The Learning Context Analysis System for Digital Textbook Service on Learning Cloud

Kwang Sik Chung
Dept. Of Computer Science, Korea National Open University, Jongno-gu, Dongsung-Dong, Seoul, Republic of Korea
Email: kchung0825@knou.ac.kr

Abstract. On previous e-learning environment, learners should learn by him/herself, decide the learning sequences and take examination, since there were no way for teachers to know what the learners do and how the learners do for their learn. That means that after teachers giving the learning contents, teachers could not interact with learners, as like off-line classes. From those reason, e-learning environment has many disadvantages compared with off-line learning environment from the view of education or learning efficiency. But, on digital textbook service environment developed by this research, basic learning devices are smartphone that supports interaction between learners, teachers and learning contents. With various kinds of sensors and environment of digital textbook service, digital textbook system could track and gather learner’s learning activity and learner’s personal learning information (learning history, learning assessment results, e-portfolio, etc.). In this paper, the learning analytic system is designed for extracting, classifying and accumulating various learning data of learners from the learner’s learning activities and from learner’s personal learning information (learning history, learning assessment results, e-portfolio, etc.). And analysis learning data can be used to decide learner states and can be useful to construct learning strategy of learning direction and learning assessment results. In this research, proposed learning analytic system collects learning data from previously proposed digital textbook service and virtual practice learning cloud, and extracts and analyses learners’ learning activity. With the proposed learning analytic system, personalized learning sequence and personalized learning contents could be delivered to learners by intelligent tutoring engine and the learning analytic system and learners’ learning interests and learning efficiency would increase.

1. Introduction
Nowadays, many people wonder whether about efficiency or effectiveness of e-learning. At the first time, e-learning environment had many kids of advantages[1]. A student can access to a training program whenever or wherever he/she wants with their own learning pace and at their own place (home, library, etc.). Especially, as information communication technology develops quickly, various ITC service are developed and e-learning system have been adapting those various ICT as new learning contents delivery. And besides with new information communication technology adoption, present e-learning system makes altered learning patterns of students, new educational models or new learning models. These kinds of learning patterns and educational and learning models are developed based on information communication technology. And the learner’s learning new roles and teacher’s new roles in e-learning environment are newly made by technology communication technology[2]. Time length and volume of digitized learning contents can be more easily adjusted according to
student’s situation, choice and decision. In comparison with previous offline learning environment, e-learning environment support learner’s decision and self-directed learning environment. Especially, self-directed learning is very effective to diligent learners. If a student would work and don't have time to study or a student have no self-directed learning capability, self-directed learning environment would make the student loss learning motivation or learning achievement. In those cases, advantages of e-learning become disadvantages of self-directed learning of e-learning. And, learning contents of e-learning are executed and played by a learner and the learner should do construct e-learning contents execution platform by him/herself. That means that personal digital divide has a decisive effect on learning capability, learning motivation or learning achievement. Those situations happen by interaction absence between students and e-learning system. e-learning does not track the student’s learning activity or dose not infer student’s learning interests. e-learning system does not infer the reason of student’s learning activity evaluation result or assessment results. Totally same learning contents make students boring and give up the study. In order to make up for these problems of e-learning environment, e-learning system should collect what a student do for their learning contents and infer how the student have the learning result or assessment results. With those kinds of analytic process, e-learning system can make personal learning environment fit for personal learning situation[3,4,5]. The personalized learning environment means the personalized learning contents and personalized learning support services[5]. In this paper, the emotional learning data analysis engine is proposed with digital textbook service[5]. The affective learning data analysis engine tracks and collects two kinds of learning data. One is learning data of a learner, and the other is affective data of a learner and learning device. The emotional learning data analysis engine collects and analyses learning analysis data of a learner and learning emotional data of a learner, learner’s emotion and learning device. After analysing learning data of a learner and affective learning data of a learner and learning device, learning data analysis engine decides state of a learner. In order to decide state of a learner, affective learning data analysis model with learning emotional model for the emotional learning data analysis engine is proposed in digital textbook service.

