended that embodied pedagogical agents adopt anthropomorphic qualities [2]. In addition to looking human-like, it is necessary for agents to express embodied actions that facilitate spatial and other forms of non-verbal communication [11] as well as provide the learner with real-time mixed initiative feedback to be perceived as “real” [12], [13]. “Social presence is a function of both verbal cues (e.g., tone of voice, prosody) and nonverbal cues (e.g. facial expression, direction of gaze, posture, and deictic gestures).” [5] Facial expressions (eye, eyebrow, and mouth movements) and deictic gestures (e.g., pointing with arms and hands, head-nodding) are important for pedagogical agents to simulate social interaction. Gesturing can reduce ambiguity by focusing learner attention, facial expressions and postures can reflect and emphasize agent message (i.e. a teacher affecting a stern posture to make the learner feel remorseful), emotion (i.e. interest, curiosity, excitement, confusion, frustration, and discouragement), personality, and other behavioural variables [5] and other animations such as blinking, gaze and other eye movement simply demonstrate that the agent is alive and responsive. In addition to appearance and communication ability, responsiveness can also be expressed by providing social interaction through real-time situated mixed initiative feedback. “To foster effective learning, we believe a key desirable feature of interaction of learners with pedagogical agents is that learners should be able to take control while they are performing problem-solving actions, and the agent should be able to take control when it appears that learners are experiencing difficulty or when they ask a question.”[12]. Agents promote interaction with the learner by expressing plausible and consistent responses to environmental changes and learner’s prompts. The content of their communicative acts must be appropriate for the particular context, conform to social rules and expectations, and behaviourally consistent i.e. the agent has a perceivable personality.

Common research problems encountered in building application which involve the usage of digital characters, especially when the application demands the facilitation of social interaction and communication with user [14], include:

• Appearance and visual fidelity - “Building a digital character is not an easy task. It requires the skills of a sculptor to create the model, the skills of a painter to texture the skin and the skills of a technical director to build the skeleton and rig the character. Most production houses hire separate artists and technicians to complete each part of this pipeline. A typical character can take days or weeks to build.” [15] “Even with the rapid evolution of technology, the creation of a professional-level avatar for video animation or simulation work can still take several weeks to months, and tens of thousands of dollars” [16]. The ability to modify how an agent looks so as to provide a variety of character types that realistically reflect gender, race, age and other such physical preferences efficiently and cost effectively remains a challenge.

• Mixed-initiative feedback - To perform mixed-initiative feedback the agent must be capable of dialoguing with the human learner. Key features require the agent to be reactive (i.e. environmentally aware of the learner’s actions, its effects on the environment and be able to respond according), proactive (i.e. the agent is capable of initiating an intervention or take over the conversation and is able to do so at the appropriate time), and socially conscious (i.e. aware of and capable of using human communication protocols and social rules). In addition the agent requires knowledge-base from which to populate its messages during the dialog. In other words, the agent has to be intelligent.

• Speech and Natural language processing - Russell & Norvig [17] illustrate a communication episode as composed of two roles (speaker and hearer) and seven processes:
  o Speaker
    • Intention (the decision to perform a speech act on the hearer)
    • Generation (constructs the sentences or utterances)
    • Synthesis (physical production of the appropriate sounds)
  o Hearer
    • Perception (perceives the physical realization of the speech act)
    • Analysis (interprets the sounds)
    • Disambiguation (infers what the speaker intended to convey)
    • Incorporation (becomes part of the hearer’s knowledge base)

Together, these processes form what is known as natural language processing (NLP). Unlike formal language, natural languages do not have a strict definition and meaning is often situated i.e. the meaning of an utterance depends on the context within which it is produced. Understanding unrestricted natural language input requires deep knowledge of the context.
and reasoning skills for disambiguation [18]. To engage in meaningful discourse, the agent must also be able to understand how sentences are joined into coherent segments and be able to resolve references that may lie across multiple sentences. While emergence of several automatic speech recognition (ASR) and text-to-speech (TTS) translators have made the physical creation (i.e. synthesis) and perception of speech sounds more accessible, the focus of natural language processing research remains focused on generation and disambiguation of natural language speech text.

- Lip-synching, gestures and behavioural authenticity - Payr [6] speculates that the design of pedagogical agents that display believable personalities, including emotions is the biggest challenge to agent researchers so far. These involves both the ability to animate verbal and non-verbal cues as well as the AI technology to know when it is apply the animation appropriately based on context. Animating the pedagogical agent consists of applying deformations at skin level and at the joint/skeletal level. In addition to the artistic aspects, animation requires the application of mathematical models and algorithms of making accurate calculations related to deformation properties. Notable researchers that tackle these issues include Maestri, Blanz and Lander [19]. Currently this is a slow process where each animation sequence has to be created separately and in advance for each skeleton type, prompting research into algorithms to transfer animations from one skeleton type to another [20] as well as algorithms and tools for creating animations real-time.

With the time, and resources that go into the development of the agents, the desire to make them reusable and thus extend their shelf life is only natural [21]. Currently the design of pedagogical agents is limited to the knowledge and skill of its author. With reusable pedagogical agents, both users and designers can select and use the best available agents.

The mainstream popularity and initial corporate interest in virtual worlds as well as the success of massively multiplayer online games (MMORG) instigated the emergence of technologies which support rapid development of interfaces that promote three dimensional human-computer interactions. These 3D virtual worlds are able to bridge the spatial divide by facilitating social interaction through digital characters, popularly referred to as avatars, that share the same virtual location thus simulating social presence or co-presence, defined as the sense of 'being there together' with other geographically dispersed users [11] and even non-existent characters (i.e. NPCs). There have been several initiatives, with varying degrees of success, to make these avatars interoperable i.e. exportable to multiple virtual environments without any extra production effort. The plethora of toolkits for building and maintaining online 3D worlds has increased motivation to harness these techniques for educational purposes with the hope that these online avenues can support the rapid development of rich, engaging and vibrant learning environments that incorporate embodied pedagogical agents.

It is the goal of this paper to propose a framework for reusable intelligent pedagogical agents by extending the notion of interoperable avatars. The pedagogical agents thus created will be used to provide real-time mixed initiative feedback within the context of a virtual environment for an undergraduate course in Java3D. After which they will be transported to other environments to test their reusability.

The rest of the paper contains the following sections. Background provides an overview of the state-of-the-art, related work and motivation. Problem Statement states the main problem to be solved and the research questions to be addressed by this research. Methodology provides the methods and materials to be used in carrying out the research experiment as well as a timeline that establishes time frame in which the research will be carried out. Results and Outcomes discuss the result to be expected, how the data generated from the experiment is to be analysed and the research deliverables. Conclusion finally gives a summary of what is to be achieved by this research project and its possible contribution to the related fields and society at large.

II. LITERATURE REVIEW

Here, we review literature relevant for our work and address how it relates to motivation behind this research.

A. Related Work

Standardization and interoperability of virtual worlds and digital assets are not new concepts. There have been three major approaches made within the last 20 years [22]:

- interoperability standards - which provide ways for different virtual worlds to exchange information e.g. by defining standards to move avatar information and assets between worlds
- infrastructure standards - which define common internal representations and application programming interfaces to be used across infrastructure
- semantic mark-up standards - which define standards in terms of the role of each object within the environment, its visual (or other) representation being stored separately, even outside of the world

At the height of virtual world popularity, in 2006-2007 the IETF Virtual World Region Agent protocol standards group considered avatar interoperability and initiated the Virtual Worlds Roadmap effort metaverse [MV] which was later abandoned with initial corporate interest in virtual worlds waned [22]. None-the-less, it is still a hot topic as in July 2008, IBM and Linden Labs which control two of the most popular virtual worlds (Second Life and OpenSim) announced an interoperability agreement following the successful transportation of avatars from the Second Life preview grid into a virtual world running on an OpenSim
Semantic mark-up standards on the other hand have been more successful for standardization purposes [22] especially the use of open standard XML schemas for exchanging digital assets. This is largely due to the support of popular 3D graphics applications e.g. 3D Max Studio, Maya, Blender, Poser, etc. Semantic mark-up languages represent a flexible way of capturing the content and even intent of a virtual world, right now, without forcing a common graphics standard [22]. Recently, the Evolver [26] web portal has streamlined the process of creating customizable reusable virtual characters that may be deployed across various applications that use avatars. Evolver is the first solution to bring together complex 3D modeling, consumer ease of use, and fully interoperable avatars [26], [27]. The evolver web site’s simplicity and user friendly interface makes it easy for anyone to dive in and create a 3D avatar that is exportable to many applications simply by clicking and dragging [27]. Unlike other 3D modelling applications that build each 3D model from scratch using structural tools, evolver is able to cut down on the time needed for development by utilizing special morphing bins that reuse a set of predesigned body types and facial features to form new models [27]. Evolver avatars rely on XML avatar files for easy deployment across several online environments including social networking sites (e.g. facebook), online virtual worlds (e.g. SecondLife, Open Wonderland), online games, video clips, greeting cards, mobile apps, as well as professional animation and pre-visualization projects using simple drag and drop techniques. Avatar XML files have become the ipso-facto standard for specifying avatar files that contain the definitions of parameters affecting avatar appearance. Including the association of attachments files such as BVH animation files is used to store skeleton and motion data i.e. relative joint positions and raw data representing rotations. The virtual worlds contain special loader modules for reading and interpreting these XML formats. Other popular schemas for exchanging digital characters have limited environment awareness and must rely on a human controller for direction in navigating and interacting with the virtual environment. While these standards are good for representing the pedagogical agent’s physical embodiment, additional techniques must be employed to support agent control for real-time interaction. Techniques currently used to support agent verbal and non-verbal communication include scripting tools such as: Avatar Mark-up Language (AML), Affective Presentation Mark-up Language (APML) and ECMAScript (E4X) format. The main problem with scripting is that it is generally hard coded therefore the agent can only react to situations foreseen by its author and therefore isn’t fully autonomous. To provide real-time interaction and feedback, the digital character must be capable of utilizing AI techniques. So far MPEG_V [28] is the only standard that endeavours to represent digital characters as agents [19]. However, even MPEG does not incorporate an agent mind, where the agent is empowered to make real-time autonomous decisions. Integrating chatbot rule-based xml schema with the more digital assets exchange schema will empower pedagogical agents to perform speech acts spiced with appropriate animations. In addition these techniques may also be extended to define the agent mind using a rule-based xml schema to define possible plans (i.e. pedagogical strategies) and their triggers. Conventional chatbot techniques are only slightly intelligent as their response rules are generally hard-coded [29]. The incorporation of learning techniques will allow the agent to increase its knowledge-base of patterns and responses in real time and thus increase its believability over time. One possibility for achieving this is the incorporation of case-base transfer learning techniques. Given a new problem p to solve, this case based transfer learning begins by retrieving one or more similar cases (that is, problem-solution pairs) from its memory, or case base, and reusing their solutions. Solution reuse may require an
adaptation of the retrieved cases' solutions for use in solving p. The proposed solutions may be revised in light of its performance [31].

III. METHODOLOGY

There are three basic characteristics of reusable intelligent pedagogical agents. They are: Interoperability and platform independence, General-purposeness, and Inheritance. Interoperability and platform independence enables the agent to be exchanged and transferred to multiple environments, while general-purposeness allows agents to learn to solve new tasks thus increasing their shelf life and finally inheritance allows agents to be extended and modified. To achieve these, the following research questions have to be answered:

* What is the most efficient framework (basic architecture) for reusable intelligent pedagogical characters?
  * formalization of a standard format for importing the pedagogical agents into online virtual world and representing base models that can be expanded thorough inheritance
  * What is the most effective framework for the reasoning capability for solving dynamic task environments:
    * formalization of a social intelligence protocols and rules that support social interaction such as co-operation, negotiation, transfer of domain knowledge and mixed initiative communication
    * formalization of case-based transfer learning techniques which include methods for task break down, pattern identification and pattern matching

Here we present our current plans to test our hypotheses.

A. Test Bed

The undergraduate course COMP 382 – 3D Game Programming in Java at Athabasca University, which teaches students computer 3D graphics with the Java3D API, will serve as the test bed to validate the model for a general purpose intelligent pedagogical agent. The test-bed will be implemented within a virtual world where the students participate in several sequential learning activities with the support of pedagogical agents using mixed initiative interaction. Here the pedagogical agent is responsible for adapting its pedagogical strategies to each individual student and activity.

B. Scenario

A student named Peter logs-in to the Virtual Learning Environment through a link in Moodle and is immediately transported into a 3D classroom which is populated with various artefacts related to various learning activities. The first time Peter logs in, he would be approached by a pedagogical agent that would endeavour to create his learner profile by asking several questions using mixed initiative interaction. Based on this profile, the pedagogical agent will select Peter’s first activity and adapt itself to play an instructional role that matches Peter’s preferences. The pedagogical agent then supports Peter through the activity using pedagogical strategies based on the role that it is playing. Throughout the activity the agent collects data which is used to update and improve Peter’s profile as well as modify the interaction and provide real-time feedback aimed to maximize Peter’s performance. Once the activity is successfully completed, Peter has the option of moving on to the next activity or logging out. If Peter chooses to log out, his state is saved so that he is able to continue to the next activity when he log-in again at a later time. Each activity involves a mixed-initiative interaction episode. At the beginning of each episode the pedagogical agent takes control of the interaction to explain and discuss the goals of the activity with Peter. During the activity pedagogical agent can perform the roles of mentor, expert, motivator, peer, etc. depending on Peter’s interaction and feedback preferences. Each role encapsulates a set of pedagogical strategies and goals. For example, the goal of the motivator is to encourage the student and ensure that (s)he is fully engaged. The motivator will achieve these goals by providing affirmative feedback as often as needed. A PAL is also interested in keeping the student engaged but the strategy employed to achieve this is quite different. A peer can support engagement through competition or collaboration.

C. Architecture

The knowledge model of the pedagogical agent is comprised of four models:

* Domain Model: represents the expert knowledge related to each task. The domain knowledge includes the content to be learned as well as the steps involved in accomplishing each task.
  * Learner Model: represents the knowledge about each student. The learner model is a sub-class of the internal model that the agent uses to store information about potential candidates for interaction i.e. other agents within the social environment. The basic model divides “others” into friends, enemies, strangers, acquaintances. The designations indicate the trust level i.e. friends are highly trusted characters, while enemies are not to be trusted. Strangers indicate characters for which no information is available and acquaintances have limited interaction but so far it has been positive therefore they hover around 50%.
  * Pedagogical Model: represents the pedagogical strategies to be employed. As mentioned these strategies are encapsulated within various instructional roles. Where the goals are defined by pedagogical actions e.g. explain, suggest, demonstrate, show, tell, inquire, affirm, agree, disagree etc. The pedagogical
actions are chosen based on the pedagogical strategy associated with the role that the pedagogical agent is playing and accomplished based on a behavioural/interaction model which contains rules and recipes to achieve each goal using mixed initiative interaction.

- Interface Model: represents knowledge about the virtual world, including all phenomena that the learner and pedagogical agent have to take into account during interaction with each other and with the environment. The interface model is comprised of both the physical and social environments. The physical environment is represented by a spatial map that indicates the perceived location of all digital assets within the environment. The social environment is represented by a workspace that indicates all the participants of a mixed-initiative interaction episode and the tools available in the environment for communication i.e. instant messaging, voice etc.

D. Experiment Design

The experiment is designed to qualitatively and quantitatively measure the performance of pedagogical agent especially the efficacy and impact on student learning. Based on the pedagogical agent’s specifications, performance is measured for the following:

- Adaptively:
  - Task: evaluate the retrieval and reuse mechanisms of the general-purpose agent by calculating its initial advantage. This involves measurement of the increase of the agent’s performance based on transfer learning, decrease in the amount of time needed to solve new problems (learning rate), and comparing these values to those of a brand new agent.
  - Student: qualitatively measure student feedback about the agent’s performance.
- Interoperability: evaluated by measuring the time and resources needed to move a pedagogical agent from one platform to another as well as comparing the performance of a imported agent to a locally created one.
- Believability: evaluate the fidelity, realism of the agent when conducting mixed-initiative interaction. Also known as a believability analysis, this may be conducted both qualitatively using a modification of the Turing test and quantitative using a believability index. In addition believability can be measured qualitatively through the student’s perception on the effect of the systems on their motivation and performance as well as their with the user interface.
- Student Engagement: this can be measured quantitatively by monitoring the level of user participation and logging the following data
  - Extent/frequency to which the system is used
    - Time of the day
  - Days of the week
  - Differences during different stages of the course
  - Relation to studied material (how long before or after studying the related material)
  - Student Performance: through the use of control groups, one can compare the performances and engagement within the course of students using the pedagogical agents compared to students working on their own without the benefit of a pedagogical agent.

IV. Conclusion

The advantages of reusable interoperable agents cannot be over-emphasised. They include the simplification of agent behaviour authoring, agent definition storage, conversion, transfer and exchange across platforms, support for the procedural generation of agents, and more effective and scalable workflow by allowing speech and animation content to be leveraged in different contexts without the extra production effort [13], [22], [25].

We propose that these techniques can be blended to create intelligent pedagogical agents that may be efficiently repurposed for various tasks across various environments and platforms; thus, facilitating the rapid development and adoption of animated embodied pedagogical agents in learning management systems.

It is the goal of this research to propose, implement, and evaluate a framework for reusable intelligent pedagogical agents by extending the notion of interoperable avatars. The pedagogical agents thus created will be used to provide real-time mixed initiative feedback within the context of a virtual environment for an undergraduate course in Java3D. After which they will be transported to other environments to test their reusability.

In all, this paper offers an overview of the state-of-the-art in pedagogical software agents, presents related work and motivation, defines the problem in terms of research hypotheses, outlines a research methodology to test the hypotheses, discusses potential outcomes, and summarises possible contribution to related fields and society at large.

REFERENCES


Soft technology design

Building cyborg social spaces

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Abstract—This is a paper about the design of systems that are part human, part machine. It uses a framework for understanding the nature of technology that builds on W. Brian Arthur’s notion of technology as the orchestration of phenomena to some use and the nature of technologies as assemblies. Technologies are treated as existing on a continuum between soft and hard, with soft technologies orchestrated by humans and hard ones embedding that orchestration within the technology. The concept is explored in relation to Athabasca Landing, a deliberately soft social system that attempts to avoid predetermined purpose and design so that its inhabitants actively create the technology as they use it. The paper describes some issues that arise and steps being taken to address them.

Keywords—social media; technology; soft systems; hard systems; social software

I. SOFT AND HARD TECHNOLOGIES

Technologies are the orchestration of phenomena to some use [1]. A subset of technologies requires involvement of humans to be the orchestrators of the phenomena in question. We call these ‘soft’ technologies. Others embed that orchestration in the technologies themselves. We call these ‘hard’. This orchestration does not have to be embedded in a physical object: for example, laws and regulations, if they cannot be broken, may be hard technologies. Virtually all technologies are assemblies of other technologies (ibid.), and the vast majority are assemblies of soft and hard technologies. To a computer programmer, a computer may be one of the softest technologies ever created while, to a sales clerk, it may be one of the hardest. This is because each instance is a different assembly, orchestrating different phenomena for different purposes, therefore each is a different technology despite using many of the same tools.

The same is true of, for example, a learning management system (LMS), which is a different technology for a course developer/tutor than it is for a student. Soft technologies provide the potential for flexibility, creativity and change, but they are prone to error, require judgment, skill and practice to use well, and are often slow and time-consuming to enact. Hard technologies are restrictive, limiting the potential for creativity and flexibility, but they make our lives easier, more efficient, perform reliably and typically fast. In any given context, from one person to the next and from one use to the next, the need for softness or hardness will vary. A technology that is too soft may require too much thought, too much learning, may be too slow, too unreliable, and too expensive. A technology that is too hard can be dehumanizing, and prevent us from acting as intelligent, creative agents. Hard technologies are intentionally proof against change. Hard technologies can, however, be softened through additive assembly. For example, if a machine only produces one kind of widget, a human can provide finishing touches, or a further hard technology can be used to change it. However, if the assembly involves replacing one technology with another, technologies can also be assembled so as to increase hardness. For example, an automatic gear-shift might replace a manual gear shift or informal coursework submission via email can be replaced with an automated submission system.

II. SOFT AND HARD TECHNOLOGIES IN ONLINE LEARNING

Pedagogies are soft technologies [2] but can be hardened. For instance, an LMS is a fairly soft technology to a course designer but it embeds not only administrative conventions in automated tools but also pedagogies. Through hardening, the LMS makes what would otherwise be a difficult process easier because it constrains choices, thus requiring less skill from its users than, say, a tailor-made system built using PHP/MySQL. However, though it makes things easier, it can harden too much. For example, in a survey of around 7000 courses running on an institutional Blackboard system, 99.15 percent of course designers had accepted the default of showing announcements as the first and most prominent item in the course, despite many (on reflection) not wanting its implied power structure and it being a relatively simple task to change it [3]. Similar defaults and more rigid constraints lead to pedagogically non-neutral features such as fixed weekly sequences, threaded discussions separated from the content that they discuss, and many other small and large influences and constraints. The process is even more constrained because such systems tend to be run centrally and therefore often embody decisions that are a necessary compromise to fit the needs of all interested parties. For instance, they may provide a standard pattern for course design, a standard visual style or a set of components designed to meet most (but seldom all) needs.
III. ATHABASCA LANDING

We have built an Elgg-based system, Athabasca Landing, that is deliberately very soft, that does not embody fixed pedagogies, working processes, or methods, but that can become whatever people need it to be. Perhaps its most fundamental guiding principle is that its users are, in every way possible, owners of the system and everything they create there. No individual has any more rights or privileges than any other, from the university president to visiting students. The purpose of the system is to become any system that users desire. We achieve this by providing a lot of small, fairly hard components that are linked through a single environment and that may be mixed and blended at will, following the principle that technologies can be softened or hardened by assembly. Individuals may choose the pieces they need in order to create a vast range of different technologies, both soft and hard. The Landing is a hierarchy-free social construction kit, consisting of the Elgg core and around 110 plugins that provide features such as blogs, wikis, photo albums, widget-based personal profiles, messaging, a widget-based personal learning environment (PLE), file sharing, podcasting, RSS aggregation, discussion, video blogging, bookmarking, group creation and more. The Elgg framework gives great freedom for people to decide, for every object they create, exactly who can see it, from totally private through to totally public. The Landing has social networking functionality but that is not its main purpose – as Chris Anderson puts it, the social network is a feature, not a destination [4]. It currently has around 2900 users and the number is steadily rising. A small core team and a loose confederation of around 75 ‘friends’ provide support and guidance and, together, manage the Landing from the bottom up, deciding what it needs and how it is run.

The Landing caters for what we have identified as the three social forms used in online learning, the group, the network and the set [5]. Groups are the traditional stuff of social learning, typified by classes, tutorial groups, committees etc, with roles, purposes, membership and structure. Typical technologies used for groups include discussion forums and LMSs. The vast majority of existing research in social methods of online and distance learning relates to groups, and almost all social constructivist pedagogies are based on the assumption of a group. Networks are looser emergent structures formed by individual connections, with no fixed borders, no hierarchies or roles. Typical tools include blogs and social network systems. Networks are the cornerstone of modern Web 2.0 approaches to learning most coherently exemplified by connectivist pedagogies and methods [6]. Sets are still looser social forms where we do not care so much about individuals as the attributes those individuals share. Typical tools include subject-organised wikis, tagging systems and publication systems. Very little research has been performed on sets, despite their ubiquity in traditional teaching (eg. through publication to specific audiences or even through classroom processes such as a show of hands or the use of statistics to guide course design). The different social forms are not exclusive, overlap, can merge with or be contained by one another. Sets and nets are especially useful in helping to generate collective intelligence [7], [8], where we amalgamate individual actions of many people in order to provide useful knowledge or guidance – collaborative filters, tag clouds, rating systems, social network analysis, for example. The Landing already provides a range of collective tools and we are building a flexible collaborative filtering widget that can be instantiated in many ways to provide many kinds of recommendation using a range of different algorithms and forms of presentation.

