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Development of MOOCs Interface for Supporting Learner Motivation

학습자 동기 부여 지원을 위한 MOOCs 인터페이스 개발

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Abstract

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With the development of information and communication technology (ICT), many people get educated not only in traditional classrooms but also online nowadays. As one way of online education, the market of MOOCs (Massive Open Online Courses) has been growing continuously since the first platform was opened to the public in 2012. Today in 2021, the number of MOOCs learners has reached up to 220 million, and MOOCs are playing an irreplaceable role in higher education, lifelong education, corporate education, etc.

Although we can expect that MOOCs will become increasingly important in the field of education, with its rapid growth during the last decade, some issues of it have been exposed. One of the issues is the low completion rate. Compared to traditional education, MOOCs learners are reported more likely to drop out, which leads to the average completion rate at around 10%. According to previous studies, one of the reasons that causes this phenomenon is lacking motivation.

As a part that interacts directly with users of an application, interface is crucial because it offers affordance and determines the way users use the application. And the interface becomes even more important when it comes to E-learning because motivators, which can affect learners' motivation, can be designed in the user interface.

However, studies have shown that the current interface design of MOOCs lacks motivation factors and fails to facilitate interactive communication among MOOCs learners. Therefore, in this research, a MOOCs interface that focuses on improving learners' motivation was designed. To achieve this goal, the research questions considered were: 1) What are the interface design guidelines and interface functions to motivate MOOCs learners to sustain their learning? 2) What is the interface to motivate MOOCs learners to sustain their learning? and 3) What are the learners' responses to the interface?

To answer the research questions, the type 1 design and development methodology proposed by Richey and Klein was followed. First, MOOCs interface design guidelines were derived by literature review and followed by 2 rounds of expert review conducted by 4 experts to ensure the internal validity. Second, a prototype of MOOCs interface was designed based on the guidelines by using prototyping tool Figma. Third, the prototype was given to 5 learners along with a series of tasks for learner response tests to ensure the external validity of the design guidelines, and based on the result, both the prototype and the guidelines were revised.

The final version of the MOOCs interface design guidelines consists of 3 motivational design principles (Autonomy, Competence, and Relatedness) , 12 motivational design guidelines (5 autonomy-supported, 4 competence-supported, and 3 relatedness-supported) along with 34 design guidelines developed for MOOCs interface. Based on these design guidelines, the functions of the MOOCs interface in this research were designed. Based on the autonomy-supported guidelines, functions such as learning mode selection (self-paced, scheduled, premiere), learning group, learning activity, goal setting, dashboard, reminder, recommendation, and feedback were designed. And based on the competence-supported guidelines, functions such as account register, course enrollment, learning path, team activity support, dashboard, and goal setting were designed. Meanwhile, based on the relatedness-supported guidelines, functions such as dashboard, feedback, keyword checklist, learning group, chatting window, group/team activity, course evaluation, team assignment, mind map, and note were designed. The participating learners were satisfied with the design. The survey data showed that learners' general perceptions of the MOOCs interface reached 4.44, perceived autonomy reached 4.40, perceived competence reached 4.52, and perceived relatedness reached 4.66 (5 points Likert scale). The in-depth interview data was open coded into three categories: 1) Advantages of the MOOCs interface, 2) Problems with the MOOCs interface, and 3) Suggestions for improvement. The advantages include providing choices for autonomy support, providing scaffolding and adaptive learning for competence support, providing interactive

learning for relatedness support, and providing novel meanwhile helpful functions that existing platforms don't have. The problems include lacking tutorials for novel functions, inconsistent icons and choice of words, and improper positioning and interaction. The suggestions for improvement include adding the wiki function, adding the reminder function, and visualizing the timetable.

The significance of this research can be summarized as follows: 1) proposed an intrinsic motivation oriented MOOCs interface. 2) introduced three learning modes to the MOOCs learning environment. 3) introduced the learning group and learning team to the MOOCs environment to facilitate learners' interaction. 4) provided an example of the dashboard for the context of MOOCs. And 5) provided insight into how to help learners achieve personalized learning in the MOOCs environment.

Keywords: MOOCs Interface, Motivation, Autonomy-support, Competence-support, Relatedness-support

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Chapter 1. Introduction

1.1. Problem Statement

With the development of information and communication technology (ICT), our daily lives have changed significantly in the past few decades. For example, online shopping sites such as Amazon changed our consumption activities, YouTube changed the way we get information, Paypal changed the way of paying, ZOOM and Google Docs make it possible to corporate online so that people can work at home, etc.

Apart from our daily life, ICT also has a great effect on education, and many educators are getting more and more interested in adopting it in education. By using ICT in education, many concepts emerged, including e-learning, mobile learning, flipped learning, ubiquitous learning, web-based learning, etc. And previous studies have exposed ICT's potential in conducting learner-centered education when used as a tool to support students' learning activities (Cho, Lee, Cho, & Park, 2019; Cho, et al., 2015; Jo, Cho, & Kim, 2019).

Particularly, during the Covid-19 pandemic, ICT played an important role in education because universities were pushed to conduct teaching and learning online (Abdullah, Husin, Haider, 2020). Because of this "Untact" has a high possibility to become the "new normal" in the Post-COVID-19 era in education, so the development of educational platforms becomes an important task (Jeong, No, Jeong, & Cho, 2020).

One important implementation of ICT in education is MOOCs (Massive Open Online Courses). As a form of e-learning, MOOCs started with the movement of universities opening educational materials to the public, and now, MOOCs learners can learn anytime, anywhere they want, as long as they can access the internet (Seo, 2015).

By opening high-quality educational content for anyone to access, MOOCs are meaningful in terms of securing fairness in education and reducing educational gaps (Christensen et al., 2013). In addition, the option is given to learners, so learners can study only the necessary contents according to their needs, which is meaningful in self-development and individualized learning. Besides, researchers have uncovered MOOCs' value for higher education, lifelong education, corporate education, AIED research, etc. (Haron et al., 2019; El-Hmoudova, 2014; Kay et al., 2013; Ong, Jambulingam, 2016).

Nowadays, there are several representative MOOC platforms, which include Coursera, Udacity, edX, xuetangx, and icourse163. According to a report from classcentral (2020), both of those platforms have been growing continuously since they were open to the public.