In chapter 2, we review previous learning analysis system and analysis model on e-learning learning environment. The proposed learning context analysis system is described in chapter 3. And the architecture and function modules of the affective learning data analysis engine are defined and described in chapter 4. Finally, we conclude this research in chapter 5.

2. Related works

‘Creative Economic Vitamin L Project’ reports measures learning activities in the learning situation by extracting raw data the minimum unit of learning behavior that can be digitized when conducting offline classroom with digital textbooks and smart devices[6]. The basic premise of the primitive data concept is that learners’ basic learning activity such as swipe, typing, click, painting, download, save, images drawing, bookmarks, etc. Educational psychological analysis in addition to learning activity analysis and estimation model through data mining is proposed[7,8]. The Learning Analytics for Prediction & Action (LAPA), an intelligent educational data mining model is proposed[8]. The University of Amsterdam launched the UvAInform project in 2013 and developed an information-based strategy for developing and implementing learning analytics services across the university [9]. The UvAInform project adopts a centralized approach to the development and implementation of learning analytics services, and seven other developments are being conducted at various university faculties. The METAL project mainly tracks online learning activities and utilizes the learning data collected for learners based on the learning data collected from educational information systems[10]. This learning data is collected to infer learner information, and dashboards are used to visualize this information to support teaching or learning activities. Previous learning analytics works focused on learner’s learning activity and tried to analyze learner’s learning activity. In this paper, learner’s emotional actions are collected and combined and analyzed with learner’s learning activity.
3. The Learning Context Analysis System

Proposed affective learning data analysis model has various learning analysis data about a learner and learning emotional data about learning device, learner’s emotion and a learner’s emotion. Learning analysis data is directly related with a learner or learning activity that is proposed by IMS Global edugraph[11]. The learning emotional data is directly related with a learner emotion, learning interests, learning concentration and learning satisfaction. The learning analysis data is defined as a learner’s profile data and learner’s learning activity data. The learning emotional data is directly analyzed and used for a learner’s learning activity and learning results. The learning emotional data is defined as learner’s attitude to learning device, learning contents and learning environment. The learning emotional data is directly analyzed and used for a learning interests and learning concentration. The affective learning data analysis model combines the learning analysis data with the learning emotional data. And The affective learning data analysis model is designed for affective learning activity so that learning activity is analyzed according to learner’s emotional state and is sent to Automated Tutoring Engine [12].

3.1. Affective Learning Data Analysis Model

The affective learning data analysis engine needs two types of learner’s learning analysis data that can be classified into learning analysis data and learning emotional data. The affective learning data analysis engine decides learners’ learning activity state by combining and analyzing learning analysis data and learning emotional data. The learning analysis data is defined as IMS Global edugraph[11].

In digital textbook service that was proposed in [13], learners can use two types of learning devices, There are two types of learning devices connected to the smart learning portal server as like in [Figure 1]. One is mobile devices as like smartphone or pad computer that have various sensors as like gyroscope sensors, proximity sensor, microphone sensor, light sensor, etc.. The other is desktop computer or laptop computer that have no sensors. Basically, proposed Learning Contexts Analysis System does not support desktop PC user, since desktop PC does not have sensors and it does not collect and send learner’s learning emotional data. In this paper, a learner who uses mobile devices connected with smart learning portal server is mentioned about. A learner connected to the smart learning portal server via their mobile devices equipped by sensors, access learning contents(lecture video, ePub textbook, e-portfolio for personal information, sample examination questions, etc.) via learning management system(LMS). Thus all kinds of learning activity are collected by learning agents on smartphone and LMS. And learner’s actions on smartphone are sensed and collected by learning agents on learner’s smartphone. On learner’s activities, corresponding learner’s activities with
learning contents metadata are sent to learning context analysis engine from learning contents management server, e-portfolio server, ePub textbook server and learning virtual experiment/exercise contents cloud.