IV. LOST IN SOCIAL SPACE

A very flat space that can become infinitely many technologies but that is built from standard components makes it extremely hard to see structures that form within it. It is very easy to become lost in social space, where different social forms and different uses all look much the same and there is (very deliberately) no top-down structure to guide people, no pre-specified purpose to channel activity and behaviour. This affects both navigation, where the lack of structure makes it very hard to get a sense of place, and authoring, where the are few cues to help decide what to do and how to do it: the nature of soft technologies means that they are invented by their users and therefore demand skill and intentional design to work effectively. The more flexible we make our tools, the more difficult they are to use. We are taking several approaches to address these issues [9], including:

1. Faceted profiles. Like most other social systems, what is presented to others through a Landing profile or in one’s PLE is a view of one set of things, simply filtered by access controls. However, real people present different facets in different social situations and in different ways, and academic life is full of social discontinuities as we move from one lesson, project or group to another. To deal with this complexity, we are creating a multi-page profile/PLE that gives greater control, allowing people to create and shift easily between different contexts, to present themselves in different ways to different people, including personal spaces for their own use that allow them to organize social and content artifacts in different ways for different purposes. We have made configurable widgets that allow people to exercise very fine-grained control over what each widget shows on these pages.

2. Using social forms to provide different menu options. There is currently a menu that provides a uniform set of tools that may, confusingly, apply equally in personal, group, set and network contexts. We will provide views to make it simpler to switch between social contexts, thereby reducing the blurring between social forms.

3. Providing exemplars, stories and templates. The softness of the Landing means that it is difficult for individuals to know what to do with it or how to make it do what they want. We are using soft processes to spread that knowledge across the sets and nets that it supports, much of which is created by users of the
Landing rather than its software designers. By spreading stories and showing exemplars, combined with the naturally occurring set and net modes that the system supports, ideas and methods can spread organically through the system.

V. CONCLUSION

The Landing, like all soft technologies, is a cyborg, an amalgam of human and machine. Designing such a system is far less about the software than it is about the people that turn it into different technologies, especially given the complex interactions between people, the spread of knowledge through the network, and the collective intelligence that emerges from the system. This takes us far beyond traditional information system design, leading to a bottom-up design process more like ecosystem management than architecture, responding to and enabling co-evolution and organic growth. We are still trying to develop a sustainable approach to management and development. This takes us far beyond traditional information system design, leading to a bottom-up design process more like ecosystem management than architecture, responding to and enabling co-evolution and organic growth. We are still trying to develop a sustainable approach to management and development. The constantly evolving system and responsive user-driven design, especially given the difficulties of managing over one hundred independently created plugins, fits very uncomfortably with the typically rigid methods employed to develop and maintain purpose-driven tools such as LMS, payroll, content management or library systems. However, we think it is worth the trouble. We see this as a crucial social Velcro for not just building and sustaining social ties but for enabling creativity, flexibility and adaptability that can be sorely compromised in existing approaches to ICT design for learning. The Landing does not seek to replace such tools that are streamlined and efficient hard technologies, but it fills the spaces that are left between them.

VI. REFERENCES


Student Clustering based on Their Online Annotation Behaviors

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Abstract— Students often annotate texts they are reading using highlighting, underlining, and written comments and marks in the margins of the text. These may serve various functions and will reflect each student’s goals and understanding of the text. This research proposes a simple biology-inspired approach to represent the patterns of student annotations and to cluster students based on the similarity between their annotations; the annotations produced were simple highlighting. To verify the effectiveness of the proposed approaches, the research compared the processing speed of the approach with generic hierarchical clustering algorithm implemented in Matlab and compared the accuracy of the clusters with the clusters created by human raters. The results show that the proposed approach is more efficient and accurate than the generic hierarchical clustering algorithm.

Keywords— Annotation; Biology-inspired; Chromosome; Patterns; Clustering

I. INTRODUCTION

Annotation is often a useful tool that readers use to help them to enhance their learning from text [1]. In one common form of annotation, students read textbooks and highlight the keywords they believe important in order to make their learning more efficient. Due to the popularity of Internet, many researchers have now developed web-based annotation tools [6][11] or reading software that supports such annotation.

Annotations made by different students are usually not same and can be considered as a behavior pattern which represents each student. For this reason, this research converts the highlights made by a student into the bit-string chromosome and designs two approaches to measure the similarity between two chromosomes. If students have similar highlights on the text, then they may be clustered into the same group. The students in the same cluster may have similar thoughts on the text or similar learning strategies for learning.

The annotation data for highlights on a text is a long data sequence of 0's and 1's. This research proposes two chromosome-based approaches to transform the students’ highlights on the text. We then use those to locate and quantify chromosome differences between students and cluster students with similar chromosomes. In order to assess the performance of the proposed chromosome-based approaches, we first compare the processing time used by each approach with that used by the generic hierarchical clustering method (implemented in Matlab). Furthermore, we check the accuracy rate of each approach by comparing them clusters identified by human raters.

The remainder of the paper is organized as follows: Section II reviews the literature on annotation and clustering approaches. Section III discusses the two proposed approaches; how to convert a student's highlights to a chromosome and how to measure the difference between two chromosomes? Section IV describes the method of clustering chromosomes. Section V shows the evaluation results. Section VI provides a conclusion and discusses possible future research directions.

II. ANNOTATION AND CLUSTERING

Clustering is a means used to divide a data set into subsets. The items in a subset are similar or have the same features as the other items [10]. Many clustering methods exist. Two well-known clustering methods are Hierarchical Clustering and Partitioning Clustering.

In Hierarchical Clustering a hierarchical tree is constructed that presents the clusters in a tree structure called a dendrogram [2]. In the hierarchical tree, the root is a cluster which contains all items from the data set and the leaves are the individual items. Figure 1(a) shows a data set with six items and Figure 1(b) shows a possible hierarchical tree for the data set. Different hierarchical trees can be established with different similarity measurement approaches.

Partitioning Clustering is different from Hierarchical Clustering as it divides the data set into subsets by pre-defined parameters such as the number of clusters and the size of clusters. K-means Clustering is one of the common partitioning clustering methods [8]: the K represents the number of clusters. The first step of K-means Clustering is to generate K clusters for the data set by randomly choosing K items as the center of the clusters.
Take Figure 1(a) as an example, supposed $K$ is set to 2 and the method randomly chooses items "a" and "e" as the cluster centers. The method then clusters items into the two clusters using a distance calculation shown in Figure 2(a). The two clusters and its items are {a, d} and {b, c, f}. The method then calculates the new center of the clusters as Figure 2(b) shows. The method stops when it cannot find any further item exchange happens among clusters, which means, items in a cluster have minimum distances to the cluster center compared with the distance to other cluster centers.

III. CHROMOSOME-BASED HIGHLIGHT PATTERN AND COMPARISONS

This research treats a student's implicit annotations (i.e., highlights added to a digital text) as a chromosome; as such, the chromosome can represent the student. The data analyzed was produced by 40 undergraduate students who read a text about the Flynn Effect [9] and highlighted sections of text they determined were important for the task of writing a summary of that text [3][4]. The text was 2894 words long and so each "chromosome" has a length of 2894 bits.

Figure 3(a) shows a sentence from the original text. Figure 3(b) shows the highlights made by one student.

Some tests consist of abstract-reasoning problems, and others focus on such special competencies as arithmetic, spatial imagery, memory or general knowledge.

(a) Original Text

(b) Highlighted Text

Figure 3.

Each word's highlight status can be represented by 0 (no highlight) and 1 (has been highlighted) as Figure 4 shows, so a bit-string chromosome can be retrieved.

The similarity of chromosomes as well as to cluster chromosomes.

In the standard approach we use one chromosome as the benchmark and measure how different the other chromosomes are to it. As Figure 5 shows, there are four differences between the chromosomes of User #1 and User #2; differences occur at positions 2, 7, 11 and 12.

Figure 5. Chromosomes represent User #1 and User #2.

We assign each difference a $2^i$ value, where the parameter $i$ means the position of the difference occurs; in this example, the assigned difference values are $2^2$, $2^7$, $2^{11}$, $2^{12}$. The total difference value between User #1 and User #2 is $2^2 + 2^7 + 2^{11} + 2^{12} = 3,138$.

Figure 6 shows another example for User #1 and User #3. In this example, the assigned difference values are $2^{12}$, $2^{14}$, $2^{15}$, $2^{23}$, and total difference value is $2^{11} + 2^{13} + 2^{14} + 2^{22} = 4,220,928$.

Figure 6. Chromosomes represent User #1 and User #3.

Although four differences occurred in both examples the similarity (i.e., the difference value) between the benchmark chromosome and comparison chromosome is quite different. Since the standard approach weights each difference by position the total difference value for pairs of chromosomes with the same number of differences can differ by a large amount; this is especially true when a chromosome's length is large.

IV. EVALUATION

To evaluate the proposed chromosome-based clustering approaches two performance indicators were used: speed (i.e., how fast the approach can process the data) and performance (i.e., how well the task is performed).

First, we implement generic hierarchical clustering method with pdist, linkage, and dendrogram functions in Matlab. We then compared the processing time that different approaches took to cluster the 40 students' annotations. Table I lists the processing times for each algorithm.

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Time Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard</td>
</tr>
<tr>
<td>mapping (ms)</td>
<td>5.74</td>
</tr>
<tr>
<td>clustering (ms)</td>
<td><strong>24.21</strong></td>
</tr>
<tr>
<td>Total (ms)</td>
<td>29.95</td>
</tr>
</tbody>
</table>

*for the generic hierarchical clustering and human clusters, there is no additional step of mapping the user's chromosome to two-dimensional plane for calculating the distances from other users' chromosomes for the preparation of partitioning clustering.

Human rater clustering was the slowest approach. The proposed approach, on the other hand, is the fastest approach.
With mapping and clustering times combined, the total time for the two approaches is approximately the same.

For the performance evaluation, we use human rated clusters as the benchmark or ideal outcome. The outputs of the two different approaches (i.e., the proposed proposed chromosome-based approach and the generic hierarchical clustering Matlab approach) were therefore compared with the human rated clusters to determine which performed the best.

Two widely used measures for evaluating the performance of such tasks from the information retrieval research field are precision and recall. It is easy to use precision and recall, but we should not consider only one at a time; that is why we need the F-measure [7]. The F-measure is a weighted combination of precision and recall and has a range of 0 to 1. F-measure has been used to evaluate the performance of clustering methods [7]. If a research favours more precision then it sets beta value close to 0.5 (i.e., $F_{0.5}$), on the other hand, it sets beta value close to 2 (i.e., $F_2$). In this research, we also use it to evaluate the performance of the proposed chromosome-based approaches. Table II lists the precision, recall, and F-measure values for each approach.

**TABLE II. AVERAGE PRECISION, RECALL AND F-MEASURE FOR EACH CLUSTERING APPROACH**

<table>
<thead>
<tr>
<th>Clustering Approach</th>
<th>Standard</th>
<th>Hierarchical Clustering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precision</td>
<td>0.7146</td>
<td>0.6843</td>
</tr>
<tr>
<td>Recall</td>
<td>0.7061</td>
<td>0.6668</td>
</tr>
<tr>
<td>$F_1$</td>
<td>0.6906</td>
<td>0.6513</td>
</tr>
<tr>
<td>$F_{0.5}$</td>
<td>0.6930</td>
<td>0.6590</td>
</tr>
</tbody>
</table>

*Beside direct use of 2894-bit string chromosomes, we also shorten the chromosome length by considering sentence-based and paragraph-based annotation. We consider a sentence is annotated if the amount of highlighted words in the sentence exceeds a certain threshold (percentage), e.g., 10%. We cluster the data set a hundred times with different sentence and word excesses a certain threshold (percentage), e.g., 10%.

The generic hierarchical clustering approach has minimum values of precision and recall compared to the proposed chromosome-based approach, but it still has more than 50% accuracy. It is not good to considering only precision or recall measure for deciding which approach is better as mentioned earlier, so the F-measure values are taken into consideration for the evaluation. According to Table II, the standard approach is the best approach and has maximum values in both $F_1$ and $F_{0.5}$ measure, which means that no matter if we favour more precision ($F_{0.5}$) or recall ($F_2$) the standard approach is the best one.

V. CONCLUSIONS

From the results of this research, we can find that the standard approach in student clustering is the best approach, although it produces huge difference values in comparing two chromosomes. Even when we take both speed and performance into consideration, we may still use the standard approach to cluster students according to their annotations.

In this research, the data set size is relatively small (i.e., $n = 40$ so 40 chromosomes). We do not know if the processing time for mapping and clustering will be linear with the data set size or exponential. It is important to figure out the relationships among the chromosome length, the data set size, and the processing time in the future.

With the student clustering results, we can further develop a recommender system to automatically provide a student the shared thoughts, hot discussions, and important notes made by other students in the past who belong to the same cluster.

ACKNOWLEDGMENT

The authors wish to thank the support of Athabasca University, the Mission Critical Research funding, NSERC, iCORE, Xerox and the research related gift funding provided to the Learning Communities Project by Mr. Allan Markin.

REFERENCES

Multiagent Virtual Learning Environments

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Abstract— Incorporating intelligence into virtual worlds for e-learning is becoming more desirable in making them smart, adaptive, personalized, and therefore, more effective and engaging. Work has been done with software agents in the context of multi-agent systems, and it makes sense to try to leverage that work when it comes to modeling functional modules, controlling realistic non-player characters, and maintaining student models in a virtual learning environment. There are challenges to integrating a multi-agent system into a virtual world including concerns with synchronization, communication, monitoring, efficiency, and control. In this paper we discuss these concerns while creating a framework that acts as an interface between a multi-agent system JADE/Jason and a 3D virtual world engine Open Wonderland.

Keywords- virtual learning environments; multiagent systems

There have been relatively mature technologies for modeling virtual humans or non-player characters (NPCs) in virtual worlds in their appearance, gestures, kinematics, and physical properties. Avatars are controlled by the user during interaction. Like objects, virtual humans or NPCs are controlled by a simple script. To build a personalized and adaptive virtual learning environment, it is desirable to incorporate intelligence to virtual worlds.

I. APPLYING ALIFE AND MAS INTO VIRTUAL WORLDS

Multiagent systems (MAS) has been adopted by researchers in virtual worlds community. There are two different goals and focuses when applying MAS into Virtual Worlds (VW). One is from the artificial life (ALife) community while another from classical Artificial Intelligence (AI) community. In ALife community, the term complex dynamical systems is usually classified into three categories or dimensions: self-representation, sensory-abilities and situational context [8]. These transformations empower avatars to complement human perceptual abilities [12]. For the autonomous agent and the avatar it represents, the ability to process eye gaze or motion data is advantageous in any implementation of virtual world applications. Situational context deals with transformations that alter the spatial or temporal structure of a conversation. For example, the communication and positions between agents and students can be optimally configured in terms of the geographical setup of a classroom. A class of 20 students can sit directly in front of a virtual instructor, and perceive the rest of the students as sitting farther away. Furthermore, by altering the flow of rendered time in the communication session, users can implement strategic uses of rewind and fast forward during a real-time interaction to increase comprehension and efficiency. This paper focuses on the architectural design for multiagent virtual learning environments.
II. THE ROLE OF MAS IN VIRTUAL CLASSROOMS

We can classify the agents in a multiagent virtual learning environment as three types: Functional agents, Non-Player Characters (NPCs) (or bots), and Personal agents.

First, the functional agents are designed to realize the game functions and pedagogy functions. So, they can be further divided into two classes: game agents (or system agents) and pedagogical agents. The game agents include user management agents, knowledge management agent, guide agents, assessment agents. Pedagogical agents are ideally positioned to offer a solution to realize the sensory abilities, the second principle of the TSI theory [8].

Second, to make the game-based learning environment more realistic and immersive, the agents in a MAS are ideal for modeling the virtual students and virtual audience which are implemented as NPCs or bots. In general, researchers in the VW community have found that honest reflection of virtual worlds, namely large mainstream worlds (for example Second Life), reveals that most places are empty, and city replicas, malls, bars, or educational places often look interesting but abandoned at the same time. Through deploying MAS controlled NPCs, the NPCs could become wanderers through the virtual world to create impressions of the societies we live in. Also, they could be used to substitute the work of real people by fulfilling different tasks such as demonstrating objects, explaining manuals or guiding the way to new locations.

Gaming frameworks are quite mature when it comes to optimizing graphics and physics—current games are visually stunning. There is more to a gaming experience than what a player sees. How a game is structured and the kind of narrative it plays also lends itself to the credibility of the virtual world a player interacts with. This includes the behavior of NPCs in the environment. If an NPC does not act in a believable way it detracts from the realism of the player’s game experience. AI techniques have been used to drive NPCs, but this is usually done in a prescriptive manner that doesn’t give a lot of freedom to NPC actions. These NPCs require simple scripting as the tasks they are following are simple procedures and need almost no interaction with the environment. Nevertheless, they enhance the immersive feeling in a virtual world and provide answers to users that are seldom possible by other means. Moreover, we can increase the intelligence of the NPCs through implementing MAS communication and coordination mechanisms and further sensory feedback to actually enable interaction between human avatars and bots that are representing people.

Third, a MAS is particularly well-suited to application domains where virtual entities are self-directed and can actively pursue their goals within an environment that they can interact with, including interactions with other entities that are also in pursuit of their own goals. In a MAS, these entities are called agents, and it is easy to see how they are ideally suited for modeling people — they are active and social in a way similar to people. the personal agents are designed for keeping track of individual interests, preferences, motivations, and goals of the human participants (i.e., learners) and building user/student models.

Finally, the communication and coordination among these three types of agents would be extremely important to make the learning environment smart. To enable game-based learning, it is crucial for the pedagogical agents to make the quizzes interactive, interesting, appropriate in the degree of difficulty, and adaptive in topics given a group of students with different student models. Based on the user models, the game agents will also be able to make decisions intelligently, e.g., to optimize the grouping and seating/standing positions of participants according to their preferences.

III. RELATED WORK

Two different approaches towards multiagent virtual learning environments are surfacing: the virtual classrooms and the fantasy worlds.

The virtual classroom has the look and feel of a regular classroom and is often made to look like a replica of the sponsoring school. Second Life is often the choice for building the 3D virtual classrooms. The results are a mixed bag with some reporting that SL has too many difficulties and is not game like. Such classrooms lack game scenarios. Fantasy worlds teleports the learner to a different place or time. For example, Virtual Singapura, an example of a fantasy world takes the learner to nineteenth century Singapore in the throes of disease epidemic.

There has been some work done over the last decade when it comes to creating agent control mechanisms for 3D virtual environments, for example, Gamebots [9], Pogamut [10], Dingum et al. (2008) provide an excellent overview of the state of the art when it comes to incorporating MAS concepts with gaming systems or other 3D virtual environments [11]. To summarize, from what is available in the literature, it looks like most work to date has relied on the Unreal Tournament engine and Gamebots. There are a number of positives to this technology including the robustness of the environment. The downsides include the fact that it is not open source, and there are therefore limitations in what can be done in terms of ensuring agents have all the information they need and that synchronization works perfectly. There are also limitations in communications that means that agents aren’t able to take full advantage of the social actions in a MAS environment.

IV. OUR PROTOTYPES, CONCLUSIONS, AND FUTURE WORK

The primary goal of my project is the creation of a robust and viable framework that interfaces a MAS to a 3D Virtual World. For a 3D VW, Open Wonderland [7] is used. For an MAS a combination of JADE and Jason is used, leveraging the strengths of both where appropriate; the framework needs to have interfaces to both. We have proposed an architecture, the WL-MAS Interface in [4]. This architecture is the foundation on which the educational game, QuizMASter, has been built. The WL-MAS will be key as it will be used by agents controlling NPCs as well as agents controlling other aspects of the game, such as score keeping and user modeling. To
ascertain what is technically feasible when it comes to creating agent-controlled NPCs in a 3D VW like Open Wonderland. The following work for the proof of concepts have been done in Open Wonderland by this group:

(1) As an initial step, we integrated Open Wonderland and JADE through the starting of a JADE server separate from Open Wonderland [12]. JADE is a middleware that facilitates the development of multiagent system. Starting a JADE agent inside the Open Wonderland world by simply using the JADE’s method jade.core.Runtime and have the agent send pertinent information back to OWL in the forms of messages to a TCP port. The interface is a modified OWL module to which code has been added to start a JADE agent. The JADE agent is started via a runtime call. Therefore, the agent will be started on a local computer. However, the rest of the agents that make up the MAS can be on other computers. The agents started by the OWL module will communicate with the rest of the JADE agents using the FIPA specified protocol. One of the agents in the MAS communicates to a TCP port that has been activated on another or the same OWL module. JADE followed the FIPA assumption that only the external behavior of system components should be specified, while leaving the implementation details and internal architectures to agent developers. It just has implemented a very general agent model that can be easily specialized to realize both reactive and BDI architectures. Moreover, the behavior abstraction of our agent model allows simple integration of external software into one of the agent tasks.

(2) The results of our previous work showed the possibilities and challenges that arise when the systems aren’t coupled enough [12]. These challenges informed our decision to keep things simple and integrate everything right into Open Wonderland. Our second model is adding a Jason module to Open Wonderland server that takes an NPC and controls its movement in the environment. Jason (http://jason.sourceforge.net/Jason/Jason.html) is an interpreter for an extended version of AgentSpeak and a platform for the development of multiagent systems. The NPC runs on the Open Wonderland server and pulls an AgentSpeak() asl file from the file system (in the Open Wonderland server cache), sets up its belief system and goals, and then runs. As yet it doesn’t get any perceptual information from the environment, but is able to guide its direction. It will be easy to extend this to have the NPC make any available action that an avatar can do within Open Wonderland. The percept feedback to the Jason agent still needs to be worked on. The MAS and Open Wonderland will be more tightly coupled than what had originally been planned so that development, deployment, and management of QuizMASter are easier when it’s all handled within a single environment. The Open Wonderland module system makes it simple to extend Open Wonderland to include the framework and any other functionality that is required [7]. More work about the benchmarking of performance for the architecture is to be done.

(3) Our third trial is to use CArTAgO (Common ARTifact infrastructure for AGents Open environments) (see Figure xxxx). CArTAgO is a general purpose framework that makes it possible to program and execute virtual environments for multi-agent systems. CArTAgO is based on the Agents & Artifacts (A&A) meta-model for modeling and designing multi-agent systems. One of the main advantages of leveraging the capabilities of Jason-CArtAgO MAS is that it enables customization of the rendering of visible artifacts for different clients [4]. Another advantage of Jason-CArtAgO MAS is that it bridges the gap between designing MAS and programming MAS. More work on user modeling is in process.

REFERENCES

The 5R Adaptive Learning Content Generation Platform for Adaptive Mobile Learning

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Abstract—Ubiquitous mobile computing and the advancement in mobile networks have encouraged the growth of mobile learning. Since learning can take place at anytime and anywhere, there is an advantage to integrate the real world objects into learning content, which creates a learning management system with time and location sensitive learning contents. Mobile devices have characteristics that include location awareness and heterogeneous. Thus, there are the possibilities and needs to provide mobile learners with location, time and device adaptation in addition to personalized learning. To implement the adaptive mobile learning, it is essential that the learning contents be of the sensitivities that should be retrieved through the adaptation mechanism built in the learning management system. In this paper, an adaptive learning content generation platform is presented. The 5R adaptation framework is adopted in this content generation platform, which enables the mobile learning system to have the capability to provide right contents to right learner through right device at right location and right time. We will also provide an example to demonstrate how to use the platform to create adaptive learning contents.

Keywords: Adaptive learning; mobile learning; location-based learning; ubiquitous learning; learning content creation.

