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A Study on Design Guidelines of Learning Analytics to Facilitate Self-Regulated Learning in MOOCs*

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The purpose of this study was to develop design guidelines on the learning analytics which can help to promote students' self-regulated learning (SRL) strategies in MOOCs learning environments. First of all, to develop the first draft of design guidelines, relevant literature review and case analysis on current MOOCs platforms such as edX, K-MOOC, Coursera, Khan Academy and FutureLearn were conducted. Then, to validate the design guidelines, expert reviews (validation questionnaires and in-depth interviews) and learner evaluation (in-depth interviews) were conducted. Through the recursive validation, the design guidelines were finalized. Overall, the final version of design guidelines on learning analytics to facilitate SRL strategies was suggested. The final design guidelines consist of 15 items in 10 categories related to the information analyzed based on individual student's learning behaviors and activities on MOOCs environments. Moreover, the results of interview also revealed that the social comparisons, learning progress reports, and personalization might contribute to the improvements of their SRL competences. This study has an implication that MOOCs could offer a higher success or completion rate to students with low SRL skills by taking advantage of the information on learning analytics

Keywords : MOOCs, Self-Regulated Learning, Learning Analytics, Design Guidelines

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Introduction

MOOCs which are derived from distance education, online education, and OER (Open Educational Resources) shape the innovative learning landscape and lead the new wave of learning (Rha, 2015). A MOOC can be defined as a free study program which is designed and developed to be studied online by huge numbers of participants (Wintrup, Wakefield, & Davis, 2015).

As MOOCs learning environment have been flourished in the world, a great number of global learners participated in them (Jordan, 2014). It means that all activities of learners and teachers could be digitalized and stored as meaningful educational big data which can be utilized for educational data mining. In other words, the state-of-the-art ICT can help make learners' data about their learning patterns, styles, and states collected, analyzed and utilized.

In spite of various benefits of online learning in MOOCs, such online learning environments including MOOCs require that students should be self-regulated or autonomous during learning compared to the classroom/offline-learning environments, since learners study alone and keep learning without direct encounter or touch with teachers and colleagues. Due to such a weakness of online learning, students with lower ability of self-regulated learning (SRL) tend to easily feel bored or frustrated and then face a crisis of dropouts (Kizilcec & Schneider, 2015; Zheng, Rosson, Shih, & Carroll, 2015). For this reason, there should be functions or tools to support their successful learning achievements by reflecting on their own learning progress based on meaningful data of learning activities extracted from MOOCs platform and to promote SRL cycle.

Recent reports on predicting future technologies and Information Communication Technology (ICT) trends which might have a big impact on education such as Horizon Reports by the New Media Consortium have discussed learning analytics and adaptive technologies for several years as one of the most influential trends and technologies on the education field (Johnson, Adams Becker, Estrada, & Freeman,

2015; Johnson, Adams Becker, Cummins, Estrada, Freeman & Hall, 2016). With the help of such innovative development of ICT, more adaptive learning environments to an individual student's cognitive, meta-cognitive and affective status would be applied to such MOOCs environments to promote SRL strategies (Goldberg, Sottilare, Roll et al., 2014).

Accordingly, this study aims to develop design guidelines on information of learning analytics which can improve students' SRL in MOOCs. The following research question was investigated in this study.

Which design guidelines of learning analytics could help to facilitate SRL strategies in MOOCs learning environments?

To achieve this goal, firstly we reviewed previous studies about SRL and analyzed the learning analytics functions of the existing typical MOOCs platforms such as edX, K-MOOC, Coursera, Khan Academy and FutureLearn, and then tried to derive design guidelines which can be applied to the design and development of a MOOCs platform. In addition, to validate the design guidelines, both experts and students participated in evaluating the design guidelines.

Theoretical Background

Self-regulated learning in massive open online courses

MOOCs generate new possibilities that are revolutionizing conventional learning environments. MOOCs provide more interactive activities that help students engaged in learning in addition to traditional course materials such as video lectures, reading material, coursework and tests. In the global society, MOOC platforms such as Coursera, edX, and Khan Academy have been internationally achieved

prospect. Locally, since last year, K-MOOC projects has been initiated in the support of Korean government and K-MOOC platform is currently offering 27 courses from ten prestigious universities in Korea.

According to the research of Jordan (2014), among 43,000 students having taken Coursera, Udacity, and edX, only 6.5 percent of them earned a basic certificate. Meyer (2012) reported that the drop-out rate of MOOCs offered by Stanford, MIT and UC Berkley was 80 to 95%. For example, only 7 percent of the 50,000 students taking the Coursera-UC Berkeley courses in Software Engineering had completed them. Although the number of participants registering on MOOCs rapidly increase and most of them seem to enjoy MOOC learning with satisfaction, only a small number of them complete the entire course and earn a certificate (Anderson, 2013; Kizilcec, Parr, 2013; Kizilcec, Perez-Sanagustin Schneider, & Maldonado, 2016; Wang & Baker, 2015). Thus, the biggest issue of MOOCs is that only a small portion of learners persists their learning with autonomy and completes their courses. In spite of MOOCs' potential to drive education paradigm and curriculum innovation, MOOCs are attacked by high drop-out rates. The K-MOOC platform which was released in October, 2015 also pays attention to form a student-centered learning environment based on the results of learning analytics research utilizing various learning activity logs and data.

SRL strategies would play a very crucial role in improving student's academic achievement and motivation as well as raising student's positive study habit (Zimmerman, 1998; Zumbrunn, Tadlock, & Rober, 2011). Zimmerman and Martinez-Pons (1986) made an effort to identify student's use of SRL strategies by conducting interviews with forty male and female students. From the results in analyzing the interview, they categorized 10 strategies as shown in Table 1.

From the results in the study above, it was found that higher achievement students utilized more SRL strategies at the same time compared to lower achievement students. In fact, as e-learning and web-based learning have been enriched in recent teaching and learning contexts, SRL has ben also a very essential

construct for students who aim to study in those learning environments which need self-goal setting, active participants, monitoring their own learning, meta-cognitive skills to solve problems (Cha & Park, 2013).