3.2. Architecture of Learning Contexts Analysis System

[Figure 2] is Architecture of Learning Context Analysis System that consists of learning contexts analysis engine and learning data storage server. Proposed Learning Contexts Analysis Engine collects learning analysis data about a learner and learning emotional data about learning device, and decides learner’s learning interest level and concentration level. Proposed Learning Contexts Analysis Engine combines results of Learning Emotional Data analysis and Learning Analysis Data analysis of proposed affective learning data analysis model. Proposed affective learning data analysis model presents emotional aspects of learner’s learning activity and learner’s learning state. Combination of Learning Emotional Data analysis results and Learning Analysis Data analysis results is emotional attitude toward learning activity that is decided by Proposed Learning Contexts Analysis Engine. Learning Emotional Data comes from Learner’s action and Educational device as like smartphones and his sensors. learning analysis data comes from profile of learners and educators, learning contents, learning activity, operational learning services, and learner’s career.

![Figure 2. Architecture of Learning Context Analysis System](image)

Proposed Learning Contexts Analysis System (LCAS) consists of Learning Contexts Analysis Engine (LCAE), Learning Data Storage Server (LDSS), Learning Emotional Database (LED), and Learning Analysis Database (LAD).

- Learner’s educational device: learners interact with smartphone or pad computer that has many kinds of sensors. The sensors collect learner’s action and learning agents on smartphone send sensed data (learning emotional data) to LDSS.
- Learning activity on learning content: learners interact with learning contents through smartphone or pad computer. Learning activity with learning contents is designed by learning instructors. The sensors collect learner’s learning activity and learning agents on smartphone send sensed data (learning activity data) to LDSS.
- Learning Data Storage Sever (LDSS): learning emotional data from learner’s educational device and learning activity data from learning contents are received and managed by LDSS. LDSS constructs LED and LAD for Learning Contexts Analysis Engine.
- Learning Contexts Analysis Engine (LCAE): In order to decide learner’s learning interest level and concentration level, LCAE requests and analyses learning emotional data and learning activity data, collect learners’ learning emotional state information, and infer and decision of learners’ learning contents

3. Service Flows of Learning Contexts Analysis System

In [Figure 3], various sensors on smartphone and seamless communication network are assumed. And we assume that bio-signals of learners are always can be collected and detected. [Figure 3] shows service flows of learning contents analysis services.
①② A learner logs on smart learning portal server via his/her smartphone. And, the learner start studying his/her learning contents that he/she attends lecture on. When the learner logged on and access smart learning portal server, LMS requests learner’s e-portfolio and other learner’s information(enrolled subjects, academic affair information, etc.) from e-portfolio server and receives and store it on learning data storage server.

③④ The learner study his/her learning subjects that he/she attends lecture on. And the learner interacts with learning contents. The learning activities of the learner are sent to LMS. LMS sends learning activities of the learner to LCMS, ePub textbook server and Virtual Experiments/practice Learning Cloud, and requests learning contents data related with learner’s learning activities from LCMS, ePub textbook server and Virtual Experiments/practice Learning Cloud.

⑤ LCMS, ePub textbook server and Virtual Experiments/practice Learning Cloud send learning responses data related with learner’s learning activities to LMS. And learner’s learning device sends learner’s emotional reaction data to LMS. LMS sends combination of learner’s learning activities, learning contents data related with learner’s learning activities, and learner’s emotional reaction data to LCAS(learning data storage server).

⑥⑦ LCAS combines learning contents data with learning response data with learner’s learning activities. LCAS requests learner’s e-portfolio and learner’s academic affair information from e-portfolio server.

⑧ LCAS decides level of learning interests and learning concentration from analysis of learner’s e-portfolio and learner’s academic affair information, combines learning contents data with learning response data with learner’s learning activities.