I. INTRODUCTION

Mobile devices and technologies have seen a rapid growth in the last few years. This growth in mobile technology development has lowered the prices for mobile devices allowing them to be available to majority of people [3]. Mobile computing devices have become ubiquitous. Current technologies have allowed for the access of information via wireless media such as mobile computing devices and mobile smart phones. One no longer needs to be connected by wire to access the Internet for information. Information can be accessed anytime and anywhere. This growth in the use of mobile computing devices has helped to gain the research interests in the areas of mobile learning technologies and applications. It has also opened the way for more research on mobile learning theory and pedagogy [4].

Mobile Learning helps complements traditional classroom learning by shifting the learning process more to the student and creating a learner-centered environment [7]. This type of learning environment encourages independent learning among students as well as gives students the opportunity to build onto what they have learned in the classroom.

Mobile learning can take place anytime and anywhere not only when the learner is at a fixed location [2]. It provides a unique opportunity for integrating real world objects into learning contents, which makes it possible to provide location-aware and context-aware contents to learners. To implement the location-based adaptive mobile learning, the learning system has to be able to provide the adaptive learning contents based on the learner’s current location as well as other information, such as learner’s profile. Mobile devices’ location awareness and the capability of interacting with environment can be used to sense or identify the learners’ current physical location. On the other hand, the learning management system has to have the learning contents with the sensitivities to be retrieved through the adaptation mechanism. In this paper, we present an adaptive learning content generation platform that serves for the content developers, instructors and others to create learning contents with the sensitivities. The 5R adaptation framework [1] is adopted the system adaptation mechanism, which allows the mobile learning system to be able to provide right contents to right learner through right device at right location and right time.

Based on the 5R Adaptation framework, this paper presents a learning content generation platform for adaptive mobile learning. Section 2 discusses the 5R adaptation framework and its significance. The learning content generation platform is discussed in section 3. Section 4 discusses the next steps and future research to be taken.

II. THE 5R ADAPTIVE FRAMEWORK

A. Concept

The 5R Adaptive framework [1] is described as learning at the right location, using the right device, at the right time by the right learner and having the right contents. The 5R framework creates the platform for an adaptive location based mobile learning. The location of the learner, device being used, the time learning is to take place and learner’s learning profile, style, and progress are all brought together when choosing the right learning content to deliver to the learner.
B. Significance
Incorporating the 5R’s – location, learner, time, contents, and device produces the right learning contents that are available at the right location and right time, as well as for the right learner based on learner’s learning profile, style, and progression, and the type of device he/she is using. The 5R adaptation framework enables the learning management system to provide adaptive and personalized content for mobile learners.

C. System
In this paper, we present the learning content creation platform that allows the learning content developers, such as instructors, to create the location-based learning contents with the 5R sensitivities. The platform ensures that learning contents developed are a result of the combination of the 5R input ontology [1]. The inputs of the platform and their metadata relationships are described based on the 5R ontology shown in figure 1 below:

![Figure 1 - The 5R inputs ontology schema [1]](image)

III. THE 5R ADAPTIVE LEARNING CONTENT GENERATION PLATFORM

Learning Management Systems (LMS) form the core of mobile learning or e-Learning [8]. These systems provide some functionalities to help students access learning materials and also for instructors to create these learning materials. These systems can also facilitate student-to-student and student-to-instructor interaction. Although these systems provide students access to learning materials, they do not always provide the right contents to all students. Some students may be farther ahead than others in their learning [8]. LMSs do not also take the location of the students into consideration. As stated by [2], developing the right models to support pervasive learning and also mobile learning is one of the challenges faced when implementing mobile learning. The content generation platform proposed in this paper helps address this challenge based on the 5R Adaptation framework propose in [1].

This learning content generation platform creates the learning contents described with the metadata based on the inputs in the ontology schema in figure 1. These main inputs are learner, location, time, learning content, and device [1, 5]. In order to better understand the system and the important terminology using in this paper, we will give the following definitions.

- **Location-Based Learning Object** – A physical object located at somewhere in the real world is used for learning
- **Learning Materials** – Instructional items, exam and assignment items, and presentation items in certain digital format can be used to describe a learning object or instruct learner to work with the learning object. They are usually stored in the database of the learning management system and they are also interactive with learner through certain digital media, such as mobile device.
- **Learning Content** – A collection of learning objects and/or learning materials is combined to serve for single learning objective for learning.
- **Location-based Learning Content** – A location-based learning object associated with the learning materials to serve for single learning objective for learning. A Location-based learning object could serve for difference learning objectives, which depends on what the learning materials is associated.

A high level of architecture diagram for the 5R adaptive mobile learning system platform is presented figure 2. To access the system, all users will have to register and be presented in the system database. A system administrator verifies and provides instructor or other learning content developers privileges to allow them to perform tasks such as learning contents development, adding, editing, modifying, delete course contents while others will be automatically sign as a learner.

![Figure 2 – High-level system architecture overview](image)
below. This shows how the objects that will be described in the following sections are related through the metadata.

The 5R adaptive learning contents supplies answers to the questions what needs to be learnt, who can participate in the learning, when can this learning take place and where this learning can take place. A location-based learning object, in this context, represents the physical object at a location where and when the learning takes place can be associated with many learning materials. The learning materials could include instructions of learning activities to guide learners what and how to learn. For example, a museum (as a location-based learning object) can have ten different sections. Each of these sections can be a separate section in a course unit and therefore have different learning materials or activities that need to be performed. All these can be associated with the museum and presented to the learner for learning activities to take place as the learner progresses through the museum. Therefore, in this platform, instructor will be able to attach geographical coordinates or other location related information to the museum as well as the opening day and time and progression level to make the museum be of the location and time sensitivities held in Learning_Object table in the database.

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In order for mobile learning to take place at the right time and right place, the adaptive learning content generated must satisfy these principles – time and location as well as all the inputs named in the 5R Adaptation framework ontology.

A. Learning Object and Content

The 5R adaptive learning content generation platform for mobile learning allows instructors and learning content developers to develop or generate learning contents that satisfies the inputs of the 5R inputs. These contents create a repository of learning objects that students can access for learning. 5R Adaptive learning contents can be linked to an object and a location or can be standalone or general contents with no specific locations. Learning content with a location can serve or be used as location-based learning contents. The learning objects can be reused to generate different contents [5]. This framework allows for learning objects to be captured and contents attached or linked at a later time.
The learning contents generated have basic information such as the name of the learning content, a brief description of the content and keywords attached to the content. To satisfy the 5R framework, the content generated should satisfy a learners learning level. This framework uses the unit or section of a course to delimit this level. The content generated also includes the learning level for prospective learner. Assignments for the units or level are can also be included in the learning content generated as well as any instructions needed for the content.

B. Location

Learning objects can be tied to a location. This allows for a real location-based learning content. In this framework, an object’s location is based on the GPS coordinates latitude and longitude. As most people cannot remember the exact coordinates, the location, after getting the latitude and longitude, can also be linked to easily identifiable things such as Wi-Fi access points, RFID, postal code, Bluetooth etc. this helps to easily locate or retrieve these objects and learning contents. An object needed for a location-based learning content needs to have a location element attached to it. However, this framework also allows for objects with no specific locations, i.e. objects that can be accessed anywhere. The location element is left blank when creation such learning contents/objects. Since GPS coordinates provide an accuracy of about 200 meters to 10km [6], the location element also includes allows for a range to be specified for the learning content so it can be available to students within the specified range the location.

C. Time

Some learning objects are located in controlled locations such as museums or national parks etc. These are controlled and have operating hours. Learning contents should therefore include this time factor when the contents are being created to accommodate these locations with operating hours. Statutory holidays can also be specified with the time for these locations to specify whether these contents can also be accessed during statutory holidays.

D. Device

Mobile devices available for mobile learning comes built on different operating system platforms from different manufacturers – Apple, BlackBerry, Windows, Google etc. These different platforms does not allow for running any type of application on all of these platforms. The learning content in this framework takes this into consideration and gives the content developer a chance to specify which device platforms the generated content can be viewed on. The framework also allows the content developers to specify which feature should be available on the devices in order to access these learning contents. This helps create contents which can be easily accessed on the right devices.
IV. CONCLUSION

With mobile-learning becoming an application hotspot, there is a dire need to be able to present students with the right learning contents for use on their mobile devices for learning. Generating the right contents for mobile learning has been said to be one of the difficult and challenging tasks [2] in mobile-learning. The 5R Adaptive content generation platform for mobile learning helps eliminate this challenge by giving learning content developers a way of generating the right learning contents for mobile-learning contents.

Mobile learning can also be used to compliment traditional classroom learning. Location-based mobile-learning contents can be generated courses that have fieldtrips. These contents will allow students to locate objects discussed in class and have hands on learning experience with these objects. Students can complete and submit assignments on location.

REFERENCES

Online Variational HDP for Topic Modeling of News Articles

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Abstract—The online version of the hierarchical Dirichlet process (HDP) represents the current state of the art in probabilistic topic modeling research, because it allows for automated topic discovery in large, open-ended corpora. This paper demonstrates the application of the algorithm to a corpus of New York Times articles. It confirms previously reported results that show an advantage over online LDA in terms of model fit, and identifies the optimal HDP parameter settings to use for the target corpus.

Keywords—Text analysis; Hierarchical Dirichlet Process; Latent Dirichlet Allocation; Topic modeling; Variational inference; Probabilistic graphical models

I. INTRODUCTION

Topic models are probabilistic models that can reveal the hidden thematic structure within a collection of documents. The goal of topic modeling is to analyze a corpus of unlabeled documents, identify topics within the corpus, and then assign each document to the topic(s) that best represent them. Topic models are useful because they provide additional ways to explore document collections and understand the relationships between documents. They are especially relevant for corpora that are too large to allow human cataloguing.

A. Latent Dirichlet Allocation

Latent Dirichlet Allocation (LDA) is the basis of much current research in topic modeling. Blei [1] provides an excellent introduction to its concepts and applications. LDA defines a topic as a distribution over the vocabulary used in the corpus. Documents are treated as mixtures of all of the topics in different proportions. The mixture model allows for a richer and more realistic topic model than methods based on density estimation techniques.

LDA assumes that documents emerge from a generative process that defines a joint distribution over hidden variables and observed data. The hidden variables represent the topic structure: the global topic distribution \( \theta_k \), the per-document topic proportions \( \theta_d \), and the per-document, per-word topic assignments \( Z_{d,n} \). The observed variable \( W_{d,n} \) represents the \( n \)th word of document \( d \). The corresponding graphical model is shown in Figure 1.

To fit a topic model, we must infer the conditional distribution of the hidden values, conditioned on the observed documents. Calculating the values exactly is intractable, so they must be estimated using approximate inference techniques. Gibbs sampling is the most common technique, but [1] prefers variational inference, because it allows advances in optimization to be applied. There is also some evidence that it converges faster than Gibbs sampling [2].

More recent research has produced a new algorithm for LDA based on online variational inference [2]. The algorithm is much faster than previous versions but the online aspect is even more significant. It allows LDA to be applied to open-ended corpora for the first time.

The key limitation of LDA is that the number of topics in the model must be determined in advance as a parameter to the model, and is fixed thereafter. If the topic count is chosen poorly, the resulting model will over- or under-fit the model.

B. Hierarchical Dirichlet Process

The Hierarchical Dirichlet Process (HDP) uses a hierarchical Bayesian model to overcome the topic number limitation of LDA [3]. The topic modeling problem is treated as a set of related clustering problems (each essentially an LDA model) which share an underlying base distribution.

Teh et al. [3] uses the “Chinese Restaurant Franchise” (CRF) metaphor to describe the generative process behind HDP:

- the franchise has \( J \) restaurants (groups of data/documents)
- each restaurant has infinitely many tables (topics)
- each restaurant offers the same infinite set of dishes (shared topic distributions)

Customers enter a restaurant, and choose an occupied table or an empty one. Then, they choose a dish from the shared menu. Customers prefer crowded tables and popular dishes.

The Bayesian model for HDP is shown in Figure 2. \( G_0 \) corresponds to the shared topics, \( G_j \) the topics for document \( j \), \( \phi_j \), the per-document, per-word topic assignments. The observed variable \( x_{j,i} \) represents the \( i \)th word of document \( j \). \( \gamma \) and \( H \) are the Dirichlet parameters for \( G_0 \).
For a corpus of biology abstracts [3], HDP successfully inferred an appropriate number of topics. It also performed as well as LDA in terms of held-out perplexity, when LDA was configured to use an optimal number of topics.

C. Online variational HDP

The online LDA work noted above paved the way for a new online version of HDP, also based on variational techniques [4]. The paper shows why the original formulation [3] of HDP is not compatible with the coordinate ascent approach that was used in [2] to develop an efficient online version of LDA. It adapts an alternative version of the stick-breaking process, and uses it to derive the update equations and algorithm for online HDP.

The online variational inference algorithm processes the corpus in small batches. For each document, the optimal variational parameters $a_j$, $b_j$, $ψ_j$, $ζ_j$ are computed by coordinate ascent. The document-level parameters are used to compute the gradient of each corpus-level variational parameters $λ$, $u$, $v$. The gradients are then used to update the corpus-level parameters, according to a decreasing learning rate $ρ_t$.

1: Initialize $λ = (λ_k)_{k=1}^{K}$, $u = (u_k)_{k=1}^{K-1}$ and $v = (v_k)_{k=1}^{K-1}$ randomly. Set $t_0 = 1$.
2: while Stopping criterion is not met do
3:   Fetch a random document $j$ from the corpus.
4:   Compute $a_j$, $b_j$, $ψ_j$, and $ζ_j$ using variational inference using document-level updates, Eq. 15 to 18.
5:   Compute the natural gradients, $∂λ(j)$, $∂u(j)$ and $∂v(j)$ using Eq. 22 to 24.
6:   Set $ρ_t = (t_0 + t)−κ$, $t_0 = t_0 + 1$.
7:   Update $λ$, $u$ and $v$ using Eq. 25 to 27.
8: end while

Figure 3. Online variational inference for the HDP [4]. Equations are reproduced in the appendix.

Wang et al. [4] compared online HDP both to batch HDP and online LDA using two large text corpora. The execution time was comparable to online LDA, but the topic model consistently provided a better fit to the data. Batch HDP was “slightly” better, but only when the data set was small enough to allow it to be processed completely.

D. Gensim

Gensim\(^3\) is an open source topic modeling framework written in Python. It provides memory-efficient code for reading and writing corpora in a variety of formats, useful features for managing vocabulary data, and implementations of several text analysis algorithms. One of these is an implementation of Hoffman’s online LDA algorithm. To facilitate comparisons between LDA and HDP test runs, and to make the work more accessible to other researchers, we have developed all of the code used for this research within the gensim framework, and contributed back to that project for inclusion in future releases.

More exactly, we have developed two separate gensim extensions as part of this research. The first is a corpus implementation that allows gensim to read and write corpora in the format used by the UCI Bag of Words Data Set.\(^2\) This allows all of the corpora in this collection to be used with any of the analysis features in gensim. The second extension is an implementation of the online HDP algorithm, adapted from the original author’s version.\(^3\) This allows the online HDP algorithm to be applied to any data set that gensim is able to read.

II. METHODS

The primary goal of this paper is to apply the online HDP algorithm to a corpus of news articles (described below), to determine whether the results observed by [4] can be reproduced for a significantly different kind of corpus. The relative advantage of online HDP over online LDA in terms of model fit will be the focus of the evaluation. The online HDP analysis will be run using the same parameter settings as the experiments in [4], and the results compared to online LDA analysis run using a range of topic numbers. The LDA parameters will be as close to the settings used in [4] as possible.

A secondary goal is to determine the impact of different parameter settings for the mini-batch size ($S$) and the learning rate $κ$, and identify the optimal values for the target corpus. To achieve this, the online HDP analysis will be run repeatedly using different combinations of values for these parameters.

III. RESULTS

A. Data

The dataset used for the analysis is the New York Times news articles portion of UCI’s Bag of Words Data Set (“the NYT corpus”). This dataset consists of a vocabulary file of 102,660 terms and a second “bag of words” file containing a sparse matrix of document ids and word counts for 300,000 documents.

This data set was processed in several ways before running any tests. First, the vocabulary was reduced by eliminating:

- terms with a “zzz” prefix (which appears to be a marker for named entities or subject labels),

some other noisy terms (e.g. terms with numbers), terms that appear less than 100 documents or more than 90% of the documents.

From the remaining words, only the 10,000 most frequent terms were retained.

The bag of words matrix was then split into three separate data sets:

- 2,000 randomly selected test documents,
- a small training set of 10,000 randomly selected documents for trial runs,
- a large training set of 298,000 documents.

Each of these three new corpora were transposed into the reduced vocabulary space and re-written in Matrix Market format (gensim’s preferred format).

**B. Evaluation Metric**

The quality of the HDP analyses are evaluated using a per-word log likelihood score based on the measure described in [4]. The version used here is simplified in that it measures the predictive likelihood of the words in a test document $w_j$ conditioned on the training corpus $D_{\text{train}}$ alone, rather than splitting the test document into two parts $w_{j1}$ (90% of the words) and $w_{j2}$ (the remaining words), and using $w_{j1}$ to further condition the result. In other words, we evaluate

$$\frac{\sum_{j \in D_{\text{test}}} \log p(w_j | D_{\text{train}})}{\sum_{j \in D_{\text{test}}} |w_j|}$$

instead of

$$\frac{\sum_{j \in D_{\text{test}}} \log p(w_{j2} | w_{j1}, D_{\text{train}})}{\sum_{j \in D_{\text{test}}} |w_{j2}|}$$

The resulting measure is more directly comparable to the likelihood scores produced by the online LDA implementation.

**C. Online HDP vs. Online LDA**

Following [4], the parameters for online HDP were set to $\gamma = 1$, $\alpha_0 = 1$, with a batch size $S = 256$, a learning rate $\kappa = 0.6$, top-level topic truncation $K = 150$, and second level topic truncation $T = 15$. The LDA analyses used the same batch size and learning rate as HDP, and a varying number of topics $K = \{5, 10, 20, 40, 60, 80, 100\}$. The Dirichlet hyperparameter $\alpha$ was set to $1/K$ where $K$ is the number of topics.

All of the tests were run on the “large” training set of 298,000 documents, and then scored using the 2,000-document test corpus. The results are shown in Figure 4.

Online HDP produced a clearly better fit than online LDA, regardless of the number of topics used for LDA. This is consistent with the results shown by [4], and shows that the online HDP algorithm can perform well on the NYT corpus – a result that should be generalizable to other news corpora.

However, the LDA results seem a bit suspect. The fit is best when the number of topics $K = 5$, and is consistently worse for increase values of $K$. This suggests that the corpus contains no more than 5 topics (unlikely given the source data) or that there was some kind of problem with the LDA test runs. One factor that might have compromised these results is the value of the $t_0$ parameter. Wang et al. [4] used $t_0 = 64$, but the gensim implementation of online LDA fixes this value at 1. The tests here use a relatively small batch size ($S = 256$), so the low value of $t_0$ may have adversely impacted the model [2].

Another possible discrepancy concerns the execution speed of online HDP. [4] suggests that online HDP requires approximately the same execution time as online LDA, but in these tests, online HDP took about 4 times as long as online LDA to process the NYT corpus (about 3 hours vs. 40 minutes). The implementations of both algorithms have been modified from those used in [4], so the speed difference may not have any significance.

**D. Optimal HDP Settings**

To determine the optimal HDP settings for the NYT corpus, the online HDP program was run repeatedly using different batch sizes $S = \{64, 256, 1024, 2048\}$ and the learning rate $\kappa = \{0.6, 0.8, 1.0\}$. The results are shown in TABLE I.

![Figure 4. Performance of online HDP and online LDA on the NYT corpus, with varying numbers of LDA topics.](http://math.nist.gov/MatrixMarket/)

![Table 1. Likelihood scores for NYT corpus using different settings for $S$ and $\kappa$.](http://math.nist.gov/MatrixMarket/)

$$\begin{array}{|c|c|c|c|c|}
\hline
\text{batch size (S)} & 64 & 256 & 1024 & 2048 \\
\hline
\text{learning rate (K)} & 0.6 & -8.16311 & -7.99934 & -7.90157 & -7.87449 \\
\text{} & 0.8 & -7.97441 & -7.93849 & -7.93188 & -7.95665 \\
\text{} & 1.0 & -7.9695 & -8.00461 & -8.02998 & -8.06921 \\
\hline
\end{array}$$

http://math.nist.gov/MatrixMarket/
The best results occurred with a larger batch size (2048) and $\kappa = 0.6$. Using $\kappa = 0.8$ also performed well, and was more consistent across different batch sizes. These results are very consistent with the patterns reported in [4] for both the Nature and PNAS corpora: for low $\kappa$, the model improves with increasing batch size, while high $\kappa$ works best with smaller batch sizes (although never as well as the former combination). This is generally consistent with the online LDA results seen by [2].

E. The Topic Model

The topic model generated by online HDP shows about 30 or 40 strong activated topics, and perhaps a similar number of weakly activated ones. The top four topics are shown with labels added by the author) in TABLE II. These topics appear to be both coherent and distinct.

<table>
<thead>
<tr>
<th>word</th>
<th>prominence</th>
<th>word</th>
<th>prominence</th>
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<th>prominence</th>
<th>word</th>
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</tr>
</thead>
<tbody>
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<td>game</td>
<td>0.01525</td>
<td>attack</td>
<td>0.00461</td>
<td>team</td>
<td>0.01539</td>
</tr>
<tr>
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<td>0.01132</td>
<td>season</td>
<td>0.01480</td>
<td>police</td>
<td>0.00407</td>
<td>player</td>
<td>0.01282</td>
</tr>
<tr>
<td>military</td>
<td>0.00809</td>
<td>team</td>
<td>0.01420</td>
<td>official</td>
<td>0.00401</td>
<td>season</td>
<td>0.01115</td>
</tr>
<tr>
<td>attack</td>
<td>0.00778</td>
<td>run</td>
<td>0.01109</td>
<td>palestinian</td>
<td>0.00350</td>
<td>game</td>
<td>0.01112</td>
</tr>
<tr>
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<td>play</td>
<td>0.01053</td>
<td>home</td>
<td>0.00344</td>
<td>play</td>
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</tr>
<tr>
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<td>games</td>
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<td>0.00341</td>
<td>coach</td>
<td>0.00664</td>
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<tr>
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<td>point</td>
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<tr>
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<td>0.00662</td>
<td>told</td>
<td>0.00281</td>
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<td>night</td>
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<td>terrorist</td>
<td>0.00224</td>
<td>league</td>
<td>0.00289</td>
</tr>
</tbody>
</table>

The update equations from Figure 3. All are reproduced from [4].

A. Document-level parameters

\begin{align}
    a_{st} &= 1 + \sum_{n=1}^{N} \zeta_{nt} \nonumber \\
    b_{st} &= \alpha_0 + \sum_{n=1}^{N} \zeta_{nt} T \nonumber \\
    \varphi_{jk} &\propto \exp \left( \sum_{n=1}^{N} \zeta_{nt} \log \left( \lambda_{jk} \right) + \beta_{jk} \right) \nonumber \\
    \zeta_{nt} &\propto \exp \left( \sum_{k=1}^{K} \varphi_{jk} \log \left( \lambda_{jk} \right) + \beta_{jk} \right) \nonumber \\
\end{align}

B. Corpus-level gradients

\begin{align}
    \partial \lambda_{w} &= -\lambda_{w} + \eta + \nu \nonumber \\
    \partial \varphi_{jk} &= -\varphi_{jk} + \gamma \nonumber \\
    \partial \zeta_{nt} &= -\zeta_{nt} + \nu \nonumber \\
\end{align}

C. Corpus-level parameters

\begin{align}
    \lambda &\leftarrow \lambda + \rho_{\lambda} \partial \lambda \nonumber \\
    \varphi_{jk} &\leftarrow \varphi_{jk} + \rho_{\varphi} \partial \varphi_{jk} \nonumber \\
\end{align}

REFERENCES


Adaptivity and Personalization in Learning Systems based on Students’ Characteristics and Context

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Abstract— Providing learners with personalized recommendations and/or adaptive courses that fit their characteristics and situation has high potential to make online and mobile learning easier and more effective for learners. However, most of the learning systems that are currently used by educational institutions do not provide adaptivity based on learners’ characteristics, needs or situation. In this paper, we introduce our research on considering different learner characteristics and their context in learning systems and therefore provide learners with personalized learning experiences.