Table 1. SRL strategies (Zimmerman& Martinez-Pons, 1986, p. 618)

Categories of strategies	Definition
1. Self-evaluation	Statements indicating student-initiated evaluations of the quality or progress of their work
2. Organizing and transforming	Statements indicating student-initiated overt or covert rearrangement of instructional materials to improve learning,
3. Goal-setting and planning	Statements indicating student setting of educational goals or sub-goals and planning for sequencing, timing, and completing activities related to those goals
4. Seeking information	Statements indicating student-initiated efforts to secure further task information from nonsocial sources when undertaking an assignment
5. Keeping records and monitoring	Statements indicating student-initiated efforts to record events or results
6. Environmental structuring	Statements indicating student-initiated efforts to select or arrange the physical setting to make learning easier
7. Self-consequences	Statements indicating student arrangement or imagination of rewards or punishment for success or failure
8. Rehearsing and memorizing	Statements indicating student-initiated efforts to memorize material by overt or covert practice
9-11. Seeking social assistance	Statements indicating student-initiated efforts to solicit help from peers (9), teachers (10), and adults (11)
12-14. Reviewing records	Statements indicating student-initiated efforts to reread tests (12) notes (13), or textbooks (14) to prepare for class or further testing
15. Other	Statements indicating learning behavior that is initiated by other persons such as teachers or parents, and all unclear verbal responses

In particular, the development of a ubiquitous learning with mobile and smart device and a wide spread of OER movements promote global learners to voluntarily and informally participate in the OER contents including OCWs and MOOCs with mobile device (Johnson, Adams Becker, Cummins, Estrada, Freeman & Ludgate, 2013).

Among such OER and OCW environments, MOOCs are recently becoming the most prestigious global learning platforms to provide global learners with an opportunity to encourage informal learning. However, in spite of various educational benefits of MOOCs, they have also revealed a critical weakness to students who lack SRL strategies. As discussed earlier, it was reported that only 7 percent of the students completed and earned a certificate of the course they signed on, even though a great deal of students enrolled on such global MOOCs. It is reported by Littlejohn, Hood, Milligan, and Mustain (2016) that MOOC learners who were either high or low in self-regulation and identified behavioral differences between the two groups in regards to SRL sub-processes, including motivations and goal setting. Since MOOC learners study alone and keep learning without direct encounter or touch with teachers and colleagues, MOOCs platforms as the other online learning environments require that students should be more self-regulated or autonomous during learning compared to the offline classroom environment. Therefore, MOOC students with lower ability of SRL will easily feel bored or frustrated and then face a crisis of dropouts.

In particular, according to Hood, Littlejohn, and Milligan (2015), MOOCs learning environments differ from traditional e-learning as follows. Firstly, due to the massiveness, diverse learners from different backgrounds and motivations participated in MOOCs. Secondly, peer interactions are more focused than interactions with tutors, meaning that learners take more responsibility for their self-regulated or self-directed learning. Finally, learning behaviors on MOOCs shows the lack of the linear, standardized learning navigation and progression since learners have different learning backgrounds and objectives. Previous research

examining SRL in non-formal contexts like MOOC learning environments suggests that the ability of learners to self-regulate their learning is more important than in formal learning situations. The reason is because the MOOC learners have to determine their own learning achievement and to regulate their learning behaviors to complete them (Fontana, Milligan, Littlejohn, & Margaryan, 2015; Milligan & Littlejohn, 2014; Redecker, Leis, Leendertse et al., 2011).

From this account, participation on such MOOCs platforms might ask learners to have more SRL strategies to complete or achieve their own learning objectives. Therefore, it shows an implication that MOOCs platforms should consider an instructional prescriptions or designs to promote learner's SRL strategies during learning. In these respects, this study intends to investigate what are effective SRL strategies to complete a MOOC and how MOOC platform can help online learners be empowered to apply SRL strategies based on information or data of learning analytics.

Learning analytics

As an effort to increase learning achievement and performance of LMS on the basis of big data generated in educational fields, adaptive learning technologies and learning analytics have been under much discussion (Johnson et al., 2015; Johnson et al., 2016). Educational data mining is concerned with developing a new algorithm or model through new patterns of big data based on information statistics, machine learning, and data mining (Romero, Ventura, Pechenizkiy, & Baker, 2010). However, learning analytic based upon information science, sociology, psychology, statistics, computer science and education is an emerging discipline which is trying to analyze problems related to learning and apply instructional treatments, methods and models automatically (Simens & Baker, 2012). Therefore, this study has a closer relationship with learning analytics based on big data drawn from MOOCs platform for its attempts to analyze activities which learners experienced during

their SRL.

Learning analytics is the measurement, tracking, collection, analysis, reporting and treatment of technological data about learners' behaviors and states in their learning contexts (Johnson et al., 2016; Park & Cho, 2014; Romero & Ventura, 2007). It has a purpose of recognizing their learning status by learners' behaviors and reactions and enhancing the learning outcomes with optimized instructional treatments. Such learning analytics enables the learning management system (LMS) to diagnose potential learning problems or difficulties on the basis of the actual learning history and activity data. Learning analytics is a technology providing an individualized learning experience and service by collecting the large amounts of various users/learners' activity data (big data) and then analyzing their learning style, tendency or preference. Thus, the application of learning analytics to MOOCs environments, it is possible to provide the most suitable online education platform to students with more personalized learning environments. Compared to classroom environments, MOOCs environments claim students as self-regulated or autonomous learners. On this account, MOOCs environments should make students with lower ability of SRL experience responsive and individualized learning when they engage with mobile and online MOOCs platform as the benefits of learning analytics Therefore, based on the meaningful big data extracted from MOOCs platform, it is necessary to recognize cognitive, affective and social states of learners and offer learning analytics algorithm as an optimal instructional treatment which leads to learning persistence and success.

Previous studies (Biswas et al., 2014) related to adaptive technologies and SRL usually dealt with intelligent tutoring system (ITS) by enhancing meta-cognitive aspects or domain-specific strategies to promote SRL. However, it is rare to provide domain-independent information about learner’s behaviors or preferences to facilitate SRL. In this respect, this study tried to investigate instructional methods to improve SRL in MOOC environments by utilizing the characteristics of the learning analytics and the functions of the learning analytics extracted from the extant MOOCs platforms.