MOOCs have many advantages for education. However, compared to traditional teaching methods, the history of MOOCs is very short, around 10 years, and It is still at the very early development stage. Many issues were exposed with the rapid growth in the past decade. For example, one of the major issues of MOOCs that has been pointed out by many researchers is the high dropout rate (CHENG, 2019; Kay et al., 2013). In a study by Jordan (2014), the rate of completion

per lecture was statistically calculated, ranging from 0.9% to 36.1%, and the average value was 6.5%. A significant number of students watch the contents of the course once only at the beginning of enrollment or do not watch the contents at all (Balakrishnan, Coetzee, 2013; Ho et al., 2014).

No matter how good educational content was provided, if a learner fails to complete the learning, it will be impossible to achieve the purpose of education. Therefore, it is necessary to make efforts to prevent dropouts and increase the completion rate of MOOCs learners.

1.2. Purpose of the Research

To solve the problem of MOOCs dropout, different approaches have been taken in previous research. For example, some research tried to find out the reasons for MOOCs learners' dropout (Zheng et al., 2015). Some research aimed to discover the influencing factors to MOOCs dropout (Jin, Chi, Gim, 2018; CHENG, 2019; Aparicio et al., 2019). Some research focused on using learning analytics to predict dropout before it happens (Whitehill et al., 2017; Shukor, Abdullah, 2019). And some research focused on improving the quality of MOOCs education, by ensuring that no important factors are omitted from the design of e-learning, thus keeping MOOCs' success (Haron et al., 2019).

As self-directed e-learning (SDEL), for learners of MOOCs, peer learners and instructors are not regularly available. Previous research has suggested that lack of time and motivation are primary causes of learner attrition in online settings (Kim, Frick, 2011).

Because of this, studies were conducted to solve MOOCs dropout from the perspective of motivation (Goopio, Cheung, 2020). For example, Song, Lee (2018) explored learning motivation factors and came up with teaching and learning strategies for MOOCs. Cho, Byun (2015) analyzed the learning patterns by motivation type.

Goopio & Cheung (2020) classified the topics covered by previous studies related to learner dropout and retention strategies into four clusters, which are predictions, persistence intentions, motivations, and exhaustions, and found out that motivation has been considered

critical to deal with MOOCs dropout. Gasevic, Kovanovic, Joksimovic, and Siemens (2014) analyzed proposals from 266 projects which were submitted to the MOOC Research Initiative (MRI) funded by the Gates Foundation and found out that motivation is one of the five main research themes for future MOOCs related research. So in this research, the approach of motivation will be used to solve the problem of MOOCs dropout.

Also, to conduct successful e-learning, interface design for learning (User interface design intended to support learning objectives) is as important as learning design/ instructional design (The design of content and activities created to support learning objectives) (Peters, 2014), because motivation can be designed in the user interface (Ramakrisnan, 2019), and poorly designed interfaces will not intrinsically motivate students to make use of the product or to learn with it (Stoney, & Wild, 1998).

While the problems of existing MOOCs' interface have been exposed by previous studies. Zheng, Rosson, Shih, Carroll (2015) interviewed users of existing MOOCs platforms, and found out that 1) learners feel lonely when they study MOOCs on their own. 2) Although discussion forums are provided by platforms like Coursera, edX, and Udacity, the majority of learners feel the discussion forums failed to facilitate interactive communication. 3) Learners desire to study MOOCs with their friends, and some of them joined or organized local study groups. Ramakrisnan (2019) argued that the current interface design lacks motivation factors to keep learners participating so that

learners tend to lose attention quickly and cannot participate fully in the online discussion interface.

Many motivation-supported user interface design studies focused on extrinsic motivators such as 'gamification' (Vaibhav, Gupta, 2014; Ramakrisnan, Jaafar, 2017; Staubitz et al., 2017). However, game elements such as points, badges, and leaderboards are not effective for incompetent students, and if these elements play a central role, there is a concern that students will lose their interest (Furdu, Tomozei, Kose, 2017), therefore, intrinsic motivation oriented interface design is needed.

And, in the real world, 'gamification' or 'social' elements have been widely used to design user interfaces to support motivation. The reason for this is because most of the time the developers don't have foundational psychological knowledge and struggle to understand how to motivate users properly, and 'gamification' and 'social' are the easy answers. To bridge this knowledge gap, frameworks for supporting motivational interface design are required (Lewis, 2013).

However, very few methodologies related to design motivation in user interface were proposed (Ramakrisnan, 2019). And for interface design of MOOCs, existing frameworks tend to focus on links between design elements, learning goals, and outcomes. For example, terms such as "engagement" and "participation" are frequently used in the literature about MOOCs, however, the design proposals to address them are rarely identified or clearly linked to established psychological constructs (Martin, Kelly, Terry, 2018).

So, designing the interface of MOOCs to support learners' motivation based on psychological knowledge is necessary. Therefore, this study intends to design MOOCs interface to support learners' motivation based on motivation theories by conducting a design and development study.

1.3. Research Questions

Considering that previous studies have shown that one of the problems of existing MOOCs platforms is that they failed to facilitate collaboration among MOOCs users (Collazos, Gonz□lez, & Garc□a, 2014), which can potentially make the learners lose their attention and cannot participate fully (Ramakrisnan, 2019). Therefore, in this research, interfaces that can help MOOCs learners interact with each other will be mainly designed, such as interfaces for grouping, interfaces for group activities, interfaces for commenting, etc. Besides, as a MOOCs system, interfaces to provide basic functions such as homepage, course enrollment page, registration and login page, personal info page, etc, will also be designed in this research. The research questions can be summarized as follows:

1) What are the interface design guidelines and interface functions to motivate MOOCs learners to sustain their learning?

2) What is the interface to motivate MOOCs learners to sustain their learning?

3) What are the learners' responses to the interface?

1.4. Definition of Terms

1.4.1. MOOCs

MOOC stands for 'massive open online course', which is a new form of distance education aimed at unlimited participation and open access via the web (Kaplan, Haenlein, 2016), and it has been one of the most prominent trends in higher education in recent years (Baturay, 2015). The term ‘MOOCs’ was first proposed by Stephen Downes and George Siemens in 2008 (Baturay, 2015; Haron et al, 2019). Since then MOOC has been considered one of the most important ways to conduct online education and has grown rapidly in the past few years.

According to The Oxford English Dictionary, MOOC was defined as “a course of study made available over the internet without charge to a very large number of people”. We can argue that this definition is not perfect because nowadays many MOOCs turn to offer courses with charge. In literature, there is no official definition of MOOC despite the name (Kay et al, 2013), thus the definition can be slightly different between research.