Keywords— adaptivity and personalization; learning styles; affective states; cognitive traits; motivational aspects; context and environment

I. INTRODUCTION

Online learning is becoming increasingly popular and more and more learners learn by using educational technologies. These learners have different characteristics, such as different prior knowledge, learning styles, cognitive abilities, motivation, and affective states, and they learn in different situations/contexts, such as from different devices with different features and functionalities, at different locations and so on. However, when looking at the learning systems that are most commonly used in technology enhanced learning, so-called learning management systems (LMS), it can be seen that these learning management systems typically provide exactly the same course for every learner without consideration of the learners’ individual characteristics, situation, and needs. Such a one-size-fits-all approach often leads to frustration, difficulties in learning and a high drop-out rate in online courses [1, 2].

Adaptive learning technologies address this issue and extend learning technologies and systems by enabling them to automatically adapt courses, learning material and/or learning activities to the learners’ individual situation, characteristics and needs, and therefore provide learners with personalized learning experiences. By considering the individual differences of learners and their learning situations, adaptive learning systems aim at increasing learners’ progress and outcome, enabling learners to learn with less effort, for example, in terms of time required for learning, and offering higher learner satisfaction. By taking into account the learners’ differences, a system can, for example, adapt learning material/activities to a learner’s prior knowledge [e.g., 3, 4], preferred learning style [e.g., 5, 6, 7], affective states [e.g., 8, 9], and so on. Furthermore, a system can take advantage of surrounding objects or people who might be able to help in the learning process [e.g., 10, 11] and consider the characteristics of the learner’s environment as well as the features of the device a learner is using [e.g., 12].

In our research, we particularly focus on six characteristics of learners: the learning styles, cognitive traits, affective states, motivational aspects, and the context/environment of learners. In the following sections, a brief overview of our research works in each of these areas is presented, followed by future research directions.

In this section, we demonstrate approaches and mechanisms for enhancing existing (and commonly used) learning systems by enabling them, on one hand, to identify learning styles and, on the other hand, to provide adaptive and personalized courses and/or recommendations to learners once their learning styles have been identified. These approaches and mechanisms are based on the Felder-Silverman learning style model (FSLSM) [15], which proposes that each learner has a preference for each of its four dimensions: the active/reflective, sensing/intuitive, visual/verbal, and sequential/global dimension.
A. Automatic and Dynamic Student Modelling of Learning Styles

Student modelling is a crucial part of any adaptive system, dealing with identifying and frequently updating information about a learner which is then used to provide adaptivity. One of our core research contributions in student modelling deals with the automatic identification of learners’ learning styles based on the continuous observation of their interactions with the system. This approach is more accurate than the use of simple questionnaires because it can: (1) collect and process data from the learners over a certain period of time; (2) identify and exclude exceptional behaviour; and (3) take dynamic aspects such as changes in learning styles into account. The accurate identification of learning styles facilitates adaptivity and personalization for learners. Therefore, we developed and evaluated a rule-based algorithm that identifies learning styles from the mining of learners’ behaviour by observing their interactions with a learning system [16]. The algorithm uses data from 27 behaviour patterns which are based on commonly used types of learning objects and behaviour in an online course. We successfully empirically evaluated our algorithm with 75 students in a course about Object Oriented Modelling presented in the learning management system Moodle, which demonstrates that the algorithm reliably identifies learners’ learning styles. Based on the successful evaluation, a stand-alone tool has been developed that accesses the database of a learning system, extracts data from it, and applies the algorithm on these data.

In recent years, more and more research groups started to work on this topic. However, most of the other works aim at identifying learning styles in particular learning systems and therefore are tailored exactly to these systems by using only those behaviour patterns which are incorporated in the respective systems. Moreover, the investigated courses are created in consideration of learning styles by using particular types of learning objects for detecting learning styles. On the other hand, our algorithm and tool uses a generic approach for automatic student modelling, which can be used for different learning systems and courses, aiming at extending existing learning systems.

Furthermore, we investigated the use of dynamic student modelling, where students’ interactions with the system are continuously monitored and students’ learning styles are updated in real-time. In order to consider dynamic student modelling in learning systems, an architecture has been designed that aims at enabling existing learning systems to build and frequently update learners’ learning styles based on FLSM. Therefore, learners’ actions in the learning system are monitored and once a learner performed a pre-defined amount of actions, his/her learning styles are re-calculated through automatic student modelling based on his/her recent behaviour. After this recalculation of learning styles, the result is analysed in the context of the currently stored learning styles of a learner as well as the results of previous re-calculations. For deciding whether an update of learners’ learning styles is required, a mathematical model has been designed and verified [17].

Current and future research in this direction deals with investigating the use of artificial intelligence techniques, in particular neural networks and particle swarm optimization, to improve the performance of our student modelling algorithm. Furthermore, we look into expanding the developed tool to not only calculate learning styles but also provide teachers with valuable information about their students’ learning styles and how well the learning objects in the course fit the learning styles of the current cohort of students, as well as provide recommendations to teachers on how to improve their courses respectively.

B. Adaptive Course Provision based on Learning Styles

In order to use the information about students’ learning styles, an adaptive mechanism has been developed and evaluated that enables LMSs to recommend appropriate course structures to learners based on their learning styles [C8]. This adaptive mechanism is a pluggable software package that can be plugged into one of the most widely used LMS, i.e., Moodle, with a very large audience all over the world. The mechanism was used to perform an empirical evaluation based on a target audience of 437 students. The results of our extensive empirical evaluation have revealed that adaptivity in the course structure and presentation can significantly reduce learning time. Based on our observations, a generic framework together with a set of algorithms were developed to extend the adaptive mechanism to be more generic and applicable for different types of courses, such as courses with practical and theoretical focus [18]. This extended adaptive mechanism was used within controlled empirical studies to teach a pilot introductory course on Computing and Information Systems at AU for students from two Alberta School Districts. The developed mechanism advances the field of user adaptive learning systems by providing a concept as well as its implementation on how these systems can adapt to learners’ learning styles. This mechanism has been and is planned to be deployed at major educational institutes in three different countries, namely Vienna University of Technology (Austria), Athabasca University (Canada), Alberta Distance Learning Centre (Canada), University of West Indies (Trinidad and Tobago).

Our current and future research in this area deals with combining the adaptive mechanism with automatic and dynamic student modelling. Furthermore, we look into extending the adaptive mechanism to also consider other characteristics of students when providing adaptive courses. In addition, we look into providing adaptive courses in mobile environments.

III. COGNITIVE TRAITS

Humans have a number of cognitive abilities. Several of these abilities are crucial for learning. These include abilities such as working memory capacity, inductive reasoning ability, information processing speed, associative learning skills, meta-cognitive skills, observation ability, analysis ability, abstraction ability, and so on.

In our research we mainly focused on investigating the relationship between cognitive traits and learning styles, in
order to improve the student modelling process of both through getting additional data from other sources. First, a comprehensive literature review was conducted, followed by an experimental study with 39 students, and then, since both results were promising, a main study with 297 students was conducted [19, 20]. The results of these experiments and detailed analysis showed that relationships exist between working memory capacity and three of the four dimensions of the learning style model. The identified relationships showed high potential to improve the student modelling process of cognitive abilities and learning styles and encourage further research on relationships between learning styles and other cognitive abilities. Furthermore, future research is planned on automatic and dynamic student modelling of cognitive traits from behaviour patterns in online courses as well as the usage of information about learners’ cognitive traits to provide them with adaptive courses.

IV. AFFECTIVE STATES

Another aspect that can influence the learning process of learners is their affective states. Affective states that are considered to be especially relevant in the learning process include, for example, boredom, confusion, frustration, confidence, satisfaction, and independence.

In our research, we proposed a framework consisting of several modules which aim at incorporating learning styles and affective states, including confidence, effort, independence, and confusion, into learning management systems [21]. Once negative affective states are determined, the system provides a learner with additional elements to guide him/her, considering his/her learning styles in order to determine which additional elements are most helpful.

Future research deals with the extension of the adaptive set of rules as well as the investigation of additional affective states.

V. MOTIVATIONAL ASPECTS

Motivation is a key factor in education. While there exist some learning system that consider techniques for motivating learners, these systems implement only one or few techniques and assume that the respective technique(s) work well for all learners. However, learners are motivated differently and what is motivating for one learner can be demotivating for another learner.

Our research in this area aims at developing mechanisms and algorithms that provide learners with motivational techniques that work well for them in their current situation. As a first step toward this goal, we introduced a framework of motivational techniques, which suggests motivational techniques that can be included in learning systems, discusses the relationships between these techniques, situations where the techniques might be demotivating for learners, and requirements of the techniques to be integrated into a course and learning system [22]. This framework aims at providing guidelines on how to implement a set of motivational techniques into learning systems and is the basis for providing personalization based on motivational aspects in learning systems.

Our current and future research in this area deals with implementing the proposed motivational techniques as well as investigations and the design of mechanisms and algorithms that provide learners with personalized motivational techniques.

VI. CONTEXT AND ENVIRONMENT

Due to the recent advances in mobile technologies, learning can take place anytime and anywhere, using not only desktop-computers but also mobile devices such as smart phones and tablets for learning. The learners’ current context/situation as well as the characteristics of the surrounding environment in which a learner learns become therefore part of another important aspect to be considered by adaptive technologies. By incorporating information about the context and environment of the learner into the adaptation process, new possibilities for providing adaptivity open up.

In our current research, we aim at enabling mobile systems to “know” the learners’ environment and provide him/her with learning objects/activities that work best in such environments. Current investigations deal with the use of different sensors of a mobile phone in order to build a comprehensive student/context model, including for example, whether a learner is in a silent or noisy environment, whether a learner is alone or in a group, whether a learner is at a particular place or moving (e.g., in a bus), etc. Future research deals with using this information to provide learners with adaptive recommendations based on his/her context.

ACKNOWLEDGMENT

The authors acknowledge the support of the Austrian Federal Ministry for Education, Science, and Culture, and the European Social Fund (ESF) (grant 31.963/46-VIII/9/2002), the National Science Council of the Republic of China, Taiwan (grant NSC 097-2811-S-008-001-), the Austrian Science Fund (FWF) (grant J2831-N13), NSERC, iCORE, Xerox, and the research related gift funding by Mr. A. Markin.

REFERENCES

Expertise Network Discovery via Topic and Link Analysis in Online Communities

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Abstract—Online communities have become important places for people to seek and share expertise. Yet with the increasing number of members and produced artifacts within the communities, it is challenging to find the influential experts who post topic-specific high-quality content. This paper presents an approach to discover expertise network in online communities based on textual information and social links. In addition to computing documents’ topic-focus degree, the approach measures the quality of documents according to users’ feedback behaviors and topic-specific influence of users who give feedback. In this way, user’s expertise rank and social links are both considered to constitute expertise network. Experiments on real dataset have shown that our approach is effective to discover the meaningful expertise networks.

Keywords—Expertise finding; online community; social link; textual information; topic-specific

I. INTRODUCTION

Nowadays, people are used to depending on search engines to search and locate information to solve their problems. Yet in some cases, people are not able to describe their problems clearly and too much returned unrelated information leads to people feeling frustrated. Actually, knowledge is usually contained in the skill, experience, and expertise of people [4]. So, the common method is to find a person (i.e. expert) with a high degree of a skill or knowledge of a certain subject [11].

Expert finding, or called expert identification, aims at answering this question “who is expert on topic X?” by analyzing interaction among people. Communications were in the past only performed within organizations using intranet, and most interactions were based on tools such as email. In recent years, Web-based communities have become important places for people to seek and share expertise. The shift toward the Web 2.0 allows people to write blogs about their activities, share knowledge in forums, write Wiki pages, and utilize social-services to stay in touch with other people [15]. It is possible to utilize the knowledge of a massive amount of people participating in interactions on the Web.

Existing works on expertise network discovery mainly focus on link analysis or topic modeling. Assuming that interactive connections among people can be useful to infer expertise, the graph connectivity based approaches analyze social links by using keyword matching. On the other hand, topic modeling approach makes use of latent topic layer to semantically capture relationship. In fact, both of graph links and textual information associated with people are important for expertise finding in online communities. Most of the existing approaches consider only one aspect but ignore the other. Additionally, the approaches of expertise network discovery need to adapt to the communities’ underlying interaction dynamics.

Therefore, we present a novel approach to discover expertise network in online communities by taking user’s expertise rank and social links into consideration. Expertise rank is measured through combination of documents’ topic-focus degree, quality of documents, and users’ activities. Experiment was conducted to evaluate effectiveness of the proposed approach using real dataset from Sina blog in China.

II. RELATED WORKS

A wide range of works have been done for expertise finding. Previous studies on expert finding can be classified into topology-based approach and topic-based approach [6]. The kernel of the topology-approach is to construct a graph on the basis of real world entities and their interactions by using keywords based matching. According to information flow between nodes in the graph, this approach focuses on link analysis to calculate expertise rank in the social network. By contrast, the topic-based approach captures the semantics-based information embodied in the documents, such as papers, blogs, discussion transcripts, emails, produced by the network entities to estimate the probability that a candidate could be an expert on a certain topic.

Regarding the topology-based approach, the classical webpage ranking algorithms PageRank [3] and HITS [9] are adopted to estimate the expertise of users by analyzing users’ interactions, such as email conversations [8]. J. Zhang et al. proposed an ExpertiseRank algorithm based on PageRank to generate a measure that not only considers how many other people one helped, but also whom he/she helped [17]. Hilltop is another method by following two steps: expert page searching and target pages ordering [2]. D. Schalla presented a ranking model DSARank based on interaction metrics and advanced context-aware ranking techniques that make use of contextual-link information [15]. Furthermore, S. Kong presented a tweet-centric approach for topic-specific author ranking in Micro-Blog. In addition to traditional reply-to relationship, the approach considers the influence of users according to their posting tweets on a certain topic. Nevertheless the topic-specific tweets were simply extracted through keyword matching [10]. The advantage of this approach is that the link between the nodes reflects the real world connection, and it was proved effective in applications such as Q/A forum and paper
citation networks. Yet this approach ignores the interested topics shared by members. As a result, each expertise network contains several topics, which mixes the meanings of the community [7].

As for the topic-based approach, Y. Li and J. Tang proposed a unified model that temporal information is modeled in a forward-and-backward propagation process in the random walk for experts finding [13]. An expert search framework was also presented that divides expert search problem into three dimensions: ranking, quoted analysis and topic maps search [16]. K. Balog et al. proposed a language modeling framework for expert finding [1]. J. Zhang et al. presented a mixture model for expert finding based on pLSA [18]. Latent Dirichlet Allocation (LDA) is an unsupervised modeling framework for expert finding [4][6][14]. The advantage of [18]. Latent Dirichlet Allocation (LDA) is an unsupervised problem into three dimensions: ranking, quoted analysis and framework was also presented that divides expert search the random walk for experts finding [13]. An expert search the community [7].

To sum up, neither social link analysis nor textual information alone is sufficient for discovering meaningful expertise network in online communities. Based on computing of the similarity between document and concept in knowledge map for message topic recognition, Y. Li et al. proposed to combine reply-to relationship and topic similarity for special interest groups discovery within forums [12]. Z. Zhao et al. proposed a topic-oriented community detection approach which combines both social objects clustering and link analysis [19]. They presented a modified K-Means algorithm for object clustering, and then members involved in the social objects are partitioned into topical clusters. By contrast, this paper focuses on expertise ranking and topic-specific expertise network constitution based on social links and textual information.

III. EXPERTISE NETWORK DISCOVERY APPROACH

The crucial issue for expertise network discovery is to find users with high expertise on a specific topic. Our approach performs topic-specific user ranking based on two assumptions. The first is that the more documents (e.g. blogs, discussion transcripts) a user posted or commented on a specific topic, the more interest he/she has on this topic. The second is that a document commented or re-tweeted, forwarded by other influential users (i.e. users with high expertise) on the topic appears to have better quality than those commented, re-tweeted or forwarded by less influential users. After finding the candidate experts, the social links between them are analyzed using Social Network Analysis (SNA) to construct expertise network on a specific topic.

We adopt LDA to obtain the document-topic matrix. Afterwards, Equation (1) is used to select the topic with the highest probability to which the document belongs, denoted as $P(d)$. Where $d$ indicates a document, $z$ denotes a specific topic and $Z$ denotes the set of discovered topics.

\[
    P(d) = \max_P(P(d|z), z \in Z)
\]

A. Reliability computing to reflect documents’ quality

In online communities, users mainly play two roles, namely author and viewer of documents. The quality score of a document is subject to the feedback behaviors of its viewers (e.g. comment, forward), as well as the expertise scores of its linked users who may also be viewers or authors of other documents. Equation (2) is used to compute the reliability of a document on a certain topic.

\[
    \text{Rel}_{d,z,i}(d) = \frac{\sum_{w=1}^{n_i} \sum_{a} \text{Exp}(z,a) \cdot \text{Num}_{w,a}}{\sum_{a} \text{Exp}(z,a) \cdot \text{Num}_{w,a}}
\]

Where $B$ denotes the users’ feedback behaviors on the document, and herein we consider three actions defined as $B=\{\text{comment}, \text{forward}, \text{read}\}$. $A_{d,z}$ denotes the set of users who perform the $i$th action on the document $d$. $D_z$ denotes the set of documents that belong to the topic $z$. $\text{Num}_{a,i}$ denotes the number of $i$th action performed by the author $a$ on the document $d$.

B. Users’ topic-focus activity measurement

It is common that users either post documents or provide feedbacks on documents in online communities. Accordingly, we define (3) and (4) to compute $\text{PosAct}(a)$ and $\text{BehAct}(a)$ of a user on topic $z$, respectively. The two indicators reflect users’ contributions and interests on a specific topic. Then, Equation (5) is defined to combine the two indicators for computing the topic-focus degrees of users. The greater the value of $\text{Act}(a)$ is, the more the user focuses on the topic $z$.

\[
    \text{PosAct}(a) = \frac{1}{\sum_{D_{z,a}}} \sum_{D_{z,a}}\text{PosAct}(a)
\]

Where $D_{z,a}$ denotes the set of documents posted by the user $a$ on the topic $z$.

\[
    \text{BehAct}(a) = \frac{1}{\sum_{D_{z,a}}} \sum_{D_{z,a}}\text{BehAct}(a)
\]

Where $\text{Num}_{a,i}$ denotes the number of $i$th action performed by the author $a$ on documents belonging to the topic $z$. To combine the diverse actions performed by users, we define (5) to measure user’s topic-focus activity.

\[
    \text{Act}(a) = \alpha \cdot \text{PosAct}(a) + \beta \cdot \text{BehAct}(a)
\]

Where $\alpha$ and $\beta$ are the adjustable parameters.

C. Topic-specific expertise ranking

According to the above-mentioned assumptions, we define (6) to compute the topic-specific expertise of an author through combination of document’s reliability, documents’ topic-focus degree, and user’s activity.

\[
    \text{Exp}_{d,z}(a) = \frac{\text{PosAct}(a) \cdot \text{BehAct}(a) \cdot |D_{z,a}|}{\text{Min}(\text{Exp}_{d,z}(a) | a \in A)}, |D_{z,a}| > 0 \text{ here}
\]

Here $A$ denotes the set of users. $D_{z,a}$ denotes the number of documents posted by a user on topic $z$, and $|D_{z,a}|=0$ means that the user only give feedbacks to documents but not post.
any document. In such case, we believe that the expertise rank of such users is minimal compared to other users who post documents.

Note that computation of $\Exp(z,a)$ in (6) is an iteration process, due to the observation that the quality of the original documents posted by a user is determined by the expertise of users who give feedback. When the iteration process is completed, $\Exp(z,a)$ is used as the final ranking score of the user $a$ on the topic $z$. Algorithm 1 shows the core pseudo code of the approach. The initial value of $\Exp(z,a)$ for each user is assigned 0.5.

Algorithm 1. ExpRank

1: for each user $a \in A$ do
2: \hspace{1em} $\Exp_{0}(z,a) \leftarrow 0.5$
3: end for
4: $n \leftarrow 0$; //iteration indicator
5: for each topic $z \in Z$ do
6: \hspace{1em} repeat
7: \hspace{2em} compute $\PosAct_t(a)$
8: \hspace{2em} compute $\BehAct_t(a)$
9: \hspace{2em} compute $\Act_t(a)$
10: \hspace{2em} for each document $d \in D_z$ do
11: \hspace{3em} compute $\Rel_{a,i}(z,d)$ for each behavior $i$
12: \hspace{2em} end for
13: \hspace{2em} for each user $a \in A$ do
14: \hspace{3em} if $\Abs(d) > 0$ do
15: \hspace{4em} $\Exp_{n+1}(z,a) \leftarrow \frac{\sum_{d \in D_z} \Abs(d) \cdot \Rel_{a,i}(z,d)}{\Abs(d)}$ \hspace{2em} //Given a topic-document list $P_t(d)$, this algorithm is to obtain the expertise ranking of users on each topic.
16: \hspace{3em} end if
17: \hspace{2em} $\Exp_{n+1}(z,a) \leftarrow \min \{\Exp_{n+1}(z,a) | a \in A\}$
18: \hspace{2em} end for
19: $n \leftarrow n+1$
20: until $\Exp(a,z)$ convergence
21: $E \leftarrow \text{Rank}(\Exp(a,z))$
22: end for
23: return expertise list $E, \forall z \in Z$

end for

A. Datasets
The dataset is from Sina that provides the most popular blog channel in China. We collected the information of all the educational blogs from September, 2008 to August, 2011. In total, we extracted 2,269 blogs, 738 authors who posted blogs, and 28313 users who only gave feedbacks without posting any blogs.

B. Experiment process and results
The first step was to preprocess the dataset. We adopted the vector space model to represent each blog. We first preprocessed the dataset through splitting words, removing stop words. Then, we adopted LDA to extract the clusters of words with probability on the basis of dataset. The results are illustrated in Table I. As shown in the table, there are seven topics in total and each topic is associated with top 10 words that provide a meaningful description of a specific focus relate to education.

On the basis of the discovered topics, the algorithm ExpRank was performed to obtain the expertise ranking for users on each topic. To simplify the algorithmic time complexity, we omitted those users who posting fewer than 2 times. Table II illustrates the top 10 experts with expertise probability on three hot topics. For example, user #609 has the highest expertise ranking on the topic "quality education".