Methodologies

Research design & participants

In order to develop and validate design guidelines for facilitating SRL in MOOCs learning environments, the following procedures were conducted in this study.

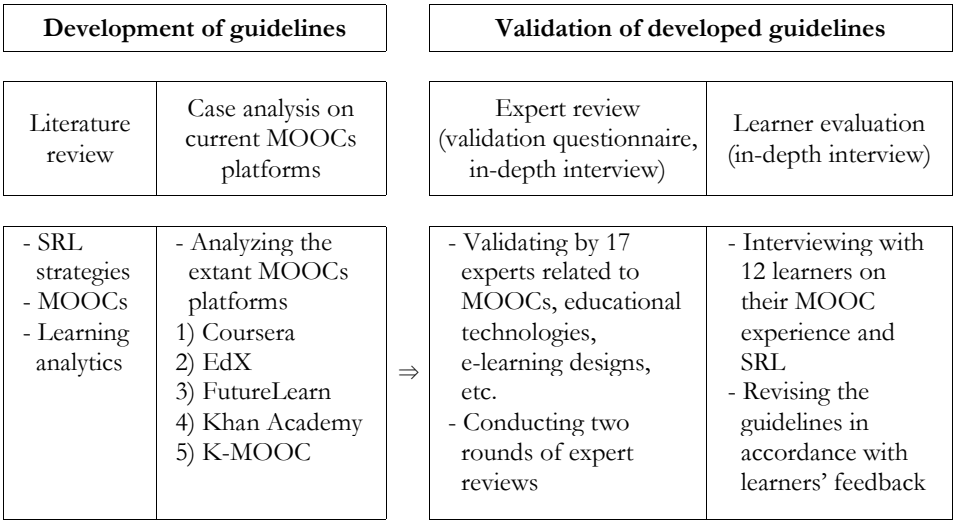


Figure 1. Research procedure

First of all, design guidelines were developed based on previous studies about SRL strategies by Zimmerman & Martinez-Pons (1986) and design guidelines to promote SRL strategies on the use of OER (Cha & Park, 2013). Then, case analysis were conducted to identify the design guidelines samples related to SRL applied on current global MOOCs platforms by using the first draft of the design guidelines developed in this study. To validate the developed guidelines, two empirical studies were conducted with both experts and learners. First of all, expert panel reviews were conducted to validate the overall guidelines and each of them and then interviews with students who had learning experiences with MOOCs were conducted to identify such SRL strategies on global MOOCs.

Instrument

Based on theoretical foundations and case analysis, the first draft of design guidelines was induced as follows.

Table 2. Design guidelines to promote SRL strategies

Categories of strategies	Definition	OER design strategies (Cha & Park, 2013)	Design guidelines for MOOCs [Providing information through learning analytics on as follows]
(Zimmerman & Martinez-Pons, 1986, p618)			
1. Self-evaluation	Statements indicating student-initiated evaluations of the quality or progress of their work	Providing a chance to reflect themselves	1.1 Learner's reflections
		Management of learning through e-portfolio systems	1.2. Learning history (achievements, progress, activities, e-portfolio, etc.)
2. Organizing and transforming	Statements indicating student-initiated overt or covert rearrangement of instructional materials to improve learning,	Providing a chance to revise the contents	2.1. Learner's preferred contents types (video clips, texts, images, voices, etc.)
		Using the authoring functions on the contents	2.2. Student's participant activity records to upload and author contents
3. Goal-setting and planning	Statements indicating student setting of educational goals or sub-goals and planning for sequencing, timing, and completing activities related to those goals	Management of their own schedules and learning objectives	3.1. Setting learning plans and objectives and following the plans
		Monitoring their own learning patterns and schedules	3.2. Monitoring learner's plans, styles, and patterns
4. Keeping records and monitoring	Statements indicating student-initiated efforts to record events or results	Providing notes to learners	4.1. The use of notes, the records of student's learning activities and study (searching and downloading, printing)
		Using interactive tools	
5. Rehearsing and memorizing	Statements indicating student-initiated efforts to memorize material by overt or covert practice	Providing exercises and learning activities	5.1. Exercise, discussions, handouts, and submission of homework, etc.

Table 2. Design guidelines to promote SRL strategies (continued)

Categories of strategies	Definition	OER design strategies (Cha & Park, 2013)	Design guidelines for MOOCs [Providing information through learning analytics on as follows]
(Zimmerman & Martinez-Pons, 1986, p618)			
6. Reviewing records	Statements indicating student-initiated efforts to reread tests notes, or textbooks to prepare for class or further testing	Constant reviewing and management of their own profile	6.1. Learner's efforts to learning activities and exercises
7. Seeking information	Statements indicating student-initiated efforts to secure further task information from nonsocial sources when undertaking an assignment	Providing a chance to search information they need	7.1. References and links referred by learners
8. Environmental structuring	Statements indicating student-initiated efforts to select or arrange the physical setting to make learning easier	Providing clouds computing service to overcome time and place limitations	8.1. Physical environments where learners are using MOOCs
		Providing UI with consideration of user experience	8.2. Personalized UI/UX contexts (learner's UI/UX preferences)
9. Seeking social assistance	Statements indicating student-initiated efforts to solicit help from peers, teachers, and adults	Providing social helps with web bulletin boards	9.1. Contact or social helps to tutors, peers, assistants, and system operators
		Providing social helps on mobile device	9.2. Q&A or discussions to overcome problems or solve the problems
10. Self-consequences	Statements indicating student arrangement or imagination of rewards or punishment for success or failure		10.1. History of certificates or credits earned
			10.2. Enrolled and completed rates of courses monthly or annually

A questionnaire was developed to ask experts' opinions based on the design guidelines shown in Table 2. Regarding learner's opinions and experiences with MOOCs related to SRL, the unstructured interviews were conducted. The interview objective was explained in details and the interviewer facilitated interviewee based on the design guidelines shown in Table 2 when the interviewee had silence for a

long period.