Commonly, researchers define MOOCs based on the name, but some researchers define MOOCs as courses while others focus on platforms. For instance, McAuley et al. (2010) defined MOOC focusing on course as “an online course with the option of free and open registration, a publicly shared curriculum, and open-ended outcomes”. Clarke (2013) defined MOOCs focusing on platforms as “large-scale initiatives in the provision of online courses”. Haron

et al. (2019) defined MOOCs focusing on the platform as" a website that provides free and high quality of educational content to anyone regardless of their physical locations and educational backgrounds". CHENG (2019) gave MOOCs a more specific definition focusing on platforms as "large-scale, open, flexible digital platforms that mainly offer learning resources in video based on systematic educational structure such as educational purpose, instructional plan, textbook, teaching plan, etc".

Some researchers defined MOOCs based on the history of MOOCs, to be more specific, trying to explain MOOCs based on some other traditional concepts such as open educational resources (OER), open courseware (OCW), open distance learning (ODL), online courses (OC). Na (2015) defined MOOC as a way of open distance learning (ODL) that provides online courses (OC) and argued that MOOC has the option to offer open educational resources (OER). Altinpulluk & Kesim (2016) defined MOOCs as "the final stage in distance education that offers open educational resources (OER) to students all around the world".

Different researchers may have different definitions of MOOCs. In this research, MOOCs are considered as online platforms that offer educational resources to anyone regardless of their physical locations and educational backgrounds.

1.4.2. Motivation

There is no agreement about what motivation is. Indeed, there are so many definitions of motivation depending on what defining characteristics do the researchers want to emphasize (Littman, 1958).

Although the definitions of motivation can be different among studies, the similarities have to be pointed out. Pardee (1990) claimed that three qualities are often used to define motivation: 1) it is a presumed internal force, 2) that energizes for action, 3) determines the direction of action.

Kleinginna(1981) analyzed 102 definitions of motivation, classified them into nine categories, and gave motivation a suggested definition as ” Motivation refers to those energizing/arousing mechanisms with relatively direct access to the final common motor pathways, which have the potential to facilitate and direct some motor circuits while inhibiting others”.

Motivation is generally classified into extrinsic and intrinsic motivation (Choi, 2002). Deci and Ryan (1985) defined intrinsic motivation as “doing an activity for itself, and the pleasure and satisfaction derived from participation”. In contrast, Ryan and Deci (2000) defined extrinsic motivation as the “performance of an activity to attain some separable outcome”. In another word, extrinsic motivation refers to external values and demands, while intrinsic motivation is related to enjoyment and inherent satisfaction of performing a task (Ryan, Deci, 2000; Alario-Hoyos et al., 2017).

Romero-Fr□as et al. (2020) concluded that many previous studies have shown the motivation of MOOCs learners is a combination of both internal factors and external factors, and considering this, in this research the definition of extrinsic and intrinsic motivation given by Deci and Ryan was adopted.

1.4.3. User Interface

User interface is a medium that helps a user to easily receive or input information when using a product or service (Cho, 2021). It is the functional and sensorial attributes of a system (appliance, software, vehicle, etc.) that are relevant to its operation by users (Kumar, 2005). It provides a layer in the process of human-machine interaction (Bae, Moon, 2011), for input, it allows the users to control the system, and for output, it allows the system to inform the users.

User interface contains two levels of design: sensory (visual, tactile, auditory, etc.) and emotional (Lee, 2020). Sensory aims to provide functions that can meet users' needs to achieve some goals effectively, while emotional aims to increase the users' liking and the perceived value of using it. So, the interface design should be designed through a holistic review by identifying the service purpose and problem, and organizing user goals and user scenarios (Cho, 2021).

User interface provides an environment where users can interact with machines. HCI literature suggested that for users, interaction always has a purpose. Considering this Blair-Early and Zender

(2008) defined the user interface as the means by which users interact with content from a machine to accomplish some goal. In this research, considering the MOOCs context, user interface refers to the means by which learners interact with learning material from a computer to realize self-regulated learning.

Chapter 2. Literature Review

2.1. MOOCs

2.1.1. Characteristics and Meaning

From the name, it is not hard to conclude the characteristics of MOOCs, which are massive, open, online, and courses. Based on this, researchers gave their thoughts about the characteristics of MOOCs.

Kay et al. (2013) believed open, online, courses are the main characteristics of MOOCs. Open means that anyone can use them to learn, and it also implies that most of the time MOOCs are free, which can remove the financial barrier for the poor students. Online means people can access them on the Internet. Course means that MOOCs provide a whole course (or subject) that includes a coherent learning sequence, integrated learning materials, and formative assessment rather than simple open learning objects.

Baturay (2015) argued that the fundamental characteristics of a MOOC are being open, participatory, and distributed. Open means participation in a MOOC is free and the learning resources are open to anyone who can access the Internet. Participatory emphasizes the learners of MOOCs participate in the learning by creating and sharing personal contributions voluntarily. Distributed means MOOCs are based on the connectivist approach. To be more specific, knowledge should be distributed across a network of learners, and learning happens when learners interact with each other.

Choi & Roh (2015) claimed that all of the MOOCs can be described by four similar characteristics, which are inner diversity, inner multiplicity, neighbor's interest, and decentralized control. Inner diversity refers to the fact that the learners of MOOCs are from different places all around the world, and they have various backgrounds. Inner multiplicity means that students interact with each other and share their opinions towards the same topic in a common language even when some of them are not from English-speaking countries. Neighbor's interest means that students from different places of the world are like neighbors, and it emphasizes the importance of interaction among them. While decentralized control is related to the role of the MOOCs learners. Although there is a facilitator in a MOOC, in the end, the learners have to control their learning activities by themselves.

Because of those characteristics, MOOCs have been considered valuable as a new and different way of teaching and learning.

MOOCs can be used in two different ways in education. One is to conduct purely online education, which means everything is supported by the MOOCs platform, including learning activities, evaluation, discussion, etc. Another is to use it to conduct blended learning. Students study on the MOOCs platforms by themselves and attend an offline class to conduct other learning activities.

Learners can benefit from MOOCs learning. Haron et al. (2019) stated that MOOC has been implemented as blended learning in Malaysia, and it not only enhanced students' understanding of the subject but also provided opportunities to make the traditional

classroom more effective, flexible, efficient, and cost-effective. And open access to high-quality instruction to the public can potentially help revolutionize higher education.

