Research Status and Revelation of Visualization Technology in Support of Online Learning in the Era of Big Data

Fan Yang, Yue Wang
College of Humanities & Sciences of Northeast Normal University
Changchun, China

Abstract—**In the era of big data, a large amount of learning information is stored online. Teachers and students have been faced with problems such as information overload for a long time. The visualization of information reduces learners' cognitive load and enhances their perception of information, which makes an important breakthrough to solve the above problems. Firstly, this paper defines the connotation of visualization technology from the learning perspective, then it analyzes the research status through documentary study method and finds that visualization technology provides strong support for the construction of learning resources, the grasp of learning process, the interaction in learning process and the reflection of learning objectives. Finally, it proposes the future application direction of visualization technology so that it can provide reference for the practice of developing visualization tools.**

Keywords—big data, visualization technology, learning resources, learning process

I. INTRODUCTION

Most efforts in educational informatization are largely reflected in the visualization of educational content and process [1]. The era of big data has come. While it provides the learners with multiple learning opportunities, the heterogeneous distribution of resources and the weak relationship of learning resources also result in learning lost and cognitive overload. The learners can not locate their own resources quickly and accurately, let alone use them efficiently. On the other hand, there is a wealth of learning process data in the online learning environment. Educators can mine meaningful information and patterns from a large number of learning data. However, the big data in the learning log can not be analyzed and processed in a manual way, and data mining is the knowledge in the field of computer science, but most teachers can not master its methods.

The development of visualization technology provides an opportunity to solve the above problems. Visualization is a method of transforming data, information, knowledge and other contents into graphics to display [2]. It is a new way to reduce the difficulty in data analysis by visualizing data information in a reasonable way and mining potential information or patterns through the analysis of atlas. The content or resources in the online learning environment are reasonably organized and visualized, which can reduce the amount of users information search, enhance the perception of information, and solve the problem of information overload faced by learners [3]. Therefore, the rational use of visualization technology can lower the difficulty of information processing, reduce the cognitive load of users, and enhance the cognitive process of learning, and thus improving the learning efficiency of learners.

II. VISUALIZATION TECHNOLOGY FROM LEARNING PERSPECTIVE

"Visualization" is to convert various data information into appropriate graphics and images by computer graphics processing techniques, and display them on the screen [4]. The study indicates that visualization is the process of transforming data, information and knowledge into visible forms and gaining a deeper understanding of them. Colin [5] believes that visual mode can accelerate the input and understanding of information, and it has retrieval function. Zhao Wei and others [6] hold that visualization technology is the theory and practice of using computer-supported and interactive visualization to display information and knowledge about teaching activities in the digital learning environment based on the teaching theory, so as to realize learning analysis and promote knowledge dissemination and innovation.

From learning perspective, visualization not only visualizes the learning content such as knowledge and data, to promote students to have a more intuitive and in-depth understanding. It also visualizes the learners' internal psychological activities and information understood in the mind. What is more important is that visualization is to connect the inside and outside visual representations in the learners' mind. Thus, on the one hand, visualization technology needs to build a certain learning environment, on the other hand, it also needs to make comprehensive use of knowledge visualization, thinking visualization, date visualization and other different ways to help students to obtain and express a deeper understanding of knowledge, and finally improve students' learning ability.

III. RESEARCH STATUS OF VISUALIZATION TECHNOLOGY SUPPORTING ONLINE LEARNING

Visualization technology's supports for online learning include: supporting the construction and understanding of learning resources, the guidance and mastery of learning process, the interaction and collaboration in the learning process, and the evaluation and reflection of learning objectives.

A. Supporting the Construction and Understanding of Learning Resources

It has been confirmed by relevant research that the visualization can help to construct the knowledge understanding and strengthen memory in the process of learning. Minhong Wang and others designed a visual online learning system based on problem solving with a dual-map display, which examined students' condition of problem solving and knowledge construction. Test results after completing the course found that students have improved significantly in their achievements, and they have made nearly moderate progress in problem solving and knowledge construction. It also found that students have made great progress in knowledge construction, although their knowledge construction performance is not high compared with their problem solving performance [7]. Gu Xiaoqing and others believe that the external presentation of knowledge has a profound impact on learners' knowledge cognition and understanding, as well as the dissemination, survival and development of knowledge itself. Learning resources should pay attention to the visual characteristics of knowledge to actuate people's visual cognition and graphic image understanding, so as to improve their learning efficiency. The visual presentation of knowledge in electronic textbooks and the use of semantic graphic tools can help learners achieve better reading comprehension and thinking training, which can improve learners' cognitive ability and learning effect and then achieve the goal of deep reading [8].