Participants

The questionnaire was distributed to a panel of 17 experts in two rounds. In the second round, an anonymous summary of the experts' opinions and mean values on 5-likerts from the first round were provided. The following table 3 summarized the experts profile to participate in the validation of the design guidelines. The experts were recruited based on the criteria established for selection. The criteria were as follows: 1) PhD in Educational Technology or 2) PhD candidates experienced research in MOOC or e-learning designs more than 7 years. Most of experts are professors or researchers related to the e-learning design.

Table 3. Experts profiles

Expert	Academic areas involved in (MOOCs /SRL research or study experience)	Occupation or positions	Academic career	1st Expert review	2nd Expert review
Expert A	E-learning and instructional design	Assistant professor	PhD, 10 years	√	-
Expert B	E-Learning, engineering education design	Research Assistant professor	PhD, 10 years	√	√
Expert C	HCI, MOOCs design and research, learning science	Assistant professor	PhD, 12 years	√	√
Expert D	Instructional media, digital textbooks	Assistant professor	PhD, 12 years	√	-
Expert E	IMS LD, e-learning design	Research Assistant professor	PhD, 10 years	√	-
Expert F	E-learning, MOOCS, UI/UX	Researcher	PhD, 10 years	√	√
Expert G	M-learning, technology & instruction	Teacher	PhD candidate, 10 years	√	√

Table 3. Experts profiles (continued)

Expert	Academic areas involved in (MOOCs /SRL research or study experience)	Occupation or positions	Academic career	1st Expert review	2nd Expert review
Expert H	Engineering education design, STEAM education	Research Assistant professor	PhD, 13 years	√	√
Expert I	Game-based learning, instructional design	Researcher	PhD, 12 years	√	-
Expert J	MOOCs design, e-learning design	Researcher	PhD candidate, 8 years	√	√
Expert K	E-learning and CSCL, online learning environments	Researcher	PhD candidate, 7 years	√	√
Expert L	Instructional design	Teacher	PhD candidate, 20 years	√	√
Expert M	Instructional design, teacher's education	Researcher	PhD, 18 years	√	√
Expert N	MOOCs and e-learning design and management	Research professor	PhD, 15 years	√	√
Expert O	Instructional design e-learning design and management	Researcher	PhD candidate, 10 years	√	√
Expert P	Online PBL system, e-learning design	Professor	PhD, 8 years	√	√
Expert Q	Visual/image design, web design, e-learning UX/UI design	Professor	PhD candidate, 13years	√	-
Expert R	Online CPS system, e-learning and instructional design	Visiting professor	PhD 7 years	√	√

In addition, the student's profile who participated in the interview is also shown in Table 4. When the students are recruited, snowball sampling (Breslow, Pritchard, DeBoer, Stump, Ho, & Seaton, 2013) was employed since it was not easy to find the students who took courses in MOOCs. This snowball sampling is

recommended when the "hidden population (p. 330)" should be obtained (Noy, 2008). Even if MOOCs have been popularized in the world, recruiting participants who had an experience in MOOCs and are appropriate for this study were more accessible through snowball sampling.

Table 4. Students profiles

Learner	Academic career	Age	Gender	MOOC Experience		No of completed MOOCs
				No of MOOCs	MOOC Platforms	
Learner A	Master	26-30	M	2-5	EdX Futurelearn	No
Learner B	Master	26-30	F	2-5	Coursera	No
Learner C	Master	26-30	M	More than 5	EdX	3 courses
Learner D	Undergraduate	26-30	F	2-5	EdX	No
Learner E	Master	26-30	F	2-5	EdX K-MOOC	No
Learner F	Master	31-35	M	2-5	EdX Coursera K-MOOC	No
Learner G	Undergraduate	21-25	F	2-5	EdX Coursera K-MOOC	No
Learner H	Undergraduate	26-30	F	2-5	EdX Coursera Futurelearn	No
Learner I	Undergraduate	31-35	M	2-5	EdX Coursera Futurelearn	3 courses
Learner J	Undergraduate	21-25	F	2-5	EdX K-MOOC	No
Learner K	Master	26-30	F	2-5	EdX Coursera	No
Learner L	Master	26-30	F	2-5	Coursera	No

Data collection & analysis

To supplement the first draft of design guidelines, data from case analysis on global MOOCs platforms such as edX and Coursera and local MOOC platform, K-MOOC, were collected by applying the design guidelines as evaluation criteria.

For the expert panel reviews, a five-point Likert-type scale was utilized with one indicating 'highly invalid' and five indicating 'highly valid'. In addition, comments and feedbacks on each item of the design guidelines were requested. Data from two rounds of the questionnaire were analyzed with descriptive statistics by using SPSS. The descriptive statistics include the mean value, the maximum-minimum value, and standard deviation. Theses values from the first round were shared and reviewed in the second round to determine consensus.

Lastly, data from in-depth interviews with learners recruited for the qualitative study were analyzed according to thematic analysis process which was suggested by Marshall and Rossman (1999). The six main phases were followed: 1) organizing the data by creating transcripts of learners' interview by reading the data many times, 2) generating categories or themes, 3) coding the data, 4) testing emergent understandings of the data with each other, 5) searching for alternative explanations of the data and finally 6) writing up the data analysis.

Results

Analyzing the five representative extant MOOC platforms

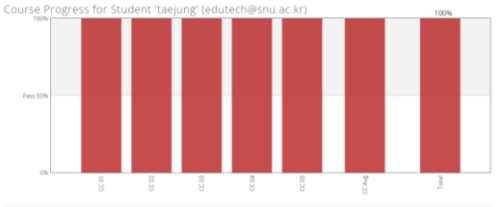
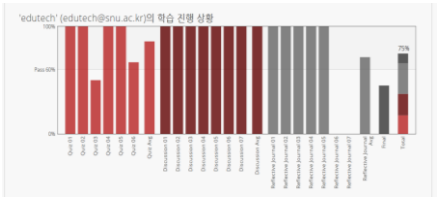
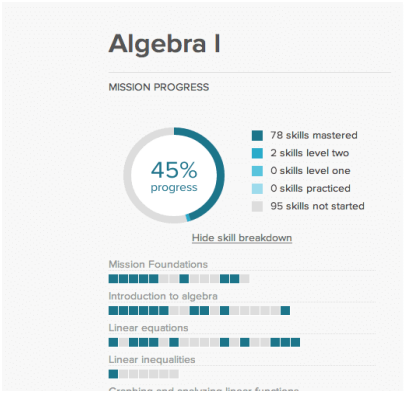
We analyzed and evaluated the domestic and foreign developed MOOCs platforms based on the first draft of the design guidelines developed as the evaluation criteria. The following table 5 shows the analysis results in edX, K-MOOC, Coursera, Khan Academy, and FutureLearn according to each item from the design guidelines as the evaluation criteria.