El-Hmoudova (2014) pointed out the meaning of MOOCs from four different aspects. For students or learners, MOOCs offer a quick and easy way to gain new knowledge. For educators, MOOCs add another item in their toolbox. By using it educators can offer an online environment for students to share and discuss informally. For universities, MOOCs offer the potential for building and extending the university as a brand. For education policymakers, MOOCs offer the chance to cut costs while offering education for more students.

Kay et al. (2013) emphasized the potential value of MOOCs from the perspective of artificial intelligence in education (AIED). He claimed that MOOCs platforms can create new opportunities for AIED research because endless learners' educational data can be collected, which can be used to help researchers to conduct learning analytics and build e-portfolio systems.

Also, MOOCs can benefit companies to train their employees. For instance, companies with a worldwide presence can use MOOCs to offer courses for employees across various countries, which can reduce the cost (Ong, Jambulingam, 2016).

2.1.2. History of MOOCs

The term "MOOCs" was first proposed by Stephen Downes and George Siemens in 2008 (Baturay, 2015; Haron et al, 2019). In this

point of view, MOOCs have a relatively short history. While some researchers combined MOOCs with other concepts and argued that the history of MOOCs can be longer than we think.

For example, Kaplan & Haenlein (2016) considered MOOCs as a new form of distance education. Cho & Byun (2015) think the concept of MOOCs is closely related to open distance learning (ODL), open education resources (OER), and online courses (OC), and argue that MOOC is a form of ODL. Stracke et al. (2019) did a literature review about the history, definitions, typologies of MOOCs and OER and concluded that from an OER perspective, MOOCs as a product can be called OER.

In this research, the history of MOOCs is considered from the creation of the term in 2008, and the history of distance education, open distance learning (ODL), open education resources (OER) contribute to the birth of MOOCs.

The first MOOC was "Connectivism and Connective Knowledge" organized by Stephen Downes and George Siemens in the year 2008 (Stracke et al., 2019). It is worth mentioning that the course was not content-focused, instead, it emphasized the interaction among the learners which was based on the connectivist pedagogy. And this kind of MOOC is called 'cMOOC'.

Compared to 'cMOOC', 'xMOOC' is the new type of MOOC, which is content-based (Baturay, 2015). Although it is controversial what is the first xMOOC, Norvig and Thrun's 'Artificial Intelligence' opened in 2011 is widely considered as the first xMOOC (Davidson, 2013), and more than 160,000 learners from 190 countries enrolled

in that course (CHENG, 2019). Today the media tend to use the term MOOC to refer to xMOOC (Kay et al., 2013) because the majority of MOOCs are xMOOCs (Baturay, 2015).

Researchers call xMOOCs and cMOOCs as two MOOC models, which are based on two pedagogical foundations in education: cMOOCs based on connectivism while xMOOCs based on behaviorism (Abu-Shanab, Musleh, 2018). The difference between xMOOCs and xMOOCs was concluded in the table shown below (Yuan, Powell, Oliver, 2014).

Table 2.1 MOOC Typologies (Yuan, L., Powell, S. & Oliver, B., 2014)

xMOOCs		cMOOCs
Scalability of provision	Massive	Community and connections
Open access – Restricted License	Open	Open access & license
Individual learning in single platform	Online	Networked learning across multiple platforms and services
Acquire a curriculum of knowledge & skills	Course	Develop shared practices, knowledge and understanding

The emergence of MOOCs shows us the potential of MOOCs in education, and since then the number of MOOCs has grown continually (Gaskell, Mills, 2014). Particularly, in 2012 MOOCs achieved explosive growth, and the New York Times called that year

“the Year of the MOOCs” (Stracke et al., 2019). In that year, Sebastian Thrun left Stanford University and developed “Udacity”, Andrew NG and Daphne Koller developed “Coursera”, Harvard University worked with MIT, and developed “edx” (CHENG, 2019). Since then, many other platforms were developed in many countries, but Udacity, Coursera, edx are still the three most important MOOCs platforms not only in the USA but also in the world, considering the number of platform users.

Compared to the USA, China was one step late for developing MOOCs platforms. In 2013, Tsinghua University joined edx and developed “xuetangx” based on edx API. In 2014, NetEase established “icourse163”, etc. Although the start was late, because of the large population of learners in China, the growth of MOOCs was eye-catching. On a forum held in China in 2014, the founder of Coursera Andrew Ng claimed among 8 new MOOCs learners, one is from China.

As a relatively new way of education, China has realized the importance of MOOCs in Education. Recently, in December 2020, Tsinghua University held the first World MOOC Conference and released the “Beijing Declaration on MOOC Development” (Ministry of Education of the People’s Republic of China, 2020), which showed the determination to develop MOOCs of the Chinese government.

2.1.3. MOOCs Platforms and MOOCs Learners

As mentioned, the USA is leading in the area of MOOCs with the opening of three MOOCs platforms: Udacity, Coursera, edx in 2012. In this part, a brief review of main MOOCs platforms nowadays will be conducted, which includes Udacity, Coursera, edx, xuetangx, icourse163. Then a comparison will be done based on the framework given by previous literature. Also, to understand who is using those platforms, previous studies were reviewed.

- Udacity

  Udacity was founded by Sebastian Thrun in 2012. As a private educational enterprise, it offers courses in bundles, concentrating in fields such as data science, programming, business, artificial intelligence, autonomous systems, cloud computing, and cybersecurity. It is not hard to notice the programs that Udacity offers are job-oriented, and most of the programs are related to computer science. And it offers nano degree programs to meet learners' diverse needs. The degree programs and nano degree programs are completely paid, learners can choose to pay monthly or pay several months with a discount.

- Coursera

  Founded by Andrew Ng and Daphne Koller in 2012, Coursera is a social enterprise company aiming to educate millions of people. It offers free courses, certificate programs, and degree programs in many subjects. For those paid programs,

learners can have a 7-days free trial. Coursera prefers to use peer assessment rather than automated computer grading (Clarke, 2013).

- edx

  edx was not founded by some people but two universities – Harvard University and MIT. So rather than an enterprise, edx claimed itself as a non-profit organization, and it is more like an online union of universities. Like Coursera, edx offers free courses and paid programs in almost every subject. The significant difference between edx with other platforms is that edx emphasizes cooperation with universities and it provided "open edx API" to help other countries develop their platforms.

- xuetangx

  xuetangx was developed by Tsinghua University based on the open edx API in 2013, and it shares many similarities with edx. For example, they are both founded by universities, both of them offer free courses and paid programs, both of them emphasize the corporation with universities, etc.