### Table I. An Illustration of the Discovered Seven Topics.

<table>
<thead>
<tr>
<th>Topic0 School Education</th>
<th>Topic1 Quality Education</th>
<th>Topic2 English Study</th>
<th>Topic3 Educational Problems</th>
<th>Topic4 College Entrance Recruiting</th>
<th>Topic5 College Ranking</th>
<th>Topic6 Family Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>0.0324</td>
<td>Society</td>
<td>0.0060</td>
<td>New Liberal</td>
<td>0.0266</td>
<td>Education</td>
</tr>
<tr>
<td>Teacher</td>
<td>0.0251</td>
<td>Life</td>
<td>0.0046</td>
<td>Miao Nian Yu</td>
<td>0.0118</td>
<td>China</td>
</tr>
<tr>
<td>Study</td>
<td>0.0271</td>
<td>Work</td>
<td>0.0033</td>
<td>College</td>
<td>0.0160</td>
<td>Examination</td>
</tr>
<tr>
<td>School</td>
<td>0.0153</td>
<td>Spina</td>
<td>0.0036</td>
<td>World</td>
<td>0.0073</td>
<td>Development</td>
</tr>
<tr>
<td>Education</td>
<td>0.0115</td>
<td>China</td>
<td>0.0036</td>
<td>China</td>
<td>0.0068</td>
<td>School</td>
</tr>
<tr>
<td>Problem</td>
<td>0.0076</td>
<td>Leadership</td>
<td>0.0155</td>
<td>Affairs</td>
<td>0.0007</td>
<td>Talent</td>
</tr>
<tr>
<td>Tutor</td>
<td>0.0073</td>
<td>Peking University</td>
<td>0.0032</td>
<td>Problem</td>
<td>0.0061</td>
<td>Society</td>
</tr>
<tr>
<td>Knowledge</td>
<td>0.0071</td>
<td>Know</td>
<td>0.0031</td>
<td>Requirement</td>
<td>0.0057</td>
<td>Student</td>
</tr>
<tr>
<td>Parents</td>
<td>0.0068</td>
<td>Today</td>
<td>0.0030</td>
<td>English</td>
<td>0.0056</td>
<td>Teacher</td>
</tr>
<tr>
<td>Ability</td>
<td>0.0060</td>
<td>Nowadays</td>
<td>0.0024</td>
<td>Open</td>
<td>0.0036</td>
<td>Country</td>
</tr>
</tbody>
</table>
Once the expertise ranking for each user was obtained, interaction between experts were analyzed to constitute expertise network on each specific topic. Herein we analyzed information flow (i.e. three actions including comment, forward, and read) between experts to constitute expertise network on each specific topic. As shown in the figures, the node denotes the expert and the edge denotes the social relationship between experts. The bigger of the node is, the higher expertise of the expert is. And the thicker of the edge is, the more close the relationship between the experts is, and vice versa.

**Figure 1.** Expertise network on topic0 “School Education”.

**Figure 2.** Expertise network on topic1 “Quality Education”.

**Figure 3.** Expertise network on topic6 “Family Education”.

Compared with the expertise networks on “school education” and “quality education”, the experts on “family education” are more active. Based on observation, we found that the number of the blogs and users on this topic are both the most, which accordingly inspired more interaction. Nevertheless, there are still many experts who seldom interact with others in the three networks. The reason behind it is that people prefer to publish their opinions in blogs rather than give comments.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>693</td>
<td>0.02412</td>
<td>503</td>
<td>0.01535</td>
</tr>
<tr>
<td>503</td>
<td>0.01082</td>
<td>154</td>
<td>0.00717</td>
</tr>
<tr>
<td>411</td>
<td>0.00824</td>
<td>428</td>
<td>0.00882</td>
</tr>
<tr>
<td>154</td>
<td>0.00764</td>
<td>674</td>
<td>0.00472</td>
</tr>
<tr>
<td>481</td>
<td>0.00574</td>
<td>511</td>
<td>0.00319</td>
</tr>
<tr>
<td>43</td>
<td>0.00510</td>
<td>218</td>
<td>0.00260</td>
</tr>
<tr>
<td>215</td>
<td>0.00299</td>
<td>474</td>
<td>0.00258</td>
</tr>
<tr>
<td>308</td>
<td>0.00242</td>
<td>693</td>
<td>0.00214</td>
</tr>
<tr>
<td>298</td>
<td>0.00201</td>
<td>424</td>
<td>0.00124</td>
</tr>
<tr>
<td>695</td>
<td>0.00138</td>
<td>481</td>
<td>0.00111</td>
</tr>
</tbody>
</table>

Additionally, as the interaction of communities change dynamically, we further explore the temporal expertise of users on the topics. Table III shows the top 10 experts on the topic “family education” during different period. As table III shows, there are several users (e.g. #693, #154, and #481) who have steady expertise on the topic, while others change differently. For example, user #503 had high expertise from Aug. 2008 to Dec. 2010, but disappeared from the top 10 name-list since Jan. 2011. This situation reflects the salient mobility of online communities.

C. Comparison

Since there was no explicit user-supplied expertise ranking data in the educational blog, we needed to use human raters to generate a “gold standard” for comparison. While the ranking algorithm produced continuous values that can potentially differentiate between all users, it is very difficult for humans to sort dozens of users into a ranked list. To evaluate a users’ expertise level, raters must browse all the blogs posted by him/her and others’ feedbacks to the blogs. It is also difficult to compare two users if they have similar performance.

To address this problem, J. Zhang et.al presented to let raters categorize the users into 5 expertise levels instead of a complete ranked list based on observation and the results of a pilot rating set [17]. Likewise, we selected three topics and invited two educational experts to rate the users’ expertise into five levels. After each human rater submitted his ratings, we tested the reliability of raters by looking at their inter-rater correlation. The Kendall’s tau_b distance between the two human raters was 0.762, and the Spearman’s rho correlation coefficient was 0.823 (p<0.01), a sufficiently high rate of inter-rater correlation.

To have a measurement of the performance for the automatic algorithm, we summed the ratings from the two
raters together as the standard human rating. And then we performed significant correlation analysis between the algorithm and human ratings on three topics. Fig. 4 illustrates the statistical results regarding Kendall’s tau-b and Spearman’s rho. As the figure shows, the ExpRank algorithm gives a relatively high correlation with the human-assigned ratings, which implies that our approach is effective to rank experts in online communities.

V. CONCLUSIONS

The automatic analysis of expertise in online communities gains more and more attention because of the increasing number of members and produced artifacts within online communities. This study deals with the problem of expertise network discovery in online communities by analyzing the textual information and social links between users. To do this, we went through three steps. First, we adopt the topic modeling approach LDA to obtain the topics for documents with the highest probability. Then, an algorithm is proposed to compute users’ expertise rank based on documents’ topic-focus degree, quality of documents, and users’ activities. Finally, SNA is used to analyze the social links between the discovered experts and accordingly construct expertise network on the specific topic. Empirical study was conducted based on a real dataset from Sina educational blogs in China. The results and comparison show that our approach is feasible and effective to find meaningful expertise networks.

Future work is to evaluate our approach on large-scale different types of datasets, such as discussion transcripts of forums and tweets of micro-blog, and to explore if the expertise networks discovered from diverse online communities have different characteristics.

ACKNOWLEDGMENT

This research work is supported by National Natural Science Foundation of China (NSFC: 61075048), Fundamental Research Funds for the Central Universities (2009SD-9), and Arts Yong Teacher Development Cultivation Project of Beijing Normal University.

REFERENCES

Note-taking Markings in Pupil’s Textbook: Features and Influence Factors

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Abstract— As an important learning strategy, note-taking has been long drawing researchers’ attention. This paper analyzes features and influence factors of note-taking markings in Chinese and mathematics textbooks for primary schools through content analysis and interviews leading to the following results. Firstly, the features of note-taking markings in the textbooks embody in three aspects of the forms, locations and contents of note-taking. Secondly, the important note-taking influence factors contain individual initiatives, teachers’ lecturing speed and the level of contents. Thirdly, the note-taking contents have obvious diversities in the subjects and grade sections. Fourthly, the textbook is an important cognitive tool for pupils’ study and an important intermediary tool for home-school communication. Fifthly, teachers have to guide pupils to develop good habits of note-taking. Sixthly, the design of note-taking function for eTextbook should take the features of note-taking markings in printed textbooks into consideration with the enrichment of note-taking forms and providing different note-taking tools, etc.

Keywords- note-taking markings; textbooks; behavior features; influence factors; the design of note-taking function for eTextbooks

I. INTRODUCTION

For a long time, taking notes has been widely used in the instruction as an important learning method, and both teachers and students have deeply understood the benefit of taking notes to the learning effects of students during the long-term process of learning and teaching. As the important significance of note-taking in the field of education, many foreign educational psychologists have carried out systematic studies on note-taking, and have achieved many research outcomes in this field (Yang Shaoning, 1998). The outcomes of former researchers mainly focus on the following areas: (1) Studies on the function of note-taking: there are storage function hypothesis and encoding function hypothesis. From the perspective of static results, storage function hypothesis regards the note-taking as the carrier of knowledge, which facilitates the learner's memorization and retrieval. From the perspective of dynamic process, encoding function hypothesis advocates that the process of taking notes can cause positive activities in learning, which is conducive to organizing memory and forming migration. (2) Studies on the theory of taking notes: there are quantitative theory and qualitative theory. The qualitative theory focuses on "which contents are in the learners’ concern and taken in their notes", while the quantitative theory focuses on "why the statements taken down can be well memorized". Both give explanation to the occurrence of the effects of taking notes (Peper, R. J., & Mayer, R. E., 1986). (3) Studies on the technique issues of taking notes: In accordance with the defects in the note-taking method of taking verbatim notes of the teacher's words in the traditional way, Kiewra (1995) proposes two theoretical hypotheses for determining the merits of note-taking methods, which are the degree of integrity and that of internal connections. He also puts forward two methods of taking notes, which are liner technique and matrix technique (Cheng-Huan Chen, Chiung-Hui Chiu, 2011). (4) Studies on the influence factors of note-taking: The researchers have found out that the quality and quantity of taking notes are influenced by the lecturing speed, the knowledge background of the subjects and the length of lectures, etc. (Hu Jin, 1999). (5) Studies on the note-taking in textbooks: The note-takings in the textbooks mainly are annotation notes containing two forms. One is marks like underlines and circles and the other is text sharing, the analysis of the function features of e-note system (C. Hoff, U. Wehling & S. Rothkugel, 2009) and so on. The above studies have achieved outcomes in the aspects of the function of note-taking, the ways and techniques of taking notes. However, so far, there have been very few studies on the topic of taking notes domestically. Mostly, only some teachers and students acknowledge the benefit of taking notes to the learning according to their experience, and they advise on how pupils should take notes and form good note-taking habit and so on only from the speculative perspective. (Cao Jinyuan, 2007).

Based on the above background, this study focuses on the features of pupils note-taking in their textbooks and the influence factors of taking notes, with the emphasis on the analysis of the Chinese and mathematics textbooks for primary schools published by People Education Press and Beijing Normal University Press. It carries out content analysis of the note-taking markings left in the textbooks by the pupils and acquires the important influence factors of taking notes through interviews. The results of the study aim to provide references to the design of note-taking function for e-textbooks. Therefore, this study proposes the following two research questions:

(1) Which features do the notes taken in the printed textbooks by pupils have?

(2) What are the factors that influence the note-taking of pupils?

II. LITERATURE ANALYSIS

A. Definitions

Teaching material: Teaching material has the broad and narrow senses. The broad sense refers to all teaching materials used in and out of the classroom by teachers and students. The narrow sense refers to the textbook materials, also known as "textbook". In this study, teaching material refers specifically
to the textbook, which is the textbook designed for pupils according to the syllabus (or curriculum standards) of different subjects.

Notes: there are three definitions of the notes in the Chinese Dictionary of Han Dynasty (the 5th edition): ① the records made by a pen, ② the records made at the time of having lectures, reports or reading, ③ a type of literature genres based on informal essays, mostly formed by the collection of a number of short essays. This study takes the definition ②, which primarily refers to the notes and annotations made by pupils in the textbooks.

B. Studies on the note-takings in printed textbooks

The template is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin in this template measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations.

Marshall (1998) collects 410 used textbooks from the campus rental bookstore. After thorough investigation, he summarizes the forms of the annotation notes in these textbooks and proposes corresponding functions (see Table 1). In addition, from the attributes of the note-taking markings, he also finds out the note contents in these textbooks contain formal classroom note-takings, private tips during self-reading, and not as an independent document. Please do not revise any of the current designations.

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Although Marshall’s (1998) study involves the study on the note-taking in the textbook, he only takes college students as the subjects without concerning about the forms of note-takings of K-12 school students. So, the studies on how K-12 school students take notes in the textbook, what features their note-takings have and what are the influence factors of pupils’ taking notes have not drawn much attention of the researchers.

C. Studies on the note-taking system in the computer environment

By observing the function of existing annotation note systems, Hoff, Wehling & Rothkugel (2009) analyze the existing note-taking system from the four dimensions of media-supported formats, annotation support, annotation management and user interaction and sort out the common attributes of these annotation system, as shown in Table 2. However, there are many limitations in these note-taking systems: ① Most note-taking systems do not support documents of multiple formats, not to mention various types of annotation media. ② Some online versions of annotation systems do not support documents of PDF format or Word format, which cannot realize cross-platform interoperability. As users usually open several documents to read, the existing note-taking systems are lack of a bond that can connect these documents, let alone visualization. ③ The sharing activities among different annotation takers are very limited. Cabanac et al. (2007) also point out that due to the inappropriate setting of the metadata, the electronic note-taking systems may not correctly express the intention of the annotation takers.

<table>
<thead>
<tr>
<th>Forms</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>To underline or highlight chapter catalog and headings; personalized note-taking symbols (such as advanced asterisk, strikethrough)</td>
<td>To remind him/her of paying attention in the future</td>
</tr>
<tr>
<td>Short highlights, circled words, annotation (marked between the lines of the texts), special symbols at paragraph boundary (use asterisk)</td>
<td>To mark location and facilitate memorization</td>
</tr>
<tr>
<td>To add comments in the margin, charts or near the equations</td>
<td>To solve problems</td>
</tr>
<tr>
<td>To add short notes in the margin, write down a lot of contents in the line spacing of the texts, annotate words and phrases in the line spacing of the texts</td>
<td>To interpret</td>
</tr>
<tr>
<td>To expand highlights or underlines</td>
<td>To use complex descriptive tracking process</td>
</tr>
<tr>
<td>Note-takings, drawing, graffiti and other marks that are unrelated to the content itself</td>
<td>Reflection along with the process of reading materials</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supporting formats</th>
<th>Documents</th>
<th>Web document (HTML), Office document (Microsoft’s office + open office)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annotations</td>
<td>Text, images, audio and video</td>
<td></td>
</tr>
<tr>
<td>Locations of the annotations</td>
<td>In the text, above the text and at the bottom of the text</td>
<td></td>
</tr>
<tr>
<td>Annotation positions</td>
<td>The entire document, pre-defined part, any part, a variety of parts</td>
<td></td>
</tr>
<tr>
<td>Semantics</td>
<td>Markup elements (problems, types of questions, ideas,</td>
<td></td>
</tr>
</tbody>
</table>
Besides, R. McFall (2005) attempts to carry out metaphor design of e-textbook annotation note-taking function in the way of that in printed textbooks and adds the functions of deleting and modifying note-takings by using the function of management of electronic note-taking system, but this system does not bring any advantages to textbook reading from the perspective of application result.

III. RESEARCH METHODOLOGY AND DESIGN

A. Research design

This research aims to analyze the features and influence factors of note-takings in present domestic Chinese and mathematics textbooks in K-12 schools. It puts forward the analytical dimensions of note-taking marking features by literature study, studies on the features of the existing note-takings and expert consulting process so as to analyze and compare the features of note-takings by calculating the number of pages containing note-takings in the textbooks. In addition, it analyzes the main influence factors of note-takings through interviewing K-12 school students for their understandings of the note-taking.

B. The selection of textbooks

The objects of this research are the Chinese and mathematics textbooks for primary schools published by People Education Press and Beijing Normal University Press that are widely selected currently. The range of selected grades is from Grade 1 to Grade 6 with a total of 50 textbooks.

C. Research tools

Referring to the research outcomes of Marshall (1998), C. Hoff, U. Wehling & S. Rothkugel (2007) and so on, this research categorizes based on the specific circumstances of the behavioral features of note-takings in the textbooks for primary schools. Ou Yongsheng (1998) thinks that the analytical unit of textbooks can be chapters, sections, units, lessons, paragraphs, words, sentences, characters, pages, and so on. It is not suitable for this research to be over specific. In order to accurately master the materials for objective analysis, the research uses "page" as the unit of analysis. The interview outlines of topics of this research are made up mainly referring to the studies of Liu Yongcan (2003) and Yin Jianlou (2009) and so on.

D. The analysis of reliability and validity

There are two scorers to take reliability tests and two scorers who are postgraduates in the major of curriculum and teaching theory and go to K-12 schools to observe classroom teaching for investigation so as to get familiar with the teaching of Chinese and mathematics.

In the reliability test process, the researcher first selects 50 pages, distributes the classification tables to the two scorers, then describes the principles and methods of classification, asks them to classify the above selected pages based on the contents accordingly, and finally uses the formula to calculate the reliability based on the results of classification. The reliability analysis formulas used in this research are as follows:

1. The degree of mutual agreement

\[ P = \frac{2M}{N1+N2} \]

Note: M: the number of mutual agreements; N1: the number of expected agreements of the first scorer; N2: the number of expected agreements of the second scorer

2. Reliability = \[ \frac{N * (Average\ degree\ of\ mutual\ agreement)}{(1 + (N-1) * (Average\ degree\ of\ mutual\ agreement))} \]

N: the number of the scorers

According to the above formulas, the reliability of this research is 0.88, which meets the requirements of content analysis. In the perspective of validity, the researcher has repeated discussions with three excellent Chinese teachers in K-12 schools and an expert of curriculum and teaching theory, and ensures to cover all important contents through constant modifications so as to satisfy the requirements of this research.

IV. RESEARCH RESULTS

A. The features of note-takings on the textbooks for primary schools

Based on rigorous statistics of the note-taking markings presented in the textbooks, the author summarizes the statistical results of the collected samples in three dimensions of the note-taking forms, locations and contents, as shown in Table 3. The features of these note-taking markings reflect that Chinese emphasizes on helping students to understand the text content and to improve their Chinese learning capability by circling, sketching and annotating the characters, words, sentences and paragraphs and mathematics focuses on help students to understand the knowledge of numbers and algebra, statistics and probability, graph transformations and space, etc. by mathematical language symbols and annotations. Although the note-takings are of various forms and vary to different subjects, the purposes and functions of note-takings are more consistent, which record the combined the reading, thinking and memorizing process of learners to enhance their understandings of teaching materials for review and knowledge transference so as to promote effective learning.

<table>
<thead>
<tr>
<th>Interactive management</th>
<th>Sharing</th>
<th>Possibility of responses</th>
<th>Notice</th>
<th>For searching</th>
<th>Information database</th>
<th>Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Private, group sharing, public</td>
<td>Discussion topics, comments on others' annotations</td>
<td>Inform authors of new annotations; reply to the annotations</td>
<td>Natural language understanding systems, metadata and annotation contents</td>
<td>Local, the Internet, available for copy (at the client terminals, peers)</td>
<td>Annotation reference points and versions</td>
</tr>
</tbody>
</table>
### TABLE III. THE SUMMATIVE RESULTS OF THE FEATURES OF NOTE-TAKINGS ON THE TEXTBOOKS FOR PRIMARY SCHOOLS

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Chinese</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note-taking forms</td>
<td>• Paragraph markings (numbers before the paragraph, double vertical bars after the paragraph); • Draw lines under or between the characters, words and sentences (straight lines, wavy lines, vertical bars between a sentence); • Highlight with a highlighter; • Character and word marking symbols (geometric images, dots, brackets, numbers); • Pinyin markings; • Outline and circle markings (circles, dots); • Text annotations (copying homework, notes for the text); • Painting and drawing lines: painting, filling in the colors, matching; • Modification symbols/tools for sentences (change symbols, correction fluid);</td>
<td>• Mathematical symbols (&gt;, &lt;, ≠, =, etc.); • Outline and circle markings (circles, dots); • Drawing with a variety of learning tools (triangle, rectangle, square, circle, etc.); • Mathematical text notes (notes for formula, formula classification); • Painting and drawing lines: painting, filling in the colors, matching;</td>
</tr>
<tr>
<td>Note-taking locations</td>
<td>• Eyebrow notes (at the margin of the headlines); • Margin notes (next to the new characters and words in the text, next to the vocabulary table); • Notes between the lines (markings before the paragraph, add annotations or notes to the text contents); • Notes beside the text (write down the main contents of the paragraph on both sides of the margins, figures of speech, sentence paraphrase); • Notes at the margin below the text (after the paragraph); • Notes at the classic words or sentences; • Fly page (homework, personal information);</td>
<td>• Notes between the lines (between the application problems, between the mathematical problems); • Notes beside the text (in the space between the exercises); • Fly page (memo, homework, personal information);</td>
</tr>
<tr>
<td>Note-taking contents</td>
<td>• Learn new characters and words: make up phrases, phonetic records, phonetic new characters; • Write Characters: Square lattice, practice strokes, stroke orders, copying the phonetic alphabets (Chinese characters); • Grammar: punctuation, rhetoric, sentence analysis (vertical bars); • Understanding the texts: the central idea, explanation of characters and words, notes of the idea of paragraphs; • Homework: note the homework, answers to homework; • The feedback process of teachers’ correcting students’ homework; • Signatures of parents, teachers and students; • Content integrity: the incompleteness of existing notes, misspelling</td>
<td>• Calculation process (addition, subtraction, multiplication, division, multi-step calculation); • Notes of the numbers (algebra and geometry calculative results); • Answers to the exercise (the answers to the application questions and fill in the blanks); • Measurement results of the learning tools (rulers, triangle rulers, compasses, etc.); • Circle the exercise; • The feedback process of teachers’ correcting students’ homework; • Homework draft; • Signatures of parents and teachers;</td>
</tr>
<tr>
<td>Others</td>
<td>Notes, a small piece of paper, sticky pictures on the books</td>
<td>Notes, a small piece of paper, text papers</td>
</tr>
</tbody>
</table>

The author further sorts out the corresponding relations between the note-taking forms of Chinese and pupils’ grade sections and the statistical results are shown in Figure 1. The figure shows that the note-taking forms are closely related to the grades of the pupils. The item of painting and drawing lines (filling in the colors/painting/matching) only appears in Grade One and Grade Two. The items of highlighting with a highlighter and outline and circle markings do not appear in the textbooks until Grade Three. The items of using notes/a small piece of paper and modification symbols/tools for sentences rarely appear in the textbooks, which can be found only in Grade Four. The appearance frequency of markings of new characters after the text decreases as the grades increase.
The author sorts out the forms and contents of note-taking markings in the mathematics textbook and the statistical results are shown in Figure 2. The frequency of the note-takings in the mathematics textbooks reflects the subject feature of mathematics and the note-taking contents are closely related to the solving process of mathematical problems. Furthermore, mathematics textbooks are also the important media for teacher-student interaction, as well as the important texts for teachers to correct pupils’ homework, which is particularly significant in the low grade sections.

B. The influence factors of pupils’ taking notes

After the interview of 18 pupils in Grade 4 to Grade 6, the author finds out that they generally agree that the note-takings provide support to their review in the future, so they will take the initiative to take notes. Teachers often ask students to take notes and sort out the notes, but rarely examine the notes. Students generally think that the speed of teacher’s lecturing is an important factor that influences their note-takings. If the teacher leaves them very little time, they will have incomplete note-takings. In terms of the difficulty of the text contents, students all agree that their note-takings are usually more detailed with more information when encountering with learning contents of low relevance to their existing knowledge.

The subjects list out the orders of the influence factors of note-takings according to the degree of importance as shown in Figure 3. The lower the score is, the higher the degree of its importance is.

Therefore, among the eight influence factors of pupils’ note-takings, four factors are related to the individual learners, which are personal initiatives, personal note-taking styles,
learning scores and the grades of pupils respectively; two are related to teachers, which are the speed of teachers’ lecturing and teaching methods; and two are related to the textbooks, which are the difficulty and edition of the contents. The personal initiatives, the speed of teachers’ lecturing and the difficulty of the text contents are the most important influence factors. Most students do not think that the edition of textbooks has any influence on the note-takings.