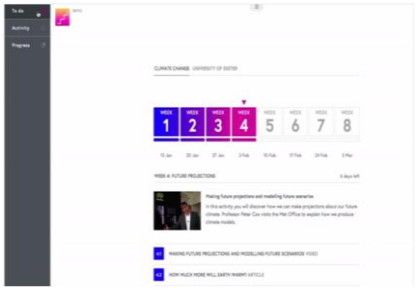
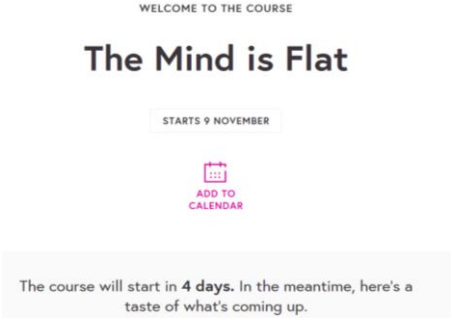
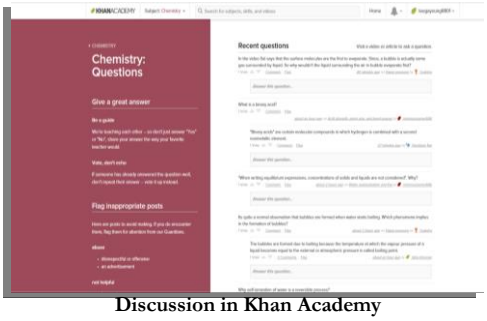
Table 5. Matching the design guidelines with the information related to learning analytics which selected MOOC platforms offer

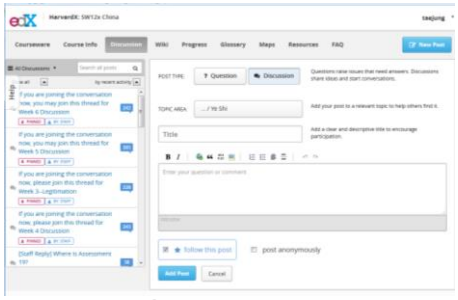
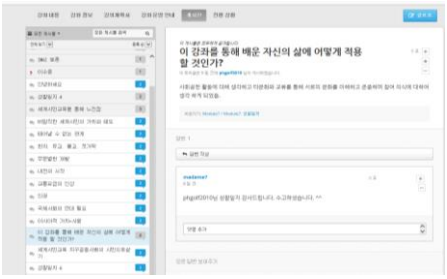
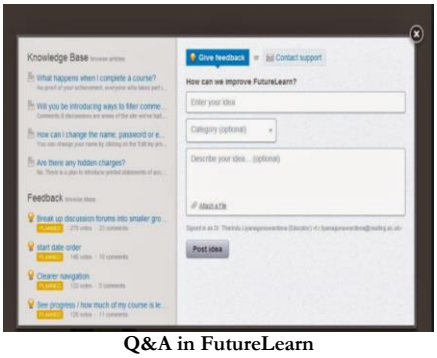
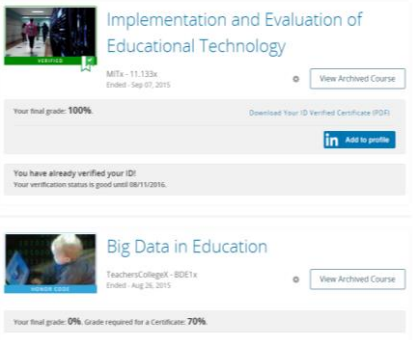
Dimensions of SRL strategies	Design guidelines for facilitating SRL in MOOCs learning environments	EdX	K-MOOC	Coursera	Khan Academy	Future Learn
1. Self-evaluation	1.1. learner's reflections	X	X	X	X	X
	1.2. Learning history (achievements, progress, activities, e-portfolio, etc.)	O	O	X	O	X
2. Organizing and transforming	2.1. Learner's preferred contents types (video clips, texts, images, voices, etc.)	X	X	X	X	X
	2.2. Student's participant activity records to upload and author contents	X	X	X	X	X
3. Goal-setting and planning	3.1. Setting learning plans and objectives and following the plans	X	X	X	X	X
	3.2. Monitoring learner's plans, styles, and patterns	X	X	X	X	O
4. Keeping records and monitoring	4.1. The use of notes, the records of student's learning activities and study (searching and downloading, printing)	X	X	X	X	X
5. Rehearsing and memorizing	5.1. Exercise, discussions, handouts, and submission of homework, etc.	X	O	X	O	X
6. Reviewing records	6.1. Learner's efforts to learning activities and exercises	X	X	X	X	X
7. Seeking information	7.1. References and links referred by learners	X	X	X	X	X
8. Environmental structuring	8.1. Physical environments where learners are using MOOCs	X	X	X	X	X
	8.2. Personalized UI/UX contexts (learner's UI/UX preferences)	X	X	X	X	X
9. Seeking social assistance	9.1. Contact or social helps to tutors, peers, assistants, and system operators	O	X	X	O	O
	9.2. Q&A or discussions to overcome problems or solve the problems	O	O	O	O	O
10. Self-consequences	10.1. History of certificates or credits earned	O	O	O	O	O
	10.2. Enrolled and completed rates of courses monthly or annually	X	X	X	O	X

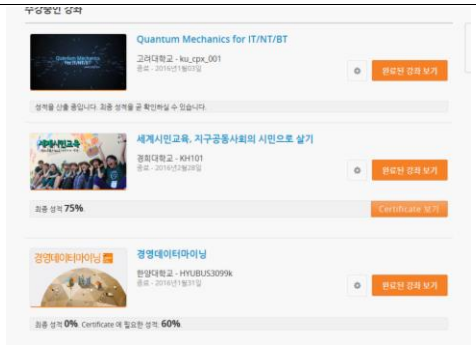
As shown in Table 5, only 7 out of 16 items on the design guidelines were identified from analyzed 5 MOOCs platforms. From the results, it can be indicated that the extant MOOCs platforms have been designed and developed to help learners do planning, rehearsing and memorizing, seeking social assistance, and self-consequences rather than self-evaluation, organizing and transforming, keeping records and monitoring, reviewing records, and environmental structuring.