- icourse163

  icourse163 was founded by an IT company named NetEase in 2014. It offers diverse subjects including free and paid courses. It offers not only courses provided by universities but also courses developed by online education companies, which can be seen as the main difference compared to xuetangx.

Conache, Dima, Mutu (2016) provided 5 frameworks to compare MOOC platforms： based on business model criteria, based on course experience, based on mobile apps, based on traffic data analysis, and based on page loading speed. In this research, the frameworks based on business model criteria, course experience, and mobile apps were used to compare those MOOCs platforms.

Table 2.2 Comparison of MOOC Based on Business Model Criteria

Criteria	Udacity	Coursera	edX	xuetangx	icourse163
Organization type	for-profit	for-profit	non-profit	non-profit	for-profit
Partnerships	corporations, universities	universities, organizations	schools, universities, non-profit organizations, corporations	universities, non-profit organizations, corporations	universities, corporations
Free courses	✗	✔	✔	✔	✔
Paid courses	✔	✔	✔	✔	✔
Completion certificates	paid courses	paid verified certificates	paid verified certificates	paid verified certificates	paid verified certificates
Series of courses	Nanodegrees, Degrees	Specializations, Degrees	X-Series	X-Series	Specializations

Table 2.3 Comparison of MOOC Platforms Based on Course Experience

Criteria	Udacity	Coursera	edX	xuetangx	icourse163
Course catalog	NA, 59 Nanodegrees	3800	3000+	3000+	NA
Self-paced courses	✔	✔	✔	✔	✔
Scheduled courses	✕	✔	✔	✔	✔
Course materials	video, text, external links	video, text, transcripts	video, text, online textbooks	video, text, online textbooks	video, Power Point , text
Discussion forum	✔	✔	✔	✔	✔
Mobile apps (Android, iOS)	✕ (not supported after January 9, 2019)	✔	✔	✔	✔
Foreign languages	subtitles	courses in foreign languages, subtitles	courses in foreign languages, subtitles	subtitles	subtitles
Assessment methods	quiz, coding exercises, projects	quiz, uploaded assignment, peer review, projects	quiz, uploaded assignment, peer review, projects	quiz, uploaded assignment	quiz, uploaded assignment

Table 2.4 MOOC Providers' Mobile Support

Criteria	Udacity	Coursera	edX	xuetangx	icourse163
Android app	✕ (not supported after January 9, 2019)	✔	✔	✔	✔
Android app rating	NA	4.3/5	4.6/5	4.0/5	NA
iOS app	✕	✔	✔	✔	✔
iOS app rating	NA	4.8/5	4.6/5	4.6/5	4.8/5

According to a report from Classcentral posted in 2020, both of those platforms have been growing continuously since those platforms were open to the public. To understand the phenomenon of MOOCs booming, it is necessary to know who are the MOOCs learners and why they learn with those MOOCs platforms.

Christensen et al. (2013) did an online survey of students enrolled in at least one of the University of Pennsylvania's 32 MOOCs offered on Coursera and found out that MOOCs learners tend to be young, well educated, employed, and most of them are from developed countries, male learners are significantly more than female learners. As for the reasons for people taking a MOOC, the results showed that the main reasons are advancing in their job and satisfying their curiosity. The results are shown in the table as follows.

Table 2.5 Who Takes MOOCs (Christensen et al., 2013)

		Total (34,779 respondents)	US (11,933 respondents)	Non-US OECD (10,784 respondents)	BRICS (5,151 respondents)	Other developing countries (6,911 respondents)
Gender	Male	56.9%	48.1%	58.4%	67.9%	61.5%
	Female	41.3%	49.4%	39.9%	31.1%	37.3%
Age	Under 30	41.1%	23.5%	37.1%	63.4%	58.8%
	Over 30	58.9%	76.5%	62.9%	36.6%	41.2%
Employment	Student	17.4%	9.8%	16.4%	28.2%	23.9%
	Part-time employed	6.9%	7.2%	7.5%	5.3%	6.6%
	Full-time employed	50.0%	51.1%	48.9%	49.4%	50.0%
	Self-employed	12.4%	11.2%	14.2%	11.8%	12.0%
	Unemployed	6.6%	6.6%	8.2%	4.1%	5.8%
	Retired	6.8%	14.0%	4.8%	1.2%	1.7%

Table 2.6 Why Do Students Participate in MOOC Courses (Christensen et al., 2013)

		Course type			Region of respondent			
	Total (n=34,779)	**Social science courses (n=17,156)**	**Science, healthcare, and math courses (n=13,156)**	**Humanities courses (n=6,902)**	**US (n=11,933)**	**Non-US OECD (10,784 respondents)**	**BRICS (n=5,151)**	**Other developing countries (6,911 respondents)**
Gain knowledge to get my degree	13.2%	12.1%	16.0%	7.0%	6.8%	12.1%	20.3%	20.9%
Gain specific skills to do my job better	43.9%	54.1%	39.0%	11.9%	37.0%	46.4%	47.7%	49.0%
Gain specific skills to get a new job	17.0%	23.2%	12.8%	3.6%	12.9%	16.9%	21.0%	21.3%
Curiosity, just for fun	50.05%	49.5%	48.7%	74.6%	55.5%	52.5%	43.7%	41.2%

There is also qualitative research aimed to figure out why learners use MOOCs platforms. For example, Zheng et al. (2015) conducted in-depth interviews with 18 interviewees and identified four types of students' motivation for MOOCs enrollment: fulfilling current needs, preparing for the future, satisfying curiosity, and connecting with people.

2.1.4. The Critiques and Drop Out Phenomenon

As mentioned, the history of MOOCs is not long, around 10 years, and it remains at a development stage. With the fast growth during the last decade, many problems of MOOCs were exposed and criticized by researchers.

Clarke (2013) stated assessment, plagiarism, and high drop-out rates are three issues of MOOCs. Kay et al. (2013) argued that the form of feedback is critical to effective MOOCs study, while the MOOCs learners usually don't know how to do self-and peer-assessment. He also mentioned that the ideal MOOCs can provide personalized learning, and the current MOOCs still have a long way to go.

Haron (2019) thought that even with the assistance of technology, teachers and students require some skills to conduct learning at MOOC. And the free environments of MOOCs require learners to keep a high level of motivation and be able to handle self-regulation. Also, since MOOCs target "massive" learners, it requires different instructional designs compared to traditional small-scale courses and makes it difficult to offer learners one-to-one supports.