V. DISCUSSION

A. The features of note-taking markings in the textbooks are significant different in accordance with subjects

By analyzing the behavioral features of the collected pupils’ note-takings, the author finds out that the focuses of note-taking contents of different subjects have significant differences, so do the note-taking contents of different knowledge points within the subject. ① The note-takings of Chinese are mainly about learning new characters and words and understanding text contents with a large number of text notes and the massive use of various symbols like circles and underline markings. Pupils annotate the texts of different literary genres from different aspects. The annotations of narratives focus on the environment, plot, characters, theme and other aspects, those of prose focus on the thoughts and feelings, the moods, artistic conception and language, etc., while those of the poetry reflect their feelings of the poems, the images in the poems, subtle meanings, poetic languages and other aesthetic and appreciation capabilities. ② The note-takings in the arithmetic process of mathematics show the learners’ utilization of addition, subtraction, multiplication and division, which truly reflect their problem-solving process. In terms of the application problems, the note-takings of circling the important information of the problems reflect their understanding process of the problems. Therefore, the process of taking notes and the contents of note-takings are important cognitive strategies for pupils to grasp key information.

B. The note-takings of Chinese are significant different in accordance with grade sections

The new curriculum standards divides Chinese for primary schools into three grade sections, which are Grade section One (Grades 1- Grade 2), Grade section Two (Grade 3- Grade 4), Grade section Three (Grade 5- Grade 6). The differences of note-taking features in Chinese are obvious in terms of grade sections and the results of sorting out are as follows.

① In Grade section One, the note-taking form is mainly personalized symbols, such as circling characters and words, underlining words and sentences and marking serial numbers of paragraphs, as well as plenty of various irregular special graphics and symbols. Note-taking contents mainly make phonetic to the new characters and make up phrases with them. The most important point reflected by the note-taking markings is that learning new characters and words is the key learning task in Grade section One. The teachers need to develop pupils’ interests in learning and writing characters. Besides, the note-taking contents have strong correlation with exercise and homework as the note-taking markings in some pages are mainly the markings of pupils’ completing their exercise or homework. So the features of pupils’ note-taking behaviors at this stage are not steady and their note-taking contents only reflect their concerns about the key knowledge points of the text without the establishment of reinforced practice. The note-taking contents also reflect the markings of their completing the exercise or homework. So the proportion of the total number of exercise is the highest in the three grade sections.

② In Grade section Two, the style of note-takings in different textbooks show some common features, such as using highlighters to highlight key characters, words and sentences and taking annotations to the contents from the characters and words to sentences and paragraphs. The note-taking contents reflect their understandings of the text contents, for example, note-takings show the pupils’ learning to summarize the main idea of paragraphs and conclude the central idea of the whole text, and also penetrate their understanding and application of some grammar points. They begin to extract some good words and good sentences, which indicates the gradual transition from the accumulation of characters and words in the first grade section to that of phrases and sentences.

③ Compared with Grade section Two, the note-taking markings in the textbooks in Grade section Three, show less accumulation of single characters and words but more application of characters and words and the understanding of text contents and structures, especially some note-takings reflect that the pupils can summarize the main contents of different articles and the development of story plots by outline note-takings. The note-takings at this stage reflect in the whole that the note-taking habits of the learners are preliminarily formed. The note-taking contents and forms better reflect their mastery of the knowledge points. The note-taking locations are closer to the associated knowledge points. So, the note-taking behavior is transforming into an effective learning strategy.

C. The textbook is an important cognitive tool for pupils’ study and an important intermediary tool for home-school communications

The author finds out that teachers, pupils and parents use textbooks as the intermediary for home-school communications, exchange activities among pupils and between teachers and pupils from the analysis of note-taking markings. The lower the grade is, the more frequent the home-school communication is. Conclude from further analysis, teachers’ activities are mainly reflected in correcting pupils’ homework, writing recommendations to parents, signing below the texts that require pupils to recite and so on; while parents’ activities are mainly reflected in the records of instructing their children to complete homework and sign after checking the homework; and the interaction among students mainly refer to the records of reciting texts in peers. Therefore, in the current teaching activities in schools, the textbook is an important intermediary tool for home-school communications. Parents acquire the information from the teachers by examining their children's textbooks and record the information of supervising their children to complete homework in the textbooks, which allows the teachers to have a full understanding when examining the textbooks. So the analysis of the features of note-taking markings reflects that the textbook does not only carry the function of an important cognitive tool for pupils’ study, but
also an important intermediary for home-school communications.

D. It is an important measure for the teachers to guide students to develop a good habit of taking notes

As an important learning strategy, note-taking has been attached great importance to by both teachers and students. The influence factors of taking notes are diverse with students, teachers and contents as the important influence factors of taking notes, among which personal initiative plays a key role. Pupils are in the critical period of forming good study habits and the amount of note-takings in class is the largest out of their note-takings. Thus teachers need to guide them to form the good habit of taking notes, for instance, training their capability of taking notes in the texts of different literary genres, standardizing the markings of note-taking by specifying unified symbols, learning the techniques of taking notes from one another by note-taking sharing activities, instruct them to take notes efficiently by providing some note-taking tools, etc. The teachers ought to help them to transform from passive note-taking to active note-taking so that the process of taking notes and note-taking contents can effectively promote their learning.

VI. IMPLICATIONS FOR ELECTRONIC TEXTBOOKS

How to change the ways of learning and teaching in the information age is the key issue that the researchers of basic education should concern about at present. As an important component of the change in the ways of learning and teaching, printed textbooks are clearly insufficient in response to the process of education reform, (Xiang Guoxiong, 2005; Lv Shilin, 2005; Huang Xianhua & Hao Bingkun, 2005; Huang Ronghui, Chen Geng, Zhang Jinbao & Wang Yunwu, 2010), so the e-textbooks are put on the agenda as a new form of textbooks (Infographic, 2010; Gong, Chen, Huang, & Zhang, 2011). In general, e-textbooks refer to a type of e-books with special functions that meet specific content standards, which are lack of systematic and detailed studies both domestically and internationally. Although some electronic textbooks or equipment have appeared in the classroom, they have not fully prepared for classroom teaching (M. Weisberg, 2011). According to the investigation conducted earlier by some scholars (Morton, Foreman, Goede, Bezzant, & Albertine, 2007), the results show that teachers and students consider the functional features of e-textbooks as the key to the process of the construction of e-textbooks in the future and the note-taking based on the textbooks is considered as an important tool with which the pupils complete their self-study and knowledge construction, so the design of note-taking function for e-textbooks is very important. At present, some existing e-textbooks have poor user experience, which simply cannot serve as an alternative other than printed textbooks. The main reason is that the design of note-taking function does not meet the needs of learning and teaching, resulting in the less natural appearance than in the printed textbooks.

The analysis results of note-taking markings of printed textbooks have significant meaning of guidance in practice for the design of note-taking function for e-textbooks, according to which, the author believes that the design of note-taking function for e-textbooks should consider the following aspects:

1. Use reading software to enrich note-taking forms: In the classroom learning process with printed textbooks, the speed of teachers' lecturing influence students' taking notes. So, in the design of note-taking function for e-textbooks, in addition to providing the functions of highlighting, drawing lines and text annotations, the functions of providing audio recording and video recording with split screens should also be taken into consideration to improve the efficiency of note-taking, so that students can concentrate on classroom learning.

2. Design the sharing function of note-taking: Traditional notes are usually taken in the textbooks, which become the cognitive tool of personal review. The teachers barely have time to examine the situations of the note-takings of the students and the students seldom borrow note-takings from each other, which leads to the errors of common sense in some parts of the note-taking contents and the difficulty in sharing the techniques and experience of taking notes. Thus e-textbooks can consider designing the function of note-taking sharing to help with learning, borrowing and commenting on the note-takings between teachers and students or among students themselves so as to promote their overall understanding of the knowledge.

3. Note-taking synchronization and backup: Traditional note-takings are dependent on the textbooks, so in case the textbooks get lost, so will the note-takings. As there are a wide range of the types of electronic reading devices, in order to support free reading on different devices, we must design the functions of synchronization and backup in the design of note-takings for e-textbooks, which can realize browsing on different platforms and protect note-takings in real-time synchronization and secure storage.

4. Note-taking management: Traditional note-takings are usually stored together with the textbooks after finish learning them, so it is difficult to track the students' note-takings. The note-taking functions of e-textbooks can consider updating the note-takings, automatically detecting the mistaken characters in the note-takings and generating note-taking marking data of the learners to help them effectively manage their note-takings so as to play the important role of note-takings.

5. A variety of supporting tools for note-takings: Due to the significant differences of note-takings in different subjects and grade sections, the note-taking functions of the e-textbooks have to provide a variety of note-taking techniques and tools to help learners to complete study the courses of different subjects in different grades.

VII. CONCLUSIONS

This paper analyzes features and influence factors of note-taking markings in Chinese and mathematics textbooks for primary schools. The conclusions are:

1. the features of note-taking markings in the textbooks embody in three aspects of the forms, locations and contents of note-taking.

2. the important note-taking influence factors contain individual initiatives, teachers' lecturing speed and the level of contents.
the note-taking contents have obvious diversities in the subjects and grade sections.

④The textbook is an important cognitive tool for pupils’ study and an important intermediary tool for home-school communication.

⑤Teachers have to guide pupils to develop good habits of note-taking.

⑥The design of note-taking function for eTextbook should take the features of note-taking markings in printed textbooks into consideration with the enrichment of note-taking forms and providing different note-taking tools, etc.

Of course, as e-textbook is still new, we need to explore the specialty of its functions and optimize the design of note-taking functions based on borrowing from the features of note-takings in printed textbooks, so as to make the utilization of e-textbooks obey the laws of learning and teaching, and also promote the learners to carry out spontaneous, collaborative and inquiry learning to meet the requirements of learning in the future.

ACKNOWLEDGMENT

项目支持：本论文受“中央高校基本科研业务费专项资金”项目北京师范大学自主科研重大课题“电子教材的开发技术及其适用性研究”的资助。

REFERENCES


Abstract— e-Textbook refers to a type of e-books with special functions that meet specific content standards. Our goal is to fully understand the feasibility of applying e-Textbooks in China's K-12 schools. Our methodology for addressing this issue involved interviewing and sending questionnaire to five groups of people: teachers, students, parents, publishers and school administrators. The interviewing and questionnaire surveyed these individuals about their views regarding the disadvantages of printed textbooks, and the function, advantages and drawbacks of e-Textbooks in the digital age. The respondents believe that the advantages of e-Textbooks outweigh their potential disadvantages and they should be used to supplement printed textbooks. They also felt that in the digital age, the use of e-textbooks is a trend and that such books do not just duplicate printed textbooks; they found that the usefulness of e-textbooks, as a teaching tool, has exceeded their expectations. However, the respondents also expressed concerns about the negative impact of e-textbooks on the physical health of students and their studies and reading skills. Many schools in China have yet to use e-textbooks, so our findings suggest that such schools should make use of them, they also a useful starting point for further make detailed investigation of the problem.

Keywords- K-12 schools; e-Textbooks; Feasibility investigation; interviews; questionnaires; target groups of users

I. INTRODUCTION

Over the last decade, with the rapid development of information technology, the emergence speed of human knowledge has increased significantly, which has brought a fundamental impact on education forms and teaching methods. Due to the difference of growth environments, students today have the fundamental features of being good at handling multiple tasks simultaneously, fast online interaction and feedback and so on, who are called "digital natives"(Marc Prensky, Zhibiao.H, Kai.W.,2009). Traditional educators insist that their students cannot study successfully while surfing online or listening to music, but information technology is constantly changing the ways of thinking and accessing to knowledge of "digital natives"(Shifu.L.,2005). Researches on modern brain science indicate that the brain of "digital natives" is changing. For instance, they are fond of and also good at handling multiple tasks simultaneously, they are keen and quick in receiving all kinds of information, they prefer "random access" in terms of the learning habit of knowledge, they like games but not "serious" structured work. It is important that the rapid development of information society has put forward new requirements of the capability of students (Ronghuai.W, Geng.C., Jinbao.Z.,Yuwu.W.,2009), so the traditional ways of learning are facing enormous challenges (Ronghuai.W,2011).

In accordance with the requirements of new learning methods of "digital natives", the researchers believe that e-Textbook can be put on the agenda of textbook reform as a trend of the development of the information age.

In fact, e-Textbooks have drawn the attention and exploration of some scholars since several years ago. They have talked about their understandings of e-Textbooks from different aspects (Guoxiong.X, 2005), which are no longer the e-Textbooks we are talking about at present. E-Textbooks in the new era are not the simple e- replica of traditional printed textbooks (Zhiting.Z&Xiaohua.Y, 2011). In general, the e-Textbooks in our understanding refer to a type of e-books with special functions in accordance with specific content standards (curriculum standards) in the form of e-documents, whose contents have to be browsed on electronic reading software and terminal reading devices that meet special requirements and cannot be modified arbitrarily. From the viewpoint of practice, e-Textbooks should mainly constitute of texts, notes, (static and dynamic) illustrations, experiments and exercises, etc. integrated with assistant learning tools and multimedia learning materials like dictionaries, calculators, notebooks, reference books and so on.

Currently, most previous studies on e-Textbooks mainly focus on the following aspects: (1) On the aspect of national project of the implementation of e-textbooks: Some developed countries (such as Singapore, South Korea, the United States and Japan, etc.) are actively exploring in the way and procedure of e-textbooks entering the class of basic education and they have carried out a series of related research projects and topics (Sung-Moo JUN.,2009; NanY.,2010; California Digital textbooks initiative, 2009; Chaohua G., Guang C., Ronghui H., Jinbao Z.,2011); (2) On the aspect of research and development of e-Textbooks: The existing e-textbooks can be divided into two categories, one of which is to add more rich- media directly to the current printed textbooks and the other one is to directly reconstruct the contents of the textbooks presented on multimedia as the supplementary apart from the original printed textbooks(Course Smart,2010;Scroll Motion,2011;Kno,2011;Inkling,2010); (3) On the exploring of the application effects of e-textbooks: Researchers focus on the differences of e-textbooks in the aspects of function features, reading, learning outcomes, physical and mental health and so on compared with printed textbooks (Mihye Kim,Kwan-Hee Yoo, Chan Park,2010 A; Mihye Kim,Kwan-Hee Yoo, Chan Park,2010 B). In the existing literature, although some
practitioners have carried out some explorations and invested in the research and development of the contents and reading devices of e-textbooks, yet there is lack of researches on the feasibility of e-textbooks in China from the perspective of users.

As the audiences involved in the application of textbooks cover the relevant groups of teachers, students, parents, textbook publishers, school administrators and so on, textbook reform is at a new historical starting point, and then what attitudes do the relevant groups of users have towards the entering of e-Textbooks in the class of K-12 schools in China? Can e-Textbooks be taken as an alternative to printed textbooks? To sum up, the feasibility of e-textbooks entering the class of K-12 schools in China as a newborn thing needs studying. Therefore, in order to have a comprehensive understanding of the feasibility of the application of e-textbooks in K-12 schools in China, this research focuses on the following issues:

1. The disadvantages of printed textbooks: What are the opinions of teachers and students in K-12 schools on the printed textbooks in support of teaching activities in the information age?

2. The attitudes towards e-textbooks: What are the attitudes of relevant groups of users (teachers in K-12 schools, parents, students, school administrators, textbook publishers) towards the application of e-textbooks in K-12 schools?

3. The advantages of e-textbooks: Compared with printed textbooks, what are the advantages of e-textbooks?

4. Function requirements: What are the opinions of teachers and students in K-12 schools on the function features of e-textbooks?

5. Problems: What are the challenges of the application of e-textbooks in K-12 schools?

II. RESEARCH METHODOLOGY

A. Research subjects

The interviewees selected in this research include school administrators, K-12 school teachers, students, parents and publishers in total of over 40 people from 19 organizations (or departments) all over China.

The questionnaires of this research are distributed to K-12 school teachers, parents and students from 24 provinces or cities in China. Due to the limitation of objective research conditions, the main data of the students are collected from those in Beijing municipality and Zhejiang province.

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B. interview outline

Based on the relevant researches conducted (Yingqing Chen, 2009; Danyi Wei & Jianzhong You, 2010; Pieter Luik & Jaan Mikk, 2008), the interview outline is composed with the contents mainly concerning three open-ended questions: ① What are your comments on the existing printed textbooks in response to the teaching in the information age? ② What are your opinions of applying e-textbooks in K-12 schools? ③ What are your expectations if the e-Textbooks enter the classroom? The above three interview questions are correspondent to research questions 1 and 2. The researchers conduct content analysis of the acquired contents of interview.

C. investigation questionnaire

In order to acquire the attitudes of more target users towards the application of e-textbooks in the classroom teaching in K-12 schools and to demonstrate the feasibility of the application of e-textbooks in teaching, according to the interview results and in reference to the research outcomes of Liangji Chen (2002) and Lijun Hu (2003), the author draws up the questionnaire of "Feasibility Investigation of Applying E-Textbooks in K-12 schools ", which consists of four dimensions of the attitudes to application, function features, potential advantages and faced problems. The reliability and validity tests of the questionnaire are as follows: The validity test uses "content validity ratio" (CVR). Five experts (outstanding teachers and experts on subjects) are invited to give scores on the validity of the questionnaire. After collecting their scores and excluding some items that are not qualified, the author retains the 37 items with CVR over 0.6, as shown in TABEII.

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Items</th>
<th>Numbers of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes to application</td>
<td>The understanding of feasibility, subjects of priority, grades of priority, purchasers, the ways of application</td>
<td>5</td>
</tr>
<tr>
<td>Function features</td>
<td>Basic functions, display size, weight of the devices, battery endurance hours</td>
<td>14</td>
</tr>
<tr>
<td>Potential advantages</td>
<td>Home-school interaction, students' development, content updates</td>
<td>7</td>
</tr>
<tr>
<td>Faced problems</td>
<td>Students' cognitive capability, the development of physical and mental health, the experience in reading textbooks, classroom management and the stability of devices</td>
<td>11</td>
</tr>
</tbody>
</table>

The reliability test selects 10 respondents to fill in the same questionnaire again after a week, which results in the correlation coefficients ranging from 0.891 to 0.995.

D. The process of investigation

The entire interview and investigation lasts 10 months from October 2010 to July 2011. The investigation platform for the questionnaire has been opened since May 2011. According to the requirements of the research, teachers, students and parents from representative areas all over China are invited to participate in filling in the questionnaire. The entire investigation lasts one month. The total number of collected questionnaires is 685, of which 144 are from K-12 school teachers, 25 from parents of students in K-12 schools and 516 from K-12 school students. After careful sifting of the data and excluding the omitted, mistaken and unserious data, the number of ultimate valid data is 627.

E. Data Processing

In this research, the interview data are sorted out manually for content analysis, and the questionnaire data are entered and sorted out by using the software SPSS16.0 for windows for statistical analysis. The consistency coefficient of all
dimensions in the statistics of the collected questionnaires, also known as Cronbach's Alpha, is .927~.934, indicating that the questionnaire well reflects the main scope of the respondents.

III. RESEARCH RESULTS

Based on the analysis of the above issues, this paper finds out the following results by sorting out the investigation data and conducting statistical analysis of the results of interviews and questionnaires.

A. The opinions of K-12 school teachers and students on printed textbooks in support of teaching activities in the information age

We interview K-12 school teachers and students with the question of "What are your comments on the existing printed textbooks in response to the teaching in the information age?” and the focuses on the status quo of their learning and teaching, the ways of the application of textbooks, the practice in the informatized learning and teaching. The results are summarized as follows:

① The contents of knowledge are left behind. We are living in a world of knowledge explosion and the development of technology is accelerating the speed of knowledge updates, but printed textbooks cannot cover the contents of knowledge in time, resulting in the inadequate and out-of-date situation of the contents of knowledge in the textbooks.

② The single way of presentation ignores the individual differences and diversity of students. Printed textbooks are mostly edited based on the students of middle level, which cannot meet the individual differences and diversity of students. So it leads to the direct result that "students of lower level cannot keep up with the progress or have difficulty in learning, while students of upper level consider the contents are so easy that they feel bored”.

③ The number of pages is constrained, in which circumstances the contents of knowledge covered in the textbooks are very limited.

④ The ways of media presentation are mainly those of static images and texts, without the integration of dynamic media presentation like video, audio and so on. Even if the textbooks are supported by CD-ROM and tapes as supplementary resources, they will have few effects due to the lack of overall consistence.

It is noteworthy that the interviewed teachers point out that the publishers usually provide supporting learning websites, instruction manuals, CD-ROMs and other supplementary resources, but in fact the effective uses of these resources are generally low, which also increases the time that teachers spend in preparing lessons. The results of the interviews are consistent with the research results of Xianhua H. (2005) et al.

B. The attitudes of relevant groups of users towards the application of e-textbooks in K-12 schools

The author interviews K-12 school teachers, students, parents, publishers and school administrators with the two questions of "What are your opinions of the application of e-textbooks in K-12 schools? And “What are your expectations if the e-textbooks enter the classroom?” focusing on the aspects of the application requirements, the expectations on functions, negative impacts and purchase intentions of e-textbooks, the feasibility of entering subjects and grades and potential advantages and so on. The interview results are sorted out in TABLE II.

<table>
<thead>
<tr>
<th>Groups of users</th>
<th>Requirements and expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers</td>
<td></td>
</tr>
<tr>
<td>Students</td>
<td></td>
</tr>
<tr>
<td>School adminis-</td>
<td>Generally hold positive atti-</td>
</tr>
<tr>
<td>trators</td>
<td>tudes towards the application</td>
</tr>
<tr>
<td>Publishers</td>
<td>expect e-textbooks to reduce</td>
</tr>
<tr>
<td>Parents</td>
<td>their homework burdens;</td>
</tr>
<tr>
<td></td>
<td>expect the functions of e-</td>
</tr>
<tr>
<td></td>
<td>textbooks to include the note-</td>
</tr>
<tr>
<td></td>
<td>taking among the texts, book-</td>
</tr>
<tr>
<td></td>
<td>marks, etc.;</td>
</tr>
<tr>
<td></td>
<td>expect improvements in the</td>
</tr>
<tr>
<td></td>
<td>visual fatigue and distrac-</td>
</tr>
<tr>
<td></td>
<td>tion in class caused by e-</td>
</tr>
<tr>
<td></td>
<td>textboxes.</td>
</tr>
</tbody>
</table>

Besides, the author sorts out the results of the questionnaire provided by the groups of core users (teachers, students and parents) in the aspects of the overall understanding of the feasibility of e-textbooks, the purchasers, the ways of usage,
the subjects and grades for the pilot use of e-textbooks in K-12 schools, shown in TABLE III, IV, V, respectively.