Table 6. Screenshots of MOOC platforms offering the information related to learning analytics for improving SRL

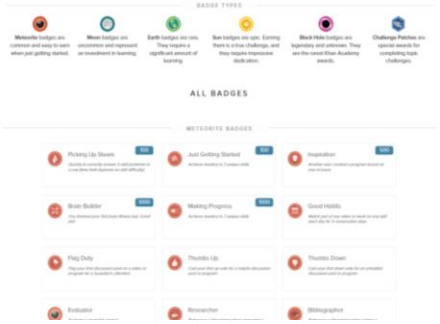
Dimensions of SRL strategies	Design guidelines for facilitating SRL in MOOCs learning environments	Screenshots of MOOC platforms offering the information related to learning analytics
1. Self-evaluation	1.2. Learning history compared to peers (achievements, progress, activities, e-portfolio, etc.)	 **Learning progress in edX**  **Learning progress in K-MOOC**  **Learning map in Khan Academy**

		 **Learning progress in FutureLearn**
3. Goal-setting and planning	3.1. Monitoring learner's plans, styles, and patterns	 **"To do" in FutureLearn**  **Add to calendar in FutureLearn**
5. Rehearsing and memorizing	5.1. Exercise, discussions, handouts, and submission of homework, etc.	 **Discussion in Khan Academy**

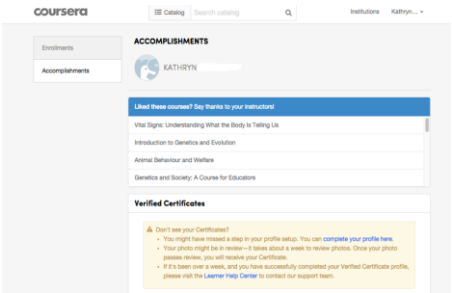
		 **Discussion in edX**
9. Seeking social assistance	9.2. Q&A to overcome problems or solve the problems	 **Q&A in K-MOOC**  **Q&A in FutureLearn**
10. Self-Consequences	10.1. History of certificates or credits earned	 Certificates in edX



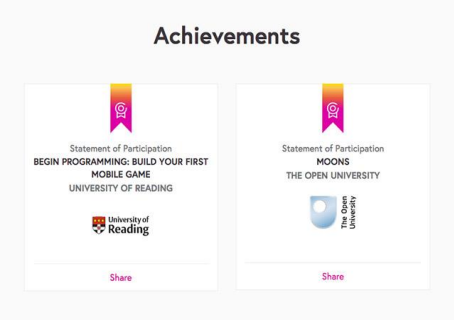
Certificates in K-MOOC



Badges in Khan Academy



Certificates in Coursera



Certificates in FutureLearn

Results of the 1st round expert panel review

The questionnaires in the first round were developed based on a comprehensive literature review and case analysis on current representative examples of global MOOCs platforms as described in the instrument section of the methodology. The questions on the first round consisted of 5-point Likert-rating scales on each item in order to determine the validation of the design guidelines for learning analytics to promote SRL on MOOCs. As shown in Table 7, 13 items on the guidelines were rated with 4-point above. Only 4 items were rated with 4-point below.

Table 7. Expert review results in the 1st round

Dimensions of SRL strategies	Design guidelines for facilitating SRL in MOOCs learning environments	Expert validation			
		M	Max value	Min value	SD
1. Self-evaluation	1.1. Learner's reflections	4.3	5	v	1.07
	1.2. Learning history compared to peers (achievements, progress, activities, e-portfolio, etc	4. 8	5	3	0.55
2. Organizing and transforming	2.1. Learner's preferred contents types (video clips, texts, images, voices, etc.)	4.2	5	3	0.62
	2.2. Student's participant activity records to upload and author contents	4.0	5	2	0.91
3. Goal-setting and planning	3.1. Setting learning plans and objectives and following the plans	4.7	5	3	0.59
	3.2. Monitoring learner's plans, styles, and patterns	4.7	5	3	0.57
4. Keeping records and monitoring	4.1. The use of notes, the records of student's learning activities and study (searching and downloading, printing)	4.4	5	2	0.78
5. Rehearsing and memorizing	5.1. Exercise, discussions, handouts, and submission of homework, etc.	4.3	5	4	0.51
6. Reviewing records	6.1. Learner's efforts to learning activities and exercises	4.3	5	3	0.67
7. Seeking information	7.1. References and links referred by learners	4.4	5	3	0.62
8. Environmental structuring	8.1. Physical environments where learners are using MOOCs	3.9	5	3	0.83
	8.2. Personalized UI/UX contexts (learner's UI/UX preferences)	3.9	5	3	0.76
9. Seeking social assistance	9.1. Contact or social helps to tutors, peers, assistants, and system operators	3.9	5	3	0.83
	9.2. Q&A or discussions to overcome problems or solve the problems	4.2	5	3	0.71
10. Self-Consequences	10.1. History of certificates or credits earned	4.2	5	3	0.65
	10.2. Enrolled and completed rates of courses monthly or annually	4.7	5	4	0.46

Results of the 2nd round expert panel reviews

The questionnaires in the second round sent out to the 12 experts as in the first round with the results of the first round and the mean value of each item on the guidelines. Based on the results of the first round, 4 items on the guidelines rated with 4-point below were eliminated. Table 8 shows the group means for the 2nd Round.