By opening educational resources to the public, one potential benefit of MOOCs has been emphasized by many researchers is that it can bring high-quality education to developing countries, thus reducing the gap of education. But Christensen et al. (2013) criticized that it is not true since most of the MOOC learners are from developed countries based on the result of the survey he did on Coursera.

Although MOOCs learning has those problems to face, many researchers still think the future of MOOCs positively considering the fast development of ICT technology. For instance, Clarke (2013) thinks with the improvement of technology and software tools, universities can benefit from using those advanced MOOCs to enrich the learning experiences, and he believes in the future universities will develop and apply different approaches to blend technology with face to face learning. Particularly in 2020, schools were forced to conduct education partially or fully online during the Covid-19 pandemic, and because of that, the process of blending technology with face-to-face learning was accelerated to some extent. Considering this, instead of criticizing the problems of MOOCs, it is more important to solve those problems, thus realizing the value of MOOCs.

This research is focused on the issue of the high dropout rate of MOOCs learners. It is critical to deal with this problem because dropping out means the learners cannot finish the course, which is a total failure for any kind of learning.

Many researchers have noticed the high dropout rate of MOOC learners. Jordan (2014) analyzed the learners' data of 39 MOOC courses on Coursera, Udacity, edx from 2011 to 2013, and found that the course completion rate is from 0.9% to 36.1%, with the average number at 6.5%. And it needs to be mentioned that quite a few students look at the content of the course once only at the beginning of enrollment, or do not view the content at all (Balakrishnan, Coetzee, 2013; Ho et al., 2014). Considering the difference between MOOCs

and traditional education regarding enrollment, Kay et al. (2013) argued that it is not fair to treat MOOCs dropout rate as comparable with the dropout rate in traditional learning, because a large percentage of MOOCs learners enrolled MOOCs just out of curiosity. But he also pointed out some other learners also have difficulties accomplishing the course. So, in this research facing the problem of high dropout rate is considered meaningfully.

Why do MOOCs learners drop out? Na (2015) concluded the reasons that lead to MOOCs learners' dropout are: 1) do not have enough time to study during their busy daily life. 2) lose interest in learning due to disappointment followed by high expectations. 3) lose the sense of goals that they must achieve. Zheng et al. (2015) interviewed 18 MOOCs learners and concluded 8 specific factors that influence the retention rate of MOOCs learning. Which are 1) high workload. 2) challenging course content. 3) lack of time. 4) lack of pressure. 5) no sense of community or awareness of others. 6) lack of social influence. 7) lengthy course start-up. 8) learning on demand. Apart from those reasons coming from the students or learning content, some researchers found the interface design is also an important factor that can affect MOOCs learners' learning retention. For instance, Liu, Kang & McKelroy (2015) argued that MOOCs learners felt the course interface was not easy to navigate when the course went on. The discussion forums became increasingly disordered because too many responses came from massive learners, which leads to the lack of interaction and useful peer feedback. However, despite the fact that the reasons for MOOCs

dropout by learners are different, as one of the identified factors, the problem of the influence of the interface on learners has not been studied adequately yet (Korableva et al., 2019).

To understand how researchers dealt with the high dropout rate of MOOCs, literature related to MOOCs dropout was reviewed.

Among those studies, some of them are not focusing on how to solve this problem directly, while trying to understand the nature of learners and their engagement. For example, Jin, Chi, Gim (2018) based on the self-determination theory and learning flow theory, found out learners' basic psychological needs (perceived autonomy, perceived competence, and perceived relatedness), attitude (perceived usefulness, perceived ease of use), and learning flow have a positive effect on MOOCs learners' continuous usage intention.

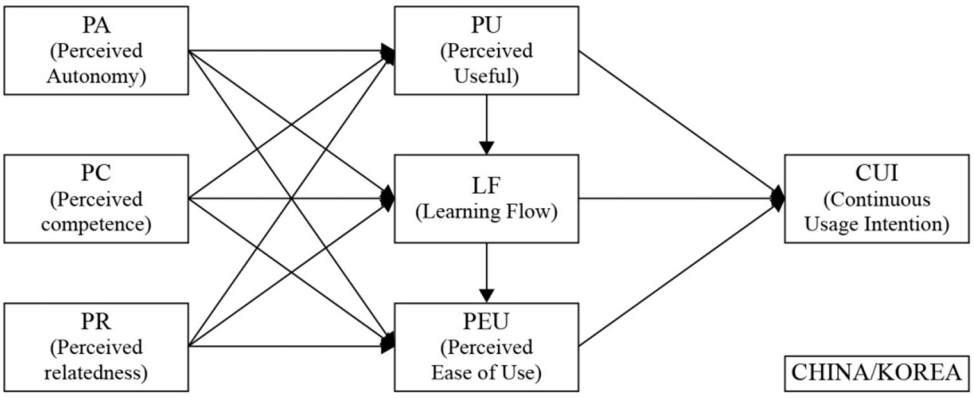

Figure 2.1 Research Model (Jin, Chi, Gim, 2018)

CHENG (2019) verified the relationship between information quality, system quality, service quality, learning satisfaction, and

usage intentions in the MOOC environment based on the information systems success model.

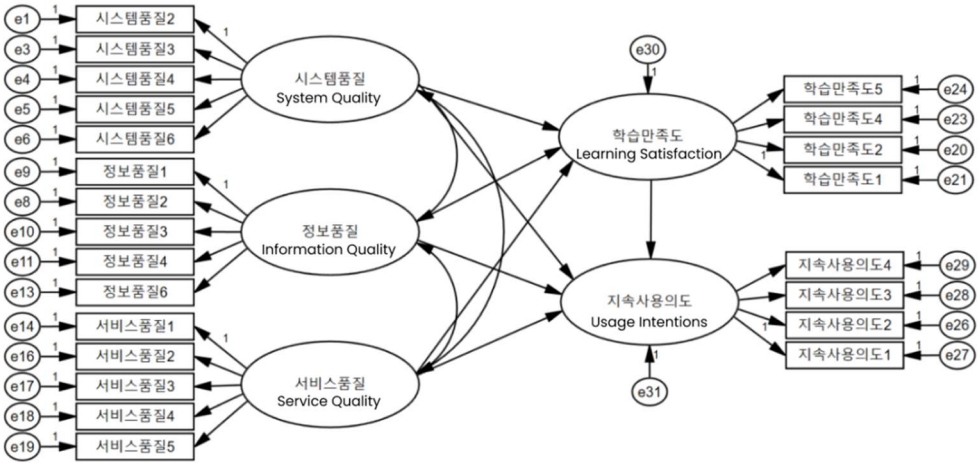

Figure 2.2 Research Model (CHENG, 2019)

Meanwhile, some researchers aimed to solve this problem directly, thus improving the retention of MOOCs learners. To achieve this, Different approaches were taken in previous studies.