**TABLE III.** The attitudes of teachers, students and parents towards the application of e-textbooks in K-12 schools (N = 627)

<table>
<thead>
<tr>
<th>Items</th>
<th>P (%)</th>
<th>S (%)</th>
<th>T (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not be overhasty, go for it step by step.</td>
<td>57.0</td>
<td>12.0</td>
<td>36.0</td>
</tr>
<tr>
<td>Feasible in the future</td>
<td>10.0</td>
<td>5.0</td>
<td>14.0</td>
</tr>
<tr>
<td>Feasible</td>
<td>33.0</td>
<td>80.0</td>
<td>38.0</td>
</tr>
<tr>
<td>Unfeasible</td>
<td>0.0</td>
<td>3.0</td>
<td>12.0</td>
</tr>
</tbody>
</table>

Notes: P=parents, S=students, T=teachers

**TABLE IV.** The proportion of the composition of purchasers of e-textbooks voted by teachers, students and parents (N = 602)

<table>
<thead>
<tr>
<th>Items</th>
<th>P (%)</th>
<th>S (%)</th>
<th>T (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchased by the above parties in negotiation</td>
<td>5.0</td>
<td>6.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Hardware device manufacturers</td>
<td>3.0</td>
<td>3.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Publishers</td>
<td>8.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Schools</td>
<td>33.0</td>
<td>17.0</td>
<td>14.0</td>
</tr>
<tr>
<td>Parents</td>
<td>8.0</td>
<td>10.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Governments</td>
<td>44.0</td>
<td>61.0</td>
<td>55.0</td>
</tr>
</tbody>
</table>

Notes: P=parents, S=students, T=teachers

**TABLE V.** The proportion of the composition of purchasers of e-textbooks voted by teachers, students and parents (N = 602)

<table>
<thead>
<tr>
<th>Items</th>
<th>P (%)</th>
<th>S (%)</th>
<th>T (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using e-textbooks with printed textbooks as the supplements</td>
<td>16.0</td>
<td>37.0</td>
<td>14.0</td>
</tr>
<tr>
<td>Using printed textbooks with e-textbooks as the supplements</td>
<td>60.0</td>
<td>23.0</td>
<td>52.0</td>
</tr>
<tr>
<td>Using e-textbooks in place of printed textbooks</td>
<td>4.0</td>
<td>21.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Using e-textbooks and printed textbooks at the same time</td>
<td>52.0</td>
<td>60.0</td>
<td>63.0</td>
</tr>
</tbody>
</table>

Notes: P=parents, S=students, T=teachers

**TABLE VI.** The order of the prioritized grades and subjects for the pilot of e-textbooks

**TABLE VII.** The requirements of the function features of e-textbooks put forward by K-12 school teachers, students and parents

<table>
<thead>
<tr>
<th>Items</th>
<th>Mean</th>
<th>Std.D</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>The reading devices should be instant on for use</td>
<td>1.78</td>
<td>.822</td>
<td>46%</td>
<td>33%</td>
<td>20%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Reading device can be synchronized with other devices</td>
<td>1.73</td>
<td>.755</td>
<td>44%</td>
<td>40%</td>
<td>14%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>It has the same presentation form as the printed textbook</td>
<td>2.05</td>
<td>.968</td>
<td>34%</td>
<td>36%</td>
<td>23%</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>It allows users to take notes in the texts at any time</td>
<td>1.74</td>
<td>.867</td>
<td>48%</td>
<td>35%</td>
<td>14%</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>The contents cannot be tampered at any time</td>
<td>2.15</td>
<td>1.064</td>
<td>35%</td>
<td>31%</td>
<td>21%</td>
<td>10%</td>
<td>2%</td>
</tr>
<tr>
<td>Support a variety of media forms, such as images, video and audios, etc.</td>
<td>1.50</td>
<td>.711</td>
<td>61%</td>
<td>29%</td>
<td>9%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>The contents can be updated in time</td>
<td>1.50</td>
<td>.712</td>
<td>62%</td>
<td>28%</td>
<td>9%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>The network means of the access to e-textbooks should be secure</td>
<td>1.49</td>
<td>.730</td>
<td>63%</td>
<td>27%</td>
<td>8%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Depend on the support of enough bandwidth</td>
<td>1.75</td>
<td>.927</td>
<td>51%</td>
<td>30%</td>
<td>14%</td>
<td>3%</td>
<td>1%</td>
</tr>
<tr>
<td>Support the management of students’ homework</td>
<td>1.71</td>
<td>.834</td>
<td>49%</td>
<td>35%</td>
<td>13%</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>Realize real-time automatic feedback of the exercise of multiple choices</td>
<td>1.70</td>
<td>.818</td>
<td>48%</td>
<td>37%</td>
<td>12%</td>
<td>1%</td>
<td>1%</td>
</tr>
</tbody>
</table>

Notes: Total agree=A, Agree=B, Neutral=C, Disagree=D, Total Disagree=E.

**TABLE VIII.** The potential advantages of the application of e-textbooks in K-12 schools in the opinions of K-12 school teachers, students and parents (N = 627)

<table>
<thead>
<tr>
<th>Grades</th>
<th>Votes(%)</th>
<th>Subjects</th>
<th>Votes(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 7</td>
<td>70.02</td>
<td>Art and music</td>
<td>66.80</td>
</tr>
<tr>
<td>Grade 8</td>
<td>14.04</td>
<td>Computer</td>
<td>65.20</td>
</tr>
<tr>
<td>Grade 9</td>
<td>12.92</td>
<td>English</td>
<td>42.10</td>
</tr>
<tr>
<td>Grade 4</td>
<td>11.64</td>
<td>Chinese</td>
<td>40.40</td>
</tr>
<tr>
<td>Grade 10</td>
<td>10.21</td>
<td>Science</td>
<td>31.60</td>
</tr>
<tr>
<td>Grade 11</td>
<td>9.41</td>
<td>Mathematics</td>
<td>27.30</td>
</tr>
<tr>
<td>Grade 5</td>
<td>9.41</td>
<td>Geography</td>
<td>27.00</td>
</tr>
<tr>
<td>Grade 3</td>
<td>8.77</td>
<td>History</td>
<td>24.70</td>
</tr>
<tr>
<td>Grade 2</td>
<td>7.34</td>
<td>Biology</td>
<td>20.30</td>
</tr>
<tr>
<td>Grade 1</td>
<td>7.02</td>
<td>Chemistry</td>
<td>20.30</td>
</tr>
<tr>
<td>Grade 6</td>
<td>6.22</td>
<td>Physics</td>
<td>19.50</td>
</tr>
<tr>
<td>Grade 12</td>
<td>2.87</td>
<td>Politics</td>
<td>17.40</td>
</tr>
</tbody>
</table>
include the sections of preview before class, classroom learning reflection; while those of students’ using textbooks mainly. The interview results indicate that K-12 school teachers and students’ using textbooks go through the entire teaching process. The interview results indicate that K-12 school teachers and students generally agree that there are obvious disadvantages of printed textbooks in support of teaching activities in the information age. The feedbacks are mainly reflected in three aspects, which are the slow updating speed and limited capacity of textbook contents, the static and single media for presentation, and the fixed arrangement that ignores the individuality and diversity of students. As the learning of students is not simple receiving, the teaching process should not just be a one-way delivering process from textbooks to teachers then to students, but the process of multi-directional interaction and inquiry among students, teachers, textbooks and the environment. Further analysis finds out that when in the specific educational scenarios, the inherent natures of stability, closure and statics are sure to have inevitable conflicts and contradictions with the diversity, open and dynamics of modern educational scenarios, which lead to the incapability of printed textbooks to adapt to the ways of learning and teaching in the information age.

B. Discussion on the attitudes of different groups of users towards e-textbooks

From the interview data, different groups of users basically hold positive attitudes towards the application of e-textbooks in K-12 schools and consider it as a tendency. However, different groups have significantly different concerns. For instance, the
teachers are most concerned about the teaching methods and activity design of e-textbooks in combination with current teaching practices; the students are most concerned about reducing the burden by using e-textbooks; the parents are most concerned about the potential negative impact of e-textbooks on the physical and mental health and cognitive development of their children; school administrators are most concerned about the construction of public service system for using e-textbooks and changes in the methods of learning and teaching by using e-textbooks; and the publishers are most concerned about the policies related to the publication of e-textbooks.

The questionnaire data show that 88% of teachers, 97% of students and 100% of parents think that the application of e-textbooks in K-12 schools is feasible, but in terms of the speed of promoting e-textbooks, 57% of parents and 36% of teachers agree that it should not be overhasty, but proceeding step by step. The results of the questionnaire are consistent with those of interviews. In terms of the purchasers of e-textbooks, most teachers, students and parents agree that e-textbooks should be put in the list of the state government procurement. In terms of the usage of e-textbooks, respondents generally expect the coexistence of e-textbooks and printed textbooks. In terms of the grade when the pilot application of e-textbooks is prioritized, 70.02% of respondents believe that it is more appropriate to start with Grade 7. And in terms of the subjects for pilot application, the voting statistics show that the top four subjects are art and music (66.8%), computers (65.2%), English (42.1%) and Chinese (40.4%), which reflects the close relationship between e-textbooks and the contents of the subjects.

IV. DISCUSSIONS

TABLE IX. THE PROBLEMS FACED BY THE APPLICATION OF E-TEXTBOOKS IN K-12 SCHOOLS IN THE OPINIONS OF K-12 SCHOOL TEACHERS, STUDENTS AND PARENTS (N=627)

<table>
<thead>
<tr>
<th>Items</th>
<th>Mean</th>
<th>Std.D</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students’ writing ability declines</td>
<td>1.77</td>
<td>.878</td>
<td>34%</td>
<td>36%</td>
<td>21%</td>
<td>6%</td>
<td>4%</td>
</tr>
<tr>
<td>Students’ concentration declines</td>
<td>1.62</td>
<td>.792</td>
<td>29%</td>
<td>29%</td>
<td>28%</td>
<td>11%</td>
<td>4%</td>
</tr>
<tr>
<td>Negative impacts on the eyesight of students</td>
<td>2.31</td>
<td>1.111</td>
<td>38%</td>
<td>33%</td>
<td>22%</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>Negative impacts on the development of students’ spine</td>
<td>2.32</td>
<td>1.130</td>
<td>32%</td>
<td>31%</td>
<td>27%</td>
<td>7%</td>
<td>3%</td>
</tr>
<tr>
<td>The verbal communication ability of students declines</td>
<td>2.02</td>
<td>1.002</td>
<td>35%</td>
<td>35%</td>
<td>22%</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>The possibility of students’ addiction to the Internet</td>
<td>2.25</td>
<td>1.169</td>
<td>30%</td>
<td>31%</td>
<td>26%</td>
<td>9%</td>
<td>5%</td>
</tr>
<tr>
<td>Difficult to achieve the good experience of reading printed materials</td>
<td>2.09</td>
<td>1.034</td>
<td>31%</td>
<td>32%</td>
<td>25%</td>
<td>8%</td>
<td>4%</td>
</tr>
<tr>
<td>Cannot help with classroom management</td>
<td>2.26</td>
<td>1.116</td>
<td>27%</td>
<td>26%</td>
<td>28%</td>
<td>13%</td>
<td>5%</td>
</tr>
<tr>
<td>Worry about the sudden crash of the devices in the operation process</td>
<td>1.71</td>
<td>.812</td>
<td>35%</td>
<td>32%</td>
<td>23%</td>
<td>5%</td>
<td>4%</td>
</tr>
</tbody>
</table>

Notes: Total agree=A; Agree=B; Neutral=C; Disagree=D; Total Disagree=E.
path that is suitable for the development of e-textbooks in China and make an appropriate implementation plan.

C. Discussion on the function features of e-textbooks

The summary of the data finds out the users have quite obvious demands on the function features of e-textbooks. In the aspect of reading devices for e-textbooks, they are concerned about the starting time of devices, data synchronization, display size, weight of devices and battery endurance hours. In the aspect of the contents of e-textbooks, they are concerned about the diversity of presentation forms, the support of note-taking in the texts, multimedia, content security and updating speed, homework management and automatic feedback, etc. In the aspect of access to the Internet, network security and bandwidth support are in their concerns. Further study finds out that the above aspects emphasize the obvious shortcomings of some typical products of e-textbooks today compared with printed textbooks. For example, in the aspect of the functions of e-textbooks, most functions are not used by teachers and students despite the offering of many functions. In the aspect of usage, teachers prefer the main usage of the coursework for classroom demonstration without much participation of students; in the aspect of teaching support, teachers are lack of support to personalized preparing lessons, and as many functions are bundled with the contents of e-textbooks, they are not able to add resources and exercises flexibly. In the ways of access, it always depends on the access to the Internet, which cannot be downloaded to local storage, so the users often have to login in repeatedly and the play of videos is not smooth due to the insufficient network bandwidth. The function features of e-textbooks obtained in this research provide a guide to action for the improvement of present products of e-textbooks. Therefore, e-textbooks are not simple replacement of printed textbooks, whose support to teaching and learning is far beyond that of printed textbooks. The function features have shown the consideration of the variety and diversity of students, which do not only obey the cognitive laws of students, but also meet the reading habits of students.

D. Discussion on the advantages of e-textbooks

The summative results of data find out that the application of e-textbooks in K-12 schools has obvious potential advantages. The e-textbook plays a positive role in home-school interaction. It helps to promote students’ learning interests, reduce the weight of schoolbags and develop their information literacy and self-study capability in the perspective of student development. It helps the sharing, delivery and quick updating of resources in the aspect of contents. Further analysis finds out that these advantages are in accordance with the learning characteristics of “digital natives”. The e-textbooks of innovative design not only take the elements of commonality and consistency in a number of educational scenarios, but also concern about mastering the complexity and regularity of the changes in the nature of knowledge in the educational scenarios as well as the variety and diversity of the knowledge updating and development in specific scenarios and conditions, which makes the design of learning activities and curriculum of diversity and people orientation draw more and more attention. Therefore, as the increasingly significant role of information and communication technology in education, the advantages of e-textbooks provide important foundation for the play of the unique role of textbooks in class in the information age and are also the important basic conditions for exploring the development of e-textbooks in the future.

E. Discussion on the problems faced by the application of e-textbooks

The summative results of the data find out the negative impacts of using e-textbooks mainly reflect in the impact on the cognitive capability of students (writing capability, concentration maintenance, reading capability and oral expression), the growth of physical and mental health (eyesight, spine, dependence on the devices and the tendency of addiction to the Internet), the experience of reading textbooks, classroom management, and the stability of devices. Therefore, in the promotion of e-textbooks in education and teaching, the problems to be resolved are of a quite great systems engineering, which requires more experimental researches into the applicability in the depth and breadth and sufficient evidence to prove whether the e-textbooks can be applied in basic education, what the advantages of e-textbooks are and what problems are to be solved. Solving these problems requires researchers to summarize the experience in the exploration for moving forward.

V. Conclusions

Textbook reform is the key to the promotion of the change of learning and teaching methods. In order to have an overall understanding of the feasibility of the application of e-textbooks in K-12 schools in China and find out the problems and challenges faced by the application of e-textbooks in present education system, the paper carries out the research in a large range of samples and different groups in the five aspects of the disadvantages of printed textbooks, the attitudes of relevant groups of users towards the application of e-textbooks in K-12 schools, the function features of e-textbooks, the advantages and challenges, and the conclusions of the research are as follows:

(1) The single, fixed and linear features of printed textbooks are insufficient to support the learning and reading of the "digital generation" and the teaching activities in the information age.

(2) The teachers, students, parents, publishers and school administrators generally believe that the use of e-textbooks is a tendency and is of high feasibility in the application in K-12 schools in hopes of the coexistence of e-textbooks and printed textbooks, but we must explore the experience of the application of e-textbooks in consideration of the basic conditions of education in China.

(3) The e-textbook is not a simple alternative to printed textbooks. Users’ expectations of function features of e-textbooks have gone beyond the support of printed textbooks to teaching and learning. These features of functions put forwards a number of mandatory norms for reading devices and show the consideration about the variety and diversity of students in the aspects of the contents and software.

(4) The e-textbooks agree with the learning characteristics of “digital natives”, which have obvious potential advantages
in the aspects of promoting home-school interaction, the 
development of students and content updating.

(5) At present, users are concerned about the use of e-
textbooks will have negative impacts on the aspects of 
students’ cognitive capability, growth in physical and mental 
health, experience of reading textbooks, classroom 
management and the stability of devices, so we need to expand the 
depth and breadth of experimental study on the applicability. 

The research results prove that e-textbooks are the 
inevitable tendency of the textbook construction in the 
information age and the application of e-textbooks will become 
one of the key means of promoting the changes of learning and 
teaching methods in the information age for a long time in the 
future. Therefore, this research provides necessary research and 
demonstration for follow-up application and promotion of e-
textbooks.

ACKNOWLEDGMENT

This research work are supported by National Natural 
Science Foundation of China (NSFC: 61075048) and Beijing 
Normal University research project “e-Textbook development technologies and its applicability research”.

REFERENCES


[16] Yinqing Chen. The research trends and development of e-
textbook[J].Textbooks Research. 2009 (12) : 111-140.


[19] Liangji Chen etc. the report of the results of the implementation of electronic schoolbag by National Science [R]. Taipei: Executive Yuan, 2002.


2012 The 1st International Symposium on Smart Learning Environment
Automatically extract interpretable topics from online discussion

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Abstract— Teachers adopting CSCL often face the challenge of handling massive textual information, and finding it difficult to have a clear grasp of the topics being addressed in the discourse. Topic modeling, an emerging field in machine learning, has the potential to solve this problem by automatically extracting from text collections formal representations of latent topics. However, the interpretation of latent topics is still a challenge, which hinders the use of this state-of-the-art technology from wider use in CSCL contexts. In a recent paper, we put forward a novel topic discovery method, the fLDA model, based on Minsky's Frame theory. This method has the advantage of providing outputs that are potentially more easily interpretable for generating the topic of each thematic cluster. In this paper, we show how fLDA can be used in extracting and visualizing the topics of asynchronous online discourse from two classrooms.

Keywords- topic modeling; frame theory; CSCL; interaction analysis

I. INTRODUCTION

Online discussion forums provide students with the opportunity to explore different problems and topics through discussion in an unconstrained manner, allowing more student-centered interactions to take place. It also provides a record of the explorations that teachers can use to gain an understanding of the students’ concerns and on that basis to make facilitation decisions. On the other hand, making sense of the massive amounts of text in the posted messages is a daunting challenge for teachers adopting CSCL in their teaching repertoire. How can a teacher readily find out the key topics of discussion among hundreds of posted messages? There is a need for semantic tools that can identify key topics in online discussion to support pedagogical decision-making.

Summarizing massive free style text has been a long-standing issue in computer science, esp. in machine learning. One of the most relevant research areas to tackle this problem is text clustering (also referred to as document clustering). Text clustering methods can be used to automatically group documents into a list of clusters. Each cluster is regarded as a collection of documents on a latent topic. By interpreting latent topics and examining their distribution, users can gain an overview of the content focus of a collection of texts. In CSCL community, researchers have applied text clustering to facilitate the automatic coding process of an online discussion forum and evaluate the progress of a thread discussion (Cristóbal and Sebastián, 2010). Although many general text clustering approaches have been applied in CSCL, it is still not clear that how students and teachers can reasonably interpret those auto-generated clusters.

Recent research in text clustering shows that the interpretability of latent topics is still a challenge (Blei, 2011). Earlier text clustering methods are based on the Vector Space Model (Salton, Wong, and Yang, 1975) using vector similarity measures, e.g., Cosine similarity, and do not provide further semantic clues for the interpretation of topics. Latent Semantic Analysis (Deerwester, Dumais, Landauer, Furnas, Harshman, 1990) uses a set of latent variables to represent topics, but still fails to provide intuitive interpretation for each topic. Topic models, like LDA (Blei, Ng and Jordan, 2003), represent each topic by a set of weighted words. These have been successfully used to identify research topics among tens of thousands of scientific articles (Griffiths and Steyvers, 2004). Other works related to the interpretability of topic model include coherence measures of topics manually (Chang, Boyd-Graber, Gerris, Wang, and Blei, 2009) and automatically (Newman, Han-Lau, Grieser and Baldwin, 2010; Musat, Velcin, Trausan-Matu, and Rizoiu, 2011), interpretability improvement by semi-supervised method (Zheng, 2008) and connecting topics, e.g., fLDA, PAM, hPAM.

Currently topic models use a set of weighted words to represent a topic. Since how users interpret a topic depends on how the topic is represented, we believe that there are ways to improve topic interpretability by changing the representation of topics. This paper introduces our recent work on a novel approach for representing latent topic, the fLDA model (Zhang, Li and Huang, 2011), and shows our preliminary exploration on using this to visualize the contents of the online discourse data from two classrooms using Knowledge Forum® to support students’ knowledge building.

II. THE fLDA MODEL

Our focus of work is to improve topic interpretability by representing each topic in a more human-readable form. The first thing we need to understand is how humans achieve understanding of situations represented by words. According to Minsky’s (1975) Frame Theory (or Schema Theory), when one encounters a new situation or makes a substantial
change in one's view of the present problem, one selects from memory a structure, called a frame. A frame is a data-structure for representing a stereotypical situation, like being in some ordinary living spaces or performing certain activities. From a computational perspective, a frame is a set of slot-value pairs. Slots are stable for a frame while the value for each slot is adaptively assigned to represent the information of a specific situation. The Schema Theory has inspired much productive research in cognitive psychology (Solso, MacLin, MacLin, 2004). It is apparent that the externalization of topics in the form of frames helps one to understand the topics. Hence in this study we explore the use of a frame-based method to extract topics from document collections in order to find out whether the output is more readily interpretable as meaningful topics by human readers. In the remainder of this section, we will briefly describe the frame-based topic discovery model we developed based on the LDA model, named fLDA (Zhang et al, 2011).

A. Definitions of key terms in the fLDA model

The following are the definitions of some basic terms used in the fLDA model.

Word—A word $w$ is the basic unit in text, and is defined as a string in its original form.

Document—A document $d$ is a sequence of words extracted from the text. It can be denoted as $d = \{w_1, w_2, \ldots, w_{n}\}$. The $i$-th element of $d$ is referred to as the $i$-th word token or $i$-th token, which is conceptually different from the term word.

Corpus—A corpus $c$ is a collection of documents.

Term frequency—The term frequency of a word $w$ in corpus $c$ is the number of occurrences of $w$ in all documents contained in $c$.

Co-occurrence frequency—The co-occurrence frequency of word $w_1$ and $w_2$ in corpus $c$ is the number of occurrences of $w_1$ in any document containing $w_2$ in $c$.

Topic frame—A topic frame $f$ is a quadruple of slots: focus, features, events and related things. A focus is a single word representing an entity semantically. A feature is a weighted word representing an entity property semantically. Each frame contains a set of features. An event is a weighted word representing a kind of action semantically. A related thing is a weighted word representing entities semantically. Each of the features, events and related things is weighted by its co-occurrence frequency with respect to the focus of the frame, and is restricted to those having non-zero weight. It should be noted that the focus words are ontologically also things.

Topic—A topic $T$ of corpus $c$ is a set of topic frames and their weights pair, and these topic frames reflect the main content of the topic-related documents. It can be denoted as $T = \{(f_1, p_{f_1}), (f_2, p_{f_2}), \ldots, (f_n, p_{f_n})\}$, where $p_{f_i}$ is equal to the term frequency of the focus of $f_i$.

III. Input and Output of fLDA Topic Modeling Algorithm

The topic modeling approach of fLDA is to input a corpus with POS-tag for each word, and output a set of topics defined by the previous sub-section. POS-tagging tools are available online in several languages, e.g. the Stanford POS tag tool for English and the ICTCLAS tool for Chinese.

In the fLDA model, each word has a semantic class and a topic. fLDA assumes a similar generative process of a corpus as LDA. Based on this assumption, we have developed a Gibbs sampling-based algorithm to assign a semantic class and a topic for each word. In Zhang, Li and Huang (2011), we use a pseudo dataset to test the recall rate and performance of this algorithm. This pseudo dataset is generated using the corpus generative process. Intuitively, every 10~30 new documents stay on one topic, and each word token in a document has 50% probability to be on the document topic and 50% to be out of the topic. A visualization has shown the output topic distribution was consistent with the parameters of the data generation rule.

We tested the quality of tagging on the semantic classes, which is the basis of frame slots using this algorithm. We chose a Knowledge Forum® discourse dataset generated by a class of primary 6 students in their discussions on the theme of Hong Kong Kids in the context of their Chinese Language subject (referred to as 6B in the case studies reported below) as the testing dataset, and used Cohen's Kappa (Jem, 1996) as the cross-validation indicator. Two graduate students achieve kappa=0.73 for their tagging, while the algorithm-human kappa=0.69. Although this is far from perfect, the result can be regarded as an acceptable one.

IV. Interpretability of fLDA Generated Topic Outputs Using Authentic CSCL Data

To explore whether fLDA can help one to interpret the topic foci of online discourse in CSCL settings, we analyzed the discourse corpuses from two classrooms (named, 6C and 6C) in one primary school participating in the Knowledge Building Teacher Network led by HKU-CITE (http://kbtm.cite.hku.hk). The theme "Hong Kong (HK) Kids" was centered around negative media reporting about Hong Kong children’s lack of general life skills and inability to handle adversity.