B. Supporting the Guidance and Mastery of Learning Process

Sheard and others get information about the use of online learning platforms by visualizing students' navigation behaviors on the course website. The tool can selectively visualize the navigation behavior of users or user groups in different periods according to the semester, course, research unit and course performance, then generate access paths, and record the access situation of each learning resource [9]. The Knewton project in the United States presents the knowledge points of the course in the forms of knowledge maps, which provides the cognition of students' potential learning paths. The system can continuously mine students' performance data to guide them personally, and allow them to learn according to the recommend learning path on the knowledge map [10]. The DLM project of Newcastle University in the United Kingdom adopts visualization technology to realize the visual navigation of personalized learning process. Students can independently add, delete and modify resources on the visual learning path recommended by teachers, and establish a meaningful connection between resources, which not only plays the guiding role of teachers but also reflects the participation of students [11]. Ma Xiulin and others explored the general

algorithm of drawing knowledge map in the learning management system, which can provide teachers with the function of creating knowledge map dynamically so that they can design and organize teaching resources, and provide learners with the function of visualizing the progress so that they can timely understand their learning process. Experiments prove that this method is of great value in improving the effectiveness of learning management system and learning efficiency of learners [12].

C. Supporting the Interaction and Collaboration in the Learning Process

Learners produce a series of interaction and collaboration in the learning process. The Cohere tool studied and developed by the OLnet Project of the Open University in the UK supports collaborative debate learning by visualizing the meaningful connection of views between different learners with knowledge maps, which can realize the visualization of thinking among peers, and to promote the exchange of ideas among learners [13]. Sung-hee Jin studied the effects of the use of two visualization tools (one with features of group participation and intergroup interaction, the other with features of group participation and individual participation) on students' participation, perceived learning, perceived satisfaction, team performance and usability. Both visualization tools have significant effects on perceived satisfaction, perceived learning and team project performance [14]. In a comprehensive learning environment, Luciana explores social content by integrating social network analysis, emotional analysis and topic classification. It uses a series of visualization and analysis to characterize the participants, scope, structure, popularity and controversy of social interaction [15].

D. Supporting the Evaluation and Reflection of Learning Objectives

The representation of learners' information can show their mastery knowledge, learning objectives, and learning preference in a certain field. The visualization of learner models can enhance the educators' understanding of learners to a certain extent, and help learners evaluate their learning objectives and self-reflect as well.

Kay presents the user model by hierarchically displaying concepts in the domain, which shows the user's status of grasping all knowledge points in a certain field. Suraweera and others intelligently tutor the entity relationship of knowledge by constructing an open learner model, the purpose of which is to teach the conceptual design of the database. Zapata Rivera and others present learners model in forms of concept maps. The major feature of this model is that it can evaluate students' mastery of a certain concept by capturing students' viewpoints, teachers' opinions, and learners' systematic feedback in learning process [16]. Professor Petery's team has conducted a series of studies on the open social learner model, which explored the integration, learning sequence, interaction, social comparison, and model recognition of the model visualization, and studied the improvement of metacognitive ability, the collaboration and communication of learners, and the mechanism of learning achievements [17]. Check-Yee Law and others examined students' understandings of an open learner

model visualization prototype tool (Doubtfire ++) and their viewpoints of its effectiveness. It examined students' views and understandings of using visual tools to help students learn about setting appropriate goals, monitoring learning performance, and reflecting on teaching. According the analysis of the survey results, Doubtfire ++ positively affects the users' perceptions of setting appropriate goals, monitoring performance and reflecting on learning [18]. Wang Liping designed and developed MindOLM, an open learner model based on mind maps, which presents the learner's learning progress by transforming the curriculum knowledge of the learner model into mind maps. She designed and developed TableOSLM, an open social learner model based on tables, which presents the learning progress of learners, learners' group and their partners by turning the curriculum knowledge of their learner model to tables [19]. Yu Shengquan and others realized the visualization of learning evaluation, learning time and learning progress on the learning meta-platform. Curriculum developers set up an evaluation program for the course. The learners can check their evaluation information at any time, get to know the learning situation and adjust their learning strategies appropriately [20].

IV. THE ENLIGHTENMENT OF VISUALIZATION TECHNOLOGY IN SUPPORTING ONLINE LEARNING

Visualization mainly relies on learning analysis technology to provide learners with attractive learning resources and effective feedback through a visual interface. Visualization technology utilizes learners' quick perception of visual channel to improve learners' efficiency in identifying and processing online learning resources and system feedback, which is conducive to promoting students' deep learning, profound meaning construction and knowledge transfer [21].

Using visual information to demonstrate the interaction and collaboration process helps learners grasp and evaluate their knowledge and promote their reflection. At present, there are only separate studies of visualizing collaborative learning process or personalized learning process. Learners will have a much richer learning experience by presenting collaborative learning and personalized learning process in a same visual map. It is required that educators develop a system that visualizes the learning path of knowledge in the field. More teachers and students with authority can modify the knowledge content or learning path in the knowledge map, and they can give feedback to each other and effectively use the collective intelligence of teachers and students. Learners can selectively adopt their peers' opinions for personalized learning.

The objects of the visual presentation of user model should not be limited to feedback information of knowledge and students' achievements. In the learning process, the status of accomplishing learning goals is also important information that reflects students' learning situation. If relevant techniques can capture the progress information of the learning goals and realize the visualization, then teachers can find the slower learners. At this time, it is necessary to take corresponding measures, such as additional tutoring alone. In addition, the existing user model lacks human-computer interaction. The visual representation of evaluation index, learning progress and other information can realize the knowledge visualization tools

of human-computer interaction, which has a significant effect in optimizing learning.