For instance, some researchers focused on improving the quality of MOOCs by offering design insights that can better serve learners' needs. For example, Haron et al. (2019) argued that Khan's eight-dimensional framework can be used to support meaningful online learning environments, because it can ensure that no important factors are omitted from the design of e-learning, thus keeping MOOCs' success. The eight dimensions are shown in the table below.

Table 2.7 Eight Dimensional of E-learning Framework (Khan, 2003)

Dimension	Description
Pedagogical	refers to teaching and learning where addresses issues concerning content analysis, audience analysis, goal analysis, media analysis, design approach.
Technological	examines issues of MOOCs' technology infrastructure, hardware, and software.
Institutional	concerned with issues of administrative affairs, academic affairs and student services related to e-learning.
Management	refers to the maintenance of the learning environment and its global large-scale distribution.
Resource Support	examines the online support and resources required to foster meaningful learning environments.
Ethical	relate to social and political influence, cultural diversity, bias, geographical diversity, learner diversity, information accessibility, etiquette, and legal issues.
Interface Design	encompasses page and site design, content design, navigation, and usability testing
Evaluation	refers to both assessments of learners and evaluation of MOOC environments.

Some researchers proposed strategies for teaching and learning based on motivation theory. Song, Lee (2018) argued the importance of Interaction in K-MOOC and came up with strategies to ensure autonomy, competence, relatedness based on self-determination theory. Some researchers used learning analytics to predict dropout before it happens (Whitehill et al., 2017; Shukor, Abdullah, 2019). And some researchers tried to improve MOOCs retention by applying gamification in the platform (Staubitz et al., 2017; Vaibhav, Gupta, 2014; Sethi, 2017; Ramakrisnan, Jaafar, 2017).

Table 2.8 Research Related to MOOCs Dropout

Research Type	Examples
Dropout reason	Zheng et al. (2015)
Influencing factors	Jin, Chi, Gim (2018); CHENG (2019); Aparicio et al. (2019)
Dropout prediction	Whitehill et al. (2017); Shukor, Abdullah (2019)
Instructional design	Haron et al. (2019); Song, Lee (2018); Drake, O'Hara, Seeman (2015)
Interface design	Staubitz et al. (2017); Vaibhav, Gupta (2014); Sethi (2017); Ramakrisnan, Jaafar (2017)

Some researchers tried to improve MOOCs learners' engagement by facilitating their collaboration. Collazos, Gonz□lez, & Garc□a (2014) proposed a concept CSCM (Computer Supported Collaborative MOOCs) to emphasize the collaboration aspects of MOOCs. He proposed a model with 7 main elements included: 1) Teachers, 2)

Collaborative Environment, 3) Study Resources (contents, collaborative activities), 4) Learning Objects Repository, 5) Technological Platform (Learning Management Systems, Learning Virtual Environments), 6) Access Services, and 7) Students.

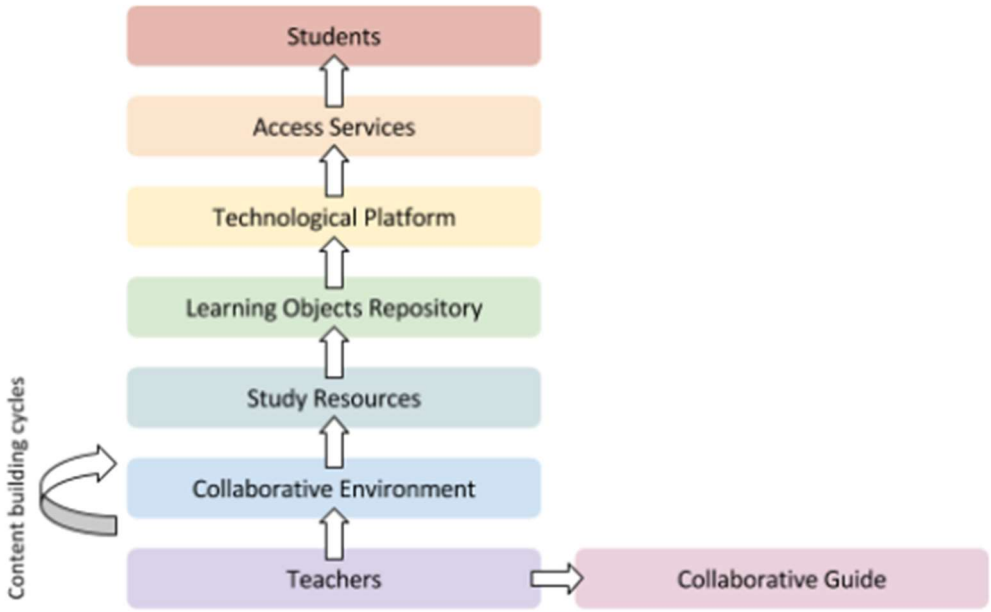

Figure 2.3 Computer Supported Collaborative MOOCs (CSCM) Model

Goopio & Cheung (2020) classified the topics covered by previous studies related to learner dropout and retention strategies into four clusters, which are predictions, persistence intentions, motivations, and exhaustions, and found out that motivation has been considered critical to deal with MOOCs dropout. Gasevic, Kovanovic, Joksimovic, and Siemens (2014) analyzed proposals from 266 projects which were submitted to the MOOC Research Initiative (MRI) funded by the

Gates Foundation and found out that motivation is one of the five main research themes for future MOOCs related research. So, in this research the approach of motivation will be used to answer the research questions.

2.2. Motivation

The purpose of this research is to develop design strategies for MOOCs interface based on motivation theories. Therefore, in this research motivation theories were first reviewed, then a motivation framework was proposed based on those theories.

2.2.1. Motivation in Learning

The importance of motivation for learning has been proved by many educators. Wang, Reeves (2007) believed that motivating students to actively engage in learning is more important for educators to help their students achieve academic success, compared with presenting them much information through instructional materials or other forms of instruction.

Motivation is critical in learning, especially in e-learning (Kim et al., 2015), because motivation can support the learners to maintain interest in given learning activities (Romero-Fr□as et al., 2020). Arquero et al. (2015) proved the link between motivation with learning interest, learning persistence, and learning performance.