A. Topic extraction

fLDA is an exploratory method and the user needs to pre-determine the number of topics to be extracted. In our preliminary exploration, we have tried several analyses using pre-set topic numbers from 4 to 10. We find that the outputs from too few or too many pre-set topics are more difficult to make meaningful interpretations, and we have set the topic number to 5 in this study. In all runs of the algorithm, we set the number of iterations to 1000.

The output generated by the fLDA algorithm is reprocessed to be top 3 weighted frames of each topic and a selection of the three documents that are most representative of the documents for the topic. Table 1 presents the high co-occurrence words for the frames generated by fLDA for the five topics. The original text of the students’ discourse was in Chinese. The English translation of the words are provided in brackets.

Based on the frames of each topic and the associated documents with high topic word frequency, we are able to
make meaningful interpretation of the topics shown in table 1 in appendix. Our interpretation of each of the corresponding topics is presented in Table 2 in appendix. The topic words found in the frames are highlighted in colors according to their semantic classes (things in blue, features in green, events in red).

B. Topic trend analysis

One use of such a topic analysis is to compare the discussion topics across corpuses and over time. To do so, we first tag each note with relevant topics. A note is tagged with a specific topic if it contains at least 2 topic words of the topic. It is possible for a note to have all five or none of the identified topics tagged. We make a visualization, per-N-notes topic trend graph, based on grouping every N=20 notes in order of created time. Due to the limitation of page number, we only show the results of 6B dataset.

As shown in figure 1, the wave shape curves in the visualization reveal note numbers of topics have declined and increased for more than two times. By looking at the curves within first 60 notes, we find that topic 3 is more stable than other topics. This may indicate that the 6B students focus more on family problems than other causes of Hong Kong kids. Another interesting finding can be recognized at the point of 121-140 notes where the note number, we only show the results of 6B dataset.

Interpretation of this kind of visualization can potentially be used to help teachers to identify the focal concerns in students’ online discussions.

More work involving the participation of teachers in evaluating the validity and usefulness of such analyses is necessary to determine the value of such a topic discovery and visualization tool.

V. CONCLUSION

We have demonstrated two promising applications of fLDA in analyzing CSCL discourse corpuses: topic extraction and topic trend analysis. Topic extraction starts with performing the fLDA algorithm to generate meaningful frames for topics from a collection of notes. Notes can be tagged with different topics according to topic word frequency. Based on these frames and a small set of top ranked notes on each topic, we make meaningful interpretations for each topic. Topic trend analysis can be done with per-N-notes topic trend visualization. Interpretation of this kind of visualization can potentially be used to help teachers to identify the focal concerns in students’ online discussions.

REFERENCES

### APPENDIX

**TABLE 1.** High co-occurrence content words in frames for top three documents for all five topics in the five topic analysis of the 6B_SC corpus.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Focus (things)</th>
<th>Feature</th>
<th>Event</th>
<th>Related things</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>制度(system)</td>
<td>难(difficult)</td>
<td>学(learn), 教育(education), 出现(occur), 减少(reduce)</td>
<td>教育制度(education system), 香港(Hong Kong), 精英(elite), 精英制度(elitism)</td>
</tr>
<tr>
<td></td>
<td>香港(HK)</td>
<td>穷(poverty)</td>
<td>学(learn), 出现(occur), 蔓延(spread), 照顾(take care)</td>
<td>制度(system), 精英制度(elitism), 教育制度(education system), 国家(country)</td>
</tr>
<tr>
<td></td>
<td>教育制度(education system)</td>
<td>难(difficult)</td>
<td>学(learn), 出现(occur), 入学(admission)</td>
<td>制度(system), 精英(elite), 香港(Hong Kong), 父母(parent), 政府(government)</td>
</tr>
<tr>
<td>2</td>
<td>港孩(HK kid)</td>
<td>小(little)  低(low)</td>
<td>懂(understand), 生活(life), 指(mean), 洗(wash), 说(say)</td>
<td>孩(child), 港(HK), 能力(capacity), 香港(HK), 健康情绪中心(mood disorders centre)</td>
</tr>
<tr>
<td></td>
<td>孩(Child)</td>
<td>低(low)  小(little)</td>
<td>懂(understand), 指(mean), 生活(life), 称(say), 杨凯诗 (a female name)</td>
<td>港孩(HK children), 港(HK), 能力(capacity), 香港(HK), 健康情绪中心(mood disorders centre)</td>
</tr>
<tr>
<td></td>
<td>能力(capacity)</td>
<td>低(low)  差(poor)</td>
<td>照顾(take care), 代劳(help), 参加(participate), 生活(life)</td>
<td>自理能力(self-care ability), 情绪智商(EQ), 抗逆力(adversity resilience)</td>
</tr>
<tr>
<td>3</td>
<td>孩子(child)</td>
<td>无可厚非(understandable), 不行(cannot), 低(low)</td>
<td>教育(education) 家庭教育(family education) 伴(accumulate) 活动(activity) 协助(assist)</td>
<td>父母(parents), 佣人(maid), 钱(money), 情绪病(mood disorder) 病(illness)</td>
</tr>
<tr>
<td></td>
<td>父母(parents)</td>
<td>过度(overly), 过分(overly), 低(low), 无可厚非(understandable) 本(basic)</td>
<td>教育(education), 给予(give), 介入(interfere), 应(must), 长大(grow up)</td>
<td>孩(child), 病(illness), 子(children), 情绪病(mood disorder)</td>
</tr>
<tr>
<td></td>
<td>病(illness)</td>
<td>低(low)</td>
<td>令(cause), 争(dispute), 吵(dispute), 醒(solve)</td>
<td>情绪病(mood disorder), 父母(parents), 公主病(princess disease), 王子病(prince disease), 孩子(child)</td>
</tr>
<tr>
<td>4</td>
<td>父母(parents)</td>
<td>小(little), 以身作则(lead by example), 有限(limited), 超速(speeding)</td>
<td>想(think), 上学(attend school), 反思(reflect), 教导(teach)</td>
<td>行为behavior, 孩子(child), 观念(idea), 能力(capacity)</td>
</tr>
<tr>
<td></td>
<td>能力(capacity)</td>
<td>低(low)</td>
<td>长大(grow up), 学习(learn), 知道(know), 珍惜(value), 思考(think)</td>
<td>父母(parents), 自理能力(self-care ability)</td>
</tr>
<tr>
<td></td>
<td>孩子(child)</td>
<td>高(high), 小(little)</td>
<td>学习(learn), 想(think)</td>
<td>父母(parents), 放手(release), 物质(material), 香港社会(HK society)</td>
</tr>
<tr>
<td>5</td>
<td>家长(parent)</td>
<td>真(true), 容易(easy), 指若无睹(turn a blind eye)</td>
<td>关心(care), 培训(train), 鼓励(encourage), 依赖(rely on)</td>
<td>子女(children), 受访家长(interviewed parents), 儿童(child), 孩子(child)</td>
</tr>
<tr>
<td></td>
<td>子女(children)</td>
<td>好(good), 重视(emphasize)</td>
<td>依赖(rely), 用餐(eat), 调查(investigate), 聘请(hire), 洗(keep)</td>
<td>受访家长(interviewed parents), 家长(parents), 能力(capacity), 照顾子女(look after child)</td>
</tr>
<tr>
<td></td>
<td>佣人(maid)</td>
<td>遇到(encounter), 帮助(help), 培训(train), 听(listen), 独立(independent)</td>
<td>培训佣人(training of maid), 儿童(child), 政府(government), 方法(method)</td>
<td></td>
</tr>
</tbody>
</table>
### Table 2. Interpretation of the Topics Identified from the _6B_6C Discourse Corpus.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Interpretation of topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The HK kids syndrome occur because of the elitist education system. Parents drill children for admission to famous schools. Parents pay too much attention to children’s school performance, ignoring the development of children’s integrity and independence.</td>
</tr>
<tr>
<td>2</td>
<td>“3 low” means low self-care capacity, low EQ and low resilience to adversity. HK kids are helped by others in their daily life, not able to take care of themselves, with poor socialization capacity.</td>
</tr>
<tr>
<td>3</td>
<td>Some HK children have mood disorders caused by overly protective parents who interfere with their children’s disputes with others, afraid of their kids being disadvantaged and always fighting on their kid’s behalf, causing their children to be unable to handle any adversity.</td>
</tr>
<tr>
<td>4</td>
<td>Parents should lead by example, and reflect on their own behavior and ideas, release their control as early as possible to let the children learn and experience failure so that they can build the capacity to solve problems.</td>
</tr>
<tr>
<td>5</td>
<td>Parents hire maids to look after their children, making them rely on others for everything. Parents should be taught to train their children’s capacity to be independent.</td>
</tr>
</tbody>
</table>
Cross-Cultural Web-Based Collaborative Learning

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Abstract— The purpose of the study was to identify the characteristic of cross-cultural web-based collaborative learning (WebCL), and to find out ways to facilitate cross-cultural WebCL. The study was carried out between the third year students of Hangzhou Normal University China and the postgraduate students of University of North Carolina Willmington U.S.. A web-based learning environment (WBLE) was developed and students from both sides collaborate for learning through WBLE. The research is based on a questionnaire as a mean of data collection method to find out characteristics of cross-cultural web-based collaborative learning, and the study progressed through finding relationships between the variables used in the data collection instrument. The findings of the analysis reveal that social interaction plays an important role and students prefers to have more prior knowledge of each other’s cultures and backgrounds and to have more in-depth conversations individually. Based on the results, three methods to facilitate cross-cultural WebCL are put forward.

Keywords- WebCL; CSCL; Cross-culture; Collaborative Learning

INTRODUCTION

The advancement of information and communication technologies has flattened the world (Friedman 2006). Web 2.0 technologies have created vast opportunities for learning (formal and informal) and have powered up the potential for global knowledge sharing, construction and distribution across groups, countries, and cultures. In this globalization age, people communicate with each other from different cultures more frequently thanks to the ICTs application.

21st century skills were proposed by Bernie Trilling in the book “21st century skills: learning for life in our times” (Trilling and Fadel 2009), which describes the components of 21st century skills, one of these skills are cross-culture communication competence. In order to become successful in the future work, student need to have multi-cultural consciousness, respect other cultures and communicate effectively with people from other cultures.

For preparing students’ 21st century skills, especially their multi-cultural abilities and collaborative abilities, directly interacting and communicating with people from other cultures is suggested as the most effective way to perceive and learn about multi-cultural abilities (Fantini 2000). However, only few students have that opportunity to communicate face to face with others from different cultures, and it is not sufficient or feasible when considering current notions that intercultural education should be implemented into all levels and forms of education in the future (Harms, Niederhauser et al. 2006).

Since Web 2.0 enables students to collaborate through web-based communication, Computer-Supported Collaborative Learning (CSCL) offers the opportunity to collaborate with peers, which can enhance students’ learning processes (Scardamalia & Bereiter, 1994; Webb & Palincsar, 1996). In this study, we are trying to adopt Web2.0 to bridge students from China and U.S. to let them learn collaboratively in a cross-cultural learning environment.

RESEARCH QUESTIONS

In order to make the collaborative learning effectively, some research need to be done. Firstly, the cross-cultural learning environment need to be established; secondly, the task model of teachers should be identified; thirdly the procedure of the collaboration should be identified in order to make students and teachers know what to do at each stage. So this pilot study mainly to identify these three problems:

1. Students’ attitude towards cross-cultural collaborative learning
2. How to make the cross-cultural collaborative learning go smoothly

METHOD

28 undergraduate students whose major is educational technology from Hangzhou Normal University (HZNU) and 34 postgraduate students whose major is Educational technology from UNCW(University of North Carolina Willmington) take part in the course. They are assigned into 5 different groups, each of which has 5-6 HZNU students and 6-7 UNCW students. When divide students into different groups, heterogeneous in group and homogeneous between groups should take into consideration, and each group has a leader to take charge of the group.

Language is a big challenge for Chinese students in the cross-cultural collaborative learning process. In order to ensure the smooth running of the whole collaborative process and to ensure that projects achieve the desired goal, we carried out a detailed plan.

First a cross-cultural web-based collaborative learning environment was developed with Blackboard which located in UNCW. Social lounge, cultural orientation and technology integration are the three stages of the collaborative process.
Social lounge and cultural orientation last for 1 week separately, which enable students from both sides communicate with each other about their basic information and culture; technology integration forum lasts for two weeks which enable students discuss topics in educational technology either set by instructors or posed by themselves. In each stage, requirements and statements are presented to students to let them understand their activity better.

Form 1 Cross-cultural collaborative learning evaluation system

<table>
<thead>
<tr>
<th>Item</th>
<th>Index</th>
<th>Analysis methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultural consideration</td>
<td>social; mutual cultural consideration; the attitude of each other's culture; culture on behavior</td>
<td>Discourse analysis; Observatio n;</td>
</tr>
<tr>
<td>Collaborative process</td>
<td>Affective; attitude toward this cross-cultural collaborative learning; satisfaction of team members in the collaborative process</td>
<td>Discourse analysis; Observatio n;</td>
</tr>
<tr>
<td></td>
<td>participation; the process of completing a group collaboration; mutual inspiration to reach a consensus</td>
<td>Questionnaire; Observatio n;</td>
</tr>
<tr>
<td></td>
<td>Interaction; number of replies from companion; times to initiate discussion.</td>
<td>Discourse analysis; Questionnaire</td>
</tr>
<tr>
<td>Performance</td>
<td>metacognitive; self-learning control</td>
<td>No analysis</td>
</tr>
<tr>
<td></td>
<td>cognitive; update their knowledge, methods or attitude</td>
<td>No analysis</td>
</tr>
</tbody>
</table>

Second, we proposed four main goals of this project: to develop multi-cultural awareness of Chinese students and promote their cross-cultural communication competence; to analyze Chinese students’ cross-cultural collaborative learning attitude; to enhance Chinese students' cross-cultural collaborative learning skills. Finally, in order to achieve the project objectives, we developed a cross-cultural collaborative learning evaluation system, and identify each index the corresponding analytical methods, according to the five evaluation areas of WebCL named social, participation, interaction, cognition, and metacognition. As shown in Form1, cultural identity, learning collaborative process and performance evaluation are the three main aspects to evaluat e.

SUBJECTS

28 undergraduates from Hangzhou Normal University and 34 students from UNCW were asked to complete a questionnaire including items on their attitudes and benefits from this cross-cultural study. All the questionnaires were fully completed and the total 62 students formed our study group.

MATERIALS

A mixed-method design involving the collection and analysis of both qualitative and quantitative data was used to address the research questions in this study. The quantitative data were collected both from the posts in the forum and the open-ended questions (the second part) from the questionnaire. The qualitative data were collected from the first part of the questionnaire, which was composed of 12 statements to be responded to on a 5-point scale (1= strongly disagree, 5=strongly agree). The quantitative data were analyzed by content analysis method, which is the process of identifying, coding, and categorizing the primary pattern in the data (Patton, 1990); and the quantitative data were analyzed by SPSS.

RESULTS

A. Culture’s influence on students

As stated before by Zulin Zhu and Ronghuai Huang, culture has a very important influence on students’ learning style, and students from different cultures behave differently from each other. In the data we collected we could see this difference mainly in two aspects, one is perception of the relationship between individual and group, the other is the structure of their posts.

Firstly, the relationship between individual and group, Chinese students would like to firstly post their family information, and always many such information, such as birth location, position of parents, harmonious relationship of family, personal interest, etc. while American students would like to introduce themselves first, and seldom mention their parents. The reason behind this is collectivism of Chinese culture and individualism of American culture, as pointed out by Sue-jen. Secondly, the structure of the post, American students would like to write ideas first and then list evident; while Chinese students would like to write evidence first, and after that give the conclusion. So we could see the American students’ post is always short, however Chinese students’ posts is always long.

B. Students attitude towards cross-cultural collaborative learning

Questions 9-12 intend to investigate the students’ attitude towards cross-cultural collaborative learning, as showed in table 2. Both Chinese students and American students think this cross-cultural collaborative learning in somewhat contributed to their life experience and expand their global perspectives(Q9 &Q10). However, on item 11, Chinese students (scored 3.79) seem to have a more positive attitude toward taking part in similar course in the future than American counterpart (scored 3.68); while, on item 12, American students have a more positive attitude on the learning experience toward this collaborative
compared with the Taiwan-US collaborative project delivered by Sue-jen Chen in 2006, American students’ attitude to collaborative learning has increased from 3.5 to 4.24, which indicates that US students’ motivation to cross-cultural collaborative learning are increased. The same result could be found in the open-end question “If I had a chance to work with students from a different culture again, I would do the following differently?” (as showed in table 3). 13 out of 34 US students say they would like to communicate and collaborate with Chinese students for longer time.

<table>
<thead>
<tr>
<th>No</th>
<th>Survey Items</th>
<th>China28 Mean(SD)</th>
<th>America34 mean(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I had no technological problem using blackboard for online learning and communication.</td>
<td>3.32 (1.28)</td>
<td>4.41 (0.96)</td>
</tr>
<tr>
<td>2</td>
<td>Course resources (e.g., utilities, tutorials, handouts, sample work) helped support my learning needs.</td>
<td>3.61 (0.63)</td>
<td>4.38 (0.79)</td>
</tr>
<tr>
<td>3</td>
<td>Social Lounge helped acquaint me with class peers.</td>
<td>3.50 (0.81)</td>
<td>3.70 (1.15)</td>
</tr>
<tr>
<td>4</td>
<td>Cultural blogs helped foster cultural awareness for cross-cultural learning.</td>
<td>3.82 (0.82)</td>
<td>4.08 (0.89)</td>
</tr>
<tr>
<td>5</td>
<td>I had much experience working with students from other country before this cross-cultural online learning experience.</td>
<td>2.32 (0.98)</td>
<td>2.41 (1.21)</td>
</tr>
<tr>
<td>6</td>
<td>I felt I was connected with my group to talk and learn together online</td>
<td>3.25 (0.93)</td>
<td>3.38 (1.11)</td>
</tr>
<tr>
<td>7</td>
<td>I felt I was connected with the class to talk and learn together online</td>
<td>3.50 (0.64)</td>
<td>3.5 (1.00)</td>
</tr>
<tr>
<td>8</td>
<td>The discussion with foreign peers contributed to my learning of subject</td>
<td>3.71 (0.85)</td>
<td>3.32 (0.94)</td>
</tr>
</tbody>
</table>

C. Cross-cultural collaborative learning process

The first question is about the technological problem using blackboard for online learning and communication, as showed in table 2, Chinese students has some technological problems (scored 3.32), while American students don’t have these technological problems (scored 4.41). The second question is about the course resources; compared with Chinese students, American students think resources are more helpful to their learning (4.38 > 3.61). The reason behind this is the language barrier; the platform and the course resources are all in English, which is a little difficult for Chinese students to use the platform and resources.

The third question is on “social lounge”, American students’ attitude toward this is a little higher than Chinese students (3.7 > 3.5). The fourth question in on “cultural orientation”, American students have much positive attitude to this section. In the observation of the learning process, we could see that American students were very interested in Chinese culture; they communicate with Chinese students a lot on Chinese traditional culture, including festivals, legends, and etc. But in the “cultural orientation” process, owning to Chinese students’ unfamiliar with Chinese traditional culture and their written English, they could not communicate better with American students on culture issues.

The fifth question is about their previous cross-cultural learning experience, from the data showed in table 2, we could see that both Chinese students and American students don’t have a lot of cross-cultural learning experience. The sixth question to the eighth question are about the “technology integration forum”, from the data collected, we could see that both sides don’t depend on their groups in their collaborative learning process, there is no difference between Chinese students and American students. But in fact it indicates that the collaborative learning topic is not set properly, cause if the topic is set properly students will collaborate more closely with each other and will depend more on their group.
it is very important to identify what teacher should do specifically in each stage, as showed in figure 4. Firstly, both sides’ teachers should consider group division, which is based on two principles: differences in group and similarity between groups. Differences in group means students in a group should have different learning characteristics, including English level, gender, characteristics, and etc., which will form a mutual helping climate in group. Similarity between groups means different groups should have similar characteristics, including numbers of students, gender, English level, and etc.. Secondly, designing learning environment should consider three sequenced stages including “social lounge”, “cultural orientation”, and “technology integration”. Social lounge let students from both sides to communicate and understand each other, and is the basis for the next stage. Cultural orientation is the basis for technology integration. Thirdly, evaluation methods contains three domains which are cultural identify, collaboration process and learning performance.

Figure1 Teachers’ task model for collaboration

B. Set collaborative topics clearly, As mentioned before, both sides students don’t depend on their groups in their collaborative learning process, which means students are not satisfied with their technology integration collaborative learning process. The reason behind this is the topic for collaboration is not set properly, while it is a key point for the successful collaborative learning to set a proper collaborative topic. As showed in figure2, the topic should be overlap of the three circles which means setting topic should consider the knowledge known by both sides and the learning content. So, students analyzing and learning content analyzing are the two main aspects when setting the collaborative learning topic.

DISCUSSIONS

A. Teachers’ task model for collaboration
Teachers design the whole learning environment, control the collaboration process, and evaluate the learning outcomes. So

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Form 3 open-ended questions in the questionnaire

<table>
<thead>
<tr>
<th>Items</th>
<th>34 students from US</th>
<th>28 students from China</th>
</tr>
</thead>
<tbody>
<tr>
<td>The three most significant cultural differences I have observed from the cross-culture collaborative learning</td>
<td>Cultural customs 25</td>
<td>Custom/Cultural 16</td>
</tr>
<tr>
<td></td>
<td>Holidays 15</td>
<td>Holidays 5</td>
</tr>
<tr>
<td></td>
<td>Child to parent (family) relationship 13</td>
<td>Attitudes to learning 4</td>
</tr>
<tr>
<td>The three things I felt most valuable to me about the cross-culture collaborative learning experience were</td>
<td>Learning about Chinese culture 28</td>
<td>Culture/Lifestyle 11</td>
</tr>
<tr>
<td></td>
<td>Communicating with Chinese people 18</td>
<td>Learn about their major/our own discipline 10</td>
</tr>
<tr>
<td></td>
<td>Learning about and using technologies to communicate 6</td>
<td>Broaden horizon/Different viewpoints 7</td>
</tr>
</tbody>
</table>

Group division

Differences in group

Social lounge

Cultural orientation

Technology integration

Similarity between

Learning environment

evaluation methods

Cultural identify

Collaboration process

Learning performance

If I had a chance to work with students from a different culture again, I would do the following differently:

Communicate with them more frequently and for longer periods of time 13

Discussions with just individual students not entire classes 10

Have more in-depth conversations 7

More in-depth conversations 7

Have more prior knowledge of each others cultures and backgrounds 7

Live chats/instant messaging (Skype) 7
Dunn and Marinetti (2006) pointed out trouble will arise if culture difference are not taken into account, or even the collaboration will failed between different cultural background. The learning difference caused by culture difference between China and US should be taken into account when the collaborative learning is carried out, and it should become an important research issues for researcher. We should confine the differences during the collaborative learning process and make specific methods to make the collaboration more effectively according to the differences we confined. Eventually we could know much about the learning style differences between China and US, and the collaborative learning will be carried out more smoothly.

In the data collected, we found Chinese student are not familiar with Chinese ancient culture, as mentioned before. Some cultures, such as dragon boat day, Kuaizi, white snack lady, spring festival, and etc are the distillation of Chinese People and the soul of Chinese five thousand years history. As Chinese, we should know these cultures and could introduce them to foreigners in English. So the basic cultural terms should be listed in bilingual languages for students who take part in the collaboration.

"Culture orientation" stage is the basis for both sides to know each other and begin to learning together, and is so important that should be paid special attention to. It is also very important for the learning environment construction, as "social presence" will be enhanced if this stage goes smoothly. In this stage, not only culture differences and bilingual language resources should be taken into account, but also Chinese students’ English level.

REFERENCES

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