![Figure 3. Learning Context Analysis System Message Flow](image)

4. Conclusion
In this paper, learning contexts analysis system is proposed for learner’s learning activity concentration level and learner’s learning interests level. Proposed learning contexts analysis system
consists of Learning Contexts Analysis Engine, Learning Contexts Data Storage Server, Learning Emotional Database, and Learning Analysis Database. Proposed learning contexts analysis system combines the learning analysis data with the learning emotional data. The learning analysis data is defined as a learner’s profile data and learner’s learning activity data. The learning analysis data is directly analyzed and used for a learner’s learning activity and learning results. The learning emotional data is defined as learner’s attitude to learning device, learning contents and learning environment. The learning emotional data is directly analyzed and used for a learning interests and learning concentration. With The learning analysis data and the learning emotional data, proposed learning contexts analysis system decides the more effective and personalized learning support services for a learner.

In near future, the result of learning context analysis is adopted to KNOU digital textbook service[13] and personalized learning support service will be delivered to KNOU students.

Acknowledgement
This work was supported by 2019 Korea National Open University Research Fund.

Reference
[1] James, G. (2002). Advantages and disadvantages of online learning Retrieved 5/ 18/2014 http://www.commitit.commit-4-deveopmentmodel210058
[2] Faraj Allahi, M., & Zarif Sanayei, N. (2009). Education based on information and communication technology in higher education, Journal of education strategies, 4(2), 167-171, [Persian].
[3] Chung, K., Kim, Y., Lee, C., Jung, KNOU Smart Learning: Beyond the Future KNOU Learning Environment, 28th proceedings of AAOU, AAOU 2014, 2014.
[4] Kwang Sik Chung, Learning Reaction Analysis Engine for Interactive Digital Textbook Platform FutureTech 2017: Advanced Multimedia and Ubiquitous Engineering pp 459-465, 2017.
[5] Kwang Sik Chung, Sungho Chin, Affective Learning Reaction Model Based on Smartphone and Sensors, Journal of Physics: Conference Series, Volume 1060, pp. 2019.
[6] Ilju Rha, C.H. Im, Young Hoan Cho, Study on Learning Analytics Model and Methodology, Seoul Metropolitan office of Education, 2015.
[7] In Young Jo, Yeosook Kim, Impact of learner's time management strategies on achievement in an e-learning environment: A Learning analytics approach, Journal of KOREAN ASSOCIATION FOR EDUCATIONAL INFORMATION AND MEDIA, 19(1),83-107. 2013.
[8] Il-Hyun Jo, Yunmi Kim, Impact of Learner’s Time Management Strategies on Achievement in an e-learning Environment: A Learning Analytics Approach, Journal of Korean Association for Educational Information and Media, Vol.19 No.1, [2013],
[9] Mol, S.T. & Kismihók, G., 2014. No Title. In Presentation at LASI-Utrecht 2014. Available at: http://www.adam-europe.eu/prj/9974/prd/37/2/R14.10.pdf.
[10] Armelle Brun, Geoffray Bonnin, Sylvain Castagnos, Azim Roussanaly, Anne Boyer, Learning Analytics Made in France:The METALproject, International Journal of Information and Learning Technology, Vol. 36 No. 4, pp. 299-313., 2019
[11] IMS Global Learning Consortium, Learning Measurement for Analytics Whitepaper, https://www.imsglobal.org/sites/default/files/caliper/IMSLearningAnalyticsWP.pdf
[12] Kwang Sik Chung, Learning Reaction Analysis Engine for Interactive Digital Textbook Platform, Advanced Multimedia and Ubiquitous Engineering: MUE/FutureTech 2017 (pp.459-465)
[13] Kwang Sik Chung, Yeon Sin Kim, Sang Im Jung, Chung Hun Lee, Younghee Woo, Virtual Practice Digital Textbook with Learning Cloud, 32th proceedings of AAOU, AAOU 2018, 2018.