Table 8. Expert review results in the 2nd round

Dimensions of SRL strategies	Design guidelines for facilitating SRL in MOOC environments	Expert validation			
		M	Max value	Min value	SD
1. Self-evaluation	1.1. Content analysis of learner's reflections	4.6	5	2	0.90
	1.2. Learning history (achievements, progress, activities, e-portfolio, etc.)	4.8	5	3	0.39
2. Organizing and transforming	2.1. Learner's preferred contents types (video clips, texts, images, voices, etc.)	4.3	5	3	0.75
	2.2. Student's participant activity records to upload and author contents	3.8	5	2	0.62
3. Goal-setting and planning	3.1. Setting learning plans and objectives and following the plans	5.0	5	3	0.47
	3.2. Monitoring learner's plans, styles, and patterns	4.6	5	3	0.67
4. Keeping records and monitoring	4.1. The use of notes, the records of student's learning activities and study (searching and downloading, printing)	4.2	5	2	0.94
5. Rehearsing and memorizing	5.1. Exercise, discussions, handouts, and submission of homework, etc.	4.6	5	4	0.51
6. Reviewing records	6.1. Learner's efforts to learning activities and exercises	4.5	5	3	0.67
7. Seeking information	7.1. References and links referred by learners	4.2	5	3	0.58
8. Seeking social assistance	8.1. Q&A or discussions to overcome problems or solve the problems	4.3	5	3	0.49
9. Self-consequences	9.1. History of certificates or credits with invested time and earned achievement scores	4.5	5	3	0.52
	9.2. Enrolled and completed rates of courses monthly or annually	4.9	5	4	0.29

In addition to the 2nd questionnaire, twelve experts provided opinions on the guidelines. According to experts' comments, the design guideline 1.1. and 9.1. were revised for more elaborate and clear descriptions. In accordance with comments of expert A, C, D, and F, the design guideline 1.1. was revised as "Content analysis of learner's reflections". The guideline 9.1. was revised as "History of certificates or credits with invested time and earned achievement scores" based on comments of expert E, H, and P.

Results of the learner interview analyzed

To examine learners' perceived learning experiences in MOOCs, in-depth interviews with 12 MOOC learners were analyzed. Regarding the MOOCs learning experience, two categories for the analysis of interview transcripts were developed. The two categories consist of experienced difficulties and helpful factors for SRL in MOOC learning environments.

All of students mentioned their difficulties in learning by utilizing MOOCs with self-regulation strategies. Even students with some certificates from MOOCs courses (Learner C and L) who successfully participated in and completed required learning activities indicated their hardship in persisting learning. Over half of them (Learner C, E, F, G H, I, and L) felt that factors to help them engage in self-regulatory learning activities were insufficient in MOOCs platforms.

In terms of suggestions and feedbacks on MOOCs improvements to help to facilitate SRL strategies, as summarized in Table 10, it was analyzed that some of suggestions and feedbacks coincided with the design guideline 2.1, 2.2, 3.2, 4.1, 5.1, 6.1, 7.1, and 9.2 developed in this study. The participants also suggested that they receive more detailed quantitative or qualitative information concerning all of their learning progress in learning activities and materials. Furthermore, some of participants expect more personalized learning environments according to their level, preference, and learning styles or patterns. In particular, it was found that

over half of them prefer to social comparison in terms of learning progress and referred learning materials. In summary, the interview results suggest that learning analytics designs related to learning progress reports, personalization, and social comparisons should be considered in order to facilitate SRL strategies for students in MOOCs.

Table 9. Learners' feedback / comments on their learning experience in MOOCs

Category	Learner comments	No of students	Students
Reasons for the difficulties of SRL in a MOOC platform	Low intrinsic / Extrinsic motivation	5	D, E, H, I, J
	Hard to manage time/Schedule	4	A, B, C, D
	Due to the characteristics of online learning that anyone can study anytime, anywhere, and free of charge,	4	C, F, H, K
	Indirect(or little) personal contact or interaction	3	G, I, L
	Few/No support functions to SRL	1	A
	Difficult to monitoring learning progress	1	B
	Not appropriate for individual learning style	1	L
Helpful factors for SRL in a MOOC platform you experienced	Supporting learning planning through progress check	5	A, B, D, I, K
	Intrinsic / Extrinsic motivation	3	E, F, I
	Requesting and providing a peer help or review /feedback	2	A, C
	Internet search	2	C, H
	Active participation in learning activities	2	H, L
	Utilizing various learning materials	1	G
	Selective in choosing lecture video /materials	1	J

Table 10. Factors that learners suggested to design/develop MOOC platform for SRL

Category	Learner's feedback	No of students (Students)	Matching with design guidelines
Learning progress	Showing individual learning progress/ achievement and certification or	12 (A~L)	1.2 9.2
Learning planning	Supporting self-directed learning planning and monitoring for time management	12 (A~L)	3.1, Time management
Records of learning activities	Detailed reports on learning logs and records of learning activities quantitatively and qualitatively	10 (B~K)	4.1 5.1 6.1
	Qualitatively analyzing learning logs and records of learning activities	2 (A, L)	
Learning materials	Analyzing content of referenced learning materials which each student and others used qualitatively	5 (B, D, E, J, L)	7.1
	Detailed reports of referenced learning materials which each student and others used quantitatively	3 (A, F, H)	
	Recommending useful references or books	1 (K)	
Preference	Informing preferred learning activity types or recommending courses with them (discussion, quiz, reflective journals etc.)	8 (A, B, D, E, F, G, I, L)	2.1 3.2
	Informing preferred content types (video clips, texts, images, voices, etc.) or recommending courses with them	7 (B, D, F, G, I, K, L)	
Personalization	Recommending courses of interest themes or lecturers	4 (B, C, D, J)	Additional suggestion
	Recommending courses suitable for each learner' level	2 (A, L)	
	Providing feedback appropriate for individual learning styles/patterns	1 (A)	
	Informing each student' reasons for not completing the course	1 (L)	
Social comparison	Analyzing individual learning styles/patterns through comparing with peers' learning progress /achievement	7 (C, F, G, H, I, J, K)	1.2, Social comparison
	Offering learning materials that others referred to	2 (B, D)	7.1, Social comparison
Miscellaneous(Tools)	Mobile push-ups (Informing new notice & discussion posts, telling learning time set	3 (B, D, K)	Not learning analytics, but additional functions and tools
	Providing interaction tools through VR, video conferencing etc.	2 (I, L)	

Finalizing the design guidelines

The design guidelines were revised based on both results from the expert reviews to validate the guidelines and interviews for learners' opinions. Table 11 shows the final version of design guidelines of learning analytics to facilitate SRL strategies in MOOCs. According to learners' responses to the question "which information do you want to be offered by MOOC platforms for SRL", the design guideline 1.2, 3.1, 4.1, 5.1, 6.1, and 7.1 are revised and the guideline 10.1 and 10.2 are added as shown in Table 11.