The purpose of visualization is to present complex and indetectable problems in an image way, so that a picture is worth a thousand words. However, in terms of data visualization at present, teachers and learners cannot easily understand the information expressed in these visualization results because the results obtained by learning analysis tools are still too professional. It is the important aspect of visualization research that how to present complex information in a simple and clear way, or how to guide teachers and learners to interpret the content and information presented by visualization. In particular, it is necessary to visualize the adaptive presentation according to the needs of teachers and students. The above questions are all worthy of attention in the future visualization research.

REFERENCES

[1] Gu, Xiaoqing.; Quan, Guolong. A Review of Research on Visual Knowledge Representation and Modeling by Semantic Graphics [J]. Research on Audiovisual Education, 2014 (5): 45-52.(In Chinese)

[2] Hao, Shibo.; Zhu, Xuefang et al. Comparative Analysis of Information Visualization Research at Home and Abroad[J]. Library and Information Service, 2013 (7) : 105-113. (In Chinese)

[3] Chen, Fanghua.; Zhao, Wei et al. Foreign Research Status and Revelation about the Application of Visualization Technology in E-learning System[J]. Modern Distance Education, 2015 (2): 67-73. (In Chinese)

[4] Li, Kedong. Visual Learning Activity Project[J]. Educational Information Technology, 2016 (7.8): 9-17. (In Chinese)

[5] Hong, Wenxue.; Wang, Jinjia. Visualization and Visualization Analysis[J].Journal of Yanshan University, 2010, (2): 95-99,105. (In Chinese)

[6] Chen, Fanghua.; Zhao, Wei et al. Foreign Research Status and Revelation about the Application of Visualization Technology in E-learning System[J]. Modern Distance Education, 2015 (2): 67-73. (In Chinese)

[7] Wang M. & B.Wu, K.shuk, N.S.Chen, J.M. Spector.Connecting problem-solving and knowledge-construction processes in a visualization-based learning environment[J]. Computers & Education. 2013, 68(4):293-306.

[8] Gu, Xiaoqing.; Quan, Guolong. A Review of Research on Visual Knowledge Representation and Modeling by Semantic Graphics [J]. Research on Audiovisual Education, 2014 (5) 45-52. (In Chinese)

[9] Sheard, J, Albrecht, D, &Butbul, E. VISION:Visualizing student interactions online [A] . The Eleventh Australasian World Wide Web Conlerenc;e(AusWeb05)[C]Queensland, Australia :2005.

[10] The Knewton Platform:Leading Adaptive Learning Provider[OL]http://www. knewton. com/asset-v2 / downloads / knewton-intro-2014. pdf.

[11] Li, Shiping.; Zhao, Wei et al. The Co-fusion of Open Learning Resources' Autonomous Aggregation and Visual Navigation-The Evaluation of Dynamic Learning Maps Project[J]. Modern Educational Technology, 2013 (9): 5-10. (In Chinese)

[12] Ma, Xiulin.; Zhao, Guoqing et al. Technical Implementation of Knowledge Visualization and Learning Progress Visualization in LMS[J]. China Academic Journal Electronic Publishing House,2013(1): 121-125. (In Chinese)

[13] Song, Xuefeng.; Zhao, Wei et al. Cohere: Make effective use of the Collective Intelligence in the Learning of OERS[J]. Modern Educational Technology, 2013(10): 107-110. (In Chinese)

[14] Jin S.-H. Using Visualization to Motivate Student Participation in Collaborative Online Learning Environments[J]. Educational Technology & Society.2017,20 (2):51–62.

[15] Oliveiar L. & A.Figueira.Visualization of sentiment spread on social networked content: Learning analytics for integrated learning environments[A]. Global Engineering Education Conference[C].IEEE,2017:1290-1298.

[16] Mazza, R. Visualization in Educational Environments[A].Handbook of Educational Data Mining [C] . Minnesota:CRC Press,2010. 9-26.

[17] Wang, Liping.; Zhao, Wei et al. The Progress View of Research on OPEN Social Learner Model[J]. Modern Distance Education Research, 2015 (2): 104-112. (In Chinese)

[18] C.Y .Law, J. Grundy, A. Cain, R. Vasa, A. Cummaudo. User Perceptions of Using an Open Learner Model Visualisation Tool for Facilitating Self-regulated Learning[A]. Proceedings of the Nineteenth Australasian Computing Education Conference[C].ACM,2017:55-64.

[19] Wang, Liping. Study on Learner Model and Teaching Model in Adaptive Learning System[D]. Northeast Normal University, 2017. (In Chinese)

[20] Yu, Shengquan.; Chen, Min. Design of Micro-lecture Based on Learning Cell System [J]. 2014 (2): 100-110. (In Chinese)

[21] Yang, Bing.; Lu, Guoqing et al. Research on Visualization Evaluation Standards of Online Learning System Data [J]. Distance Education in China, 2017 (12): 54-61. (In Chinese)