Table 11. Final design guidelines to facilitate SRL in MOOCs learning environments

Dimensions of SRL strategies	Final design guidelines for facilitating SRL in MOOC environments (Providing information through learning analytics on as follows)
1. Self-evaluation	1.1. Content analysis of learner's reflections
	1.2. Learning history compared to others (achievements, progress, activities, e-portfolio, etc.)
2. Organizing and transforming	2.1. Learner's preferred contents types (video clips, texts, images, voices, etc.)
	2.2. Student's participant activity records to upload and author contents
3. Goal-setting and planning	3.1. Setting learning objectives and plans for effective time management
	3.2. Monitoring learner's plans, styles, and patterns
4. Keeping records and monitoring	4.1. Records of student's learning activities such as note-taking, searching, downloading, and printing
5. Rehearsing and memorizing	5.1. Details about participation in the exercise, discussion, homework, etc.
6. Reviewing records	6.1. Quantitative and qualitative analysis of learning exercise such as quiz, discussions and exams for reviewing
7. Seeking information	7.1. References and links referred by learners and others
8. Seeking social assistance	8.1. Q&A to overcome problems or solve the problems
9. Self-consequences	9.1. History of certificates or credits with invested time and earned achievement scores
	9.2. Enrolled and completed rates of courses monthly or annually
10. Structuring personalized learning environments	10.1. Recommending courses for each learner's level or interest
	10.2. Feedback on learning success and failure appropriate for individual learning styles or patterns

Discussion and Conclusion

In recent years, as MOOCs become a big issue which attracts a variety of global learners, the number of platforms, courses, learners in MOOCs has been rapidly increasing. Even though MOOCs have many benefits such as openness, interactivity, autonomy, etc., MOOCs have shown a weakness for the lower rate of completion and the higher rate of dropouts (Anderson, 2013; Kizilcec et al., 2015; Parr, 2013; Wang & Baker, 2015). In this regard, this study suggests a solution by applying learning analytics to MOOCs platforms in order to facilitate SRL strategies for students who have a learning objective to earn a certificate or to increase a success rate of courses in MOOCs. Therefore, MOOCs platforms might consider providing information or customized instructional services to promote student's SRL strategies.

From this perspective, design guidelines for learning analytics in MOOCs learning environments to facilitate SRL strategies were developed in this study. For the research objective, first of all, the first draft of design guidelines were developed on the foundations of SRL strategies by Zimmerman & Martinez-Pons (1986) and design guidelines to promote SRL strategies on the use of OER (Cha & Park, 2013). In addition, current global MOOCs platforms were analyzed to supplement the design guidelines. Then, to validate the design guidelines, two rounds of expert panel reviews and learners' interviews were conducted. Overall, the final version of design guidelines on learning analytics to facilitate SRL strategies was suggested.

Overall, based on the results from this study, several implications have been derived, which will be discussed as follows. First of all, the results of the case analysis shows that current global and local MOOCs platforms are not providing appropriate information on learning analytics for students who lack SRL strategies. However, MOOCs platforms should consider personalized learning services or feedbacks for students who set the goals to complete the course or increase the success rate of receiving certificates and for minimizing dropout rates (Daniel,

2012; Yousef et al., 2014; Yousef et al., 2015).

Second, the design guidelines developed on the foundations of SRL strategies by Zimmerman & Martinez-Pons (1986) and design guidelines to promote SRL strategies on the use of OER (Cha & Park, 2013) were finalized through the validation process by both experts and learners. The final design guidelines suggest that students take advantage of the information related to planning, rehearsing and memorizing, seeking social assistance, and self-consequences, self-evaluation, organizing and transforming, keeping records and monitoring, reviewing records, and environmental structuring in online learning environments to promote SRL strategies (Zimmerman & Martinez-Pons, 1986).

Finally, the results of interview revealed that the social comparisons, learning progress reports, and personalization might contribute to promoting SRL strategies and completing the courses in MOOCs learning environments. As Horizon reports introduced for several years (Johnson et al., 2013; Johnson et al., 2015; Johnson et al., 2016), it is anticipated that adaptive technologies and learning analytics might be a big impact on online learning environments. Therefore, it can be argued that the MOOCs platforms designers and the providers should consider such state-of-the-art technologies and the design guidelines developed in this study in terms of SRL strategies to deal with the problems with high dropouts and sustainability of the platforms. As shown in the results, the design guidelines are more focused on meaningful data to be analyzed according to learner's learning behaviors and preferences in terms of SRL strategies. In fact, most of instructional design interventions or design strategies to promote SRL in the traditional e-learning environments were usually given a form of prompts or guided tasks, or training programs (Cho, 2004; Rowe & Rafferty, 2013) based on the results of SRL strategies Zimmerman and Martinez-Pons (1986) made. However, this study has a meaningful implication on the design guidelines developed from the learning analytics perspective, having a difference that the information and data to facilitate SRL strategies will be automatically offered by MOOCs learning environments

customized on learner's activities.

However, in spite of the difference, it has also a limitation that this study dealt with an analysis part on the learning analytics to promote SRL in MOOC environments, but not prescriptive part to provide instructional interventions for the improvement of SRL strategies. Therefore, it is suggested that further study aims to develop guidelines for prescriptions or instructional interventions on how to promote SRL by utilizing the data and information provided based on the analysis of SRL from the results of this study. In addition, it has another limitation that the design guidelines on the application in a real context could not be validated. For future study, after the design guidelines are applied to the MOOCs platforms, the effectiveness of SRL strategies should be evaluated, and then the design guidelines should be revised and modified.

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