According to Rigby, Deci, Patrick, and Ryan (1992), many previous studies aimed to find out the relationship between motivation and learning achievement have confirmed that when students are more engaged in learning, they will understand new knowledge better and be more flexible when using it.

From the point of intrinsic and extrinsic motivation, Lee, Cheung, Chen (2005) noted that both intrinsic motivation (perceived

enjoyment) and extrinsic motivation (perceived usefulness or task value) play a role in learners' attitudes towards online courses. In the context of MOOCs, Gottfried et al. (2007) claimed that intrinsic motivation has more weight in the learning achievements and attitudes of learners since the certifications received after completing the courses have a relatively low recognition (Wang, Baker, 2015).

Kim & Frick (2011) found that the best predictors of motivation during self-directed e-learning (SDEL) were perceived quality of instruction and learning (e-learning is right for me) and motivation to begin. To motivate learners in SDEL, instructional design principles for sustaining learner motivation in SDEL were given below.

1. Provide learners with content that is relevant and useful to them.
2. Incorporate multimedia presentations that stimulate learner interest.
3. Include learning activities that simulate real-world situations.
4. Provide content at a difficulty level which is in a learner's zone of proximal development.
5. Provide learners with hands-on activities that engage them in learning.
6. Provide learners with feedback on their performance.
7. Design the website so that it is easy for learners to navigate.

8. If possible, incorporate some social interaction in the learning process (e.g., with an instructor, technical support staff, or an animated pedagogical agent).

2.2.2. Motivation Theories

In this research, 11 motivation theories were reviewed. Each of these theories showed their opinions on the factors that can affect learners' motivation. After comparing the differences and similarities, a motivation framework was concluded.

The motivation theories reviewed in this research are 1) hierarchy of needs theory. 2) ERG theory. 3) learned needs theory. 4) two-factor theory. 5) reinforcement theory. 6) expectancy theory. 7) goal-setting theory. 8) self-determination theory. 9) the ARCS model 10) social cognitive theory. 11) RAMP framework.

Hierarchy of needs theory was first proposed by Maslow in 1943 and then refined in 1954 (McLeod, 2007). According to this theory, people get motivated when their various personal needs are satisfied (Gawel, 1996). In this theory, the needs of human beings were described as a 5-level pyramid. Human beings' basic needs construct the bottom, and high-level needs form the top. From the bottom to the top, those needs are physiological needs, safety needs, belonging and love needs, esteem needs, self-Actualization needs. At first, Maslow argued that low-level needs must be satisfied first then move to higher level needs, but he realized the satisfaction of the needs can be partially instead of "all or none" (McLeod, 2007).

Figure 2.4 The Original Hierarchy of Needs Five-stage Model (McLeod, 2007)

Alderfer (1969) came up with ERG theory as an alternative to Maslow's hierarchy of needs theory based on three types of human needs, which are: existence, relatedness, and growth. Existence needs refer to safety, physiological and material needs. Relatedness needs refer to senses of security, belonging, and respect. Growth needs refer to self-esteem and self-actualization (Yang, Hwang, Chen, 2011). ERG theory has been used as a tool to study the motivation of humans in the workplace to increase productivity, and help us to know what leads to job satisfaction (Caulton, 2012).

Theory of needs (also known as learned needs theory) was proposed by McClelland in 1961, which contains three types of needs that must be satisfied to motivate people, namely need for achievement (nACH), need for power (nPOW), and need for

affiliation (nAFF) (Arnolds, Boshoff, 2003). According to Royle, Hall (2012), nACH refers to a person's drive to excel, nPOW refers to a person's desire to be influential, and nAFF refers to a person's desire to have close, friendly, relationships with others.

Herzberg proposed two-factor theory to reveal the factors that affect people's attitudes towards work by using a two-dimensional paradigm in 1959 (Gawel, 1996). The name "two factors" refers to motivation factors and hygiene factors. Alshmemri, Shahwan-Akl, Maude (2017) concluded the motivation factors and hygiene factors in the table shown below, he claimed that motivation and hygiene factors can be considered as intrinsic and extrinsic factors.

Table 2.9 Factors in Two Factor Theory (Alshmemri, Shahwan-Akl, Maude, 2017)

Motivation Factors	Hygiene Factors
Advancement	Interpersonal relationship
Work itself	Salary
Possibility of growth	Policies and administration
Responsibility	Supervision
Recognition	Working conditions
Achievement	

Reinforcement theory contains two kinds of reinforcement: positive reinforcement and negative reinforcement. Skinner defined reinforcement in "The Behavior of Organisms" in 1938 and re-

defined it in “Science and Human Behavior” in 1953 (Scharff, 1999). Reinforcement theory is considered one of the oldest theories of motivation to describe humans’ behavior (Gordan, Amutan, 2014). Positive reinforcement refers to giving a positive response when a person shows positive and required behavior, while negative reinforcement refers to rewarding a person by removing negative consequences.

Expectancy theory was proposed by Vroom in 1964, which suggested that people consciously choose action, based on their perceptions, attitudes, and beliefs to enhance and avoid pain (Isaac, Zerbe, Pitt, 2001). In this theory, Vroom pointed out three factors that can affect human motivation: valence, expectancy, and instrumentality. Valence refers to “affective orientations toward particular outcomes”, expectancy refers to “a momentary belief followed by a particular outcome”, and instrumentality refers to “a person’s perception of the probability that performance will lead to a specific outcome” (Lee, 2007; Vroom, 1964). According to expectancy theory, Motivational Force = Expectancy * Instrumentality * Valence, which means if any of those factors is zero, then the motivation will be zero.

Goal-setting theory was presented by Locke in 1990. In the 1960s, three approaches to study motivation were dominant, namely: Hull’s Drive Theory, Skinner’s Reinforcement Theory, and McClelland’s Theory of Needs. And as an alternative, the approach to study motivation from the aspect of goal setting emerged (Locke, Latham, 1994). Goal-setting theory believes the difference in peoples’

performance is caused by different performance goals (Locke, Latham, 1994), because established goals can drive the behavior, and goal accomplishment can further motivate individuals to perform. According to goal setting theory, five principles should be considered to improve the chance of success, which are: 1) clarity. 2) challenge. 3) commitment. 4) feedback. 5) task complexity.

Self-determination theory was first introduced by Deci and Ryan in the book Self-Determination and Intrinsic Motivation in Human Behavior in 1985. Self-determination theory evolves from the idea of intrinsic and extrinsic motivations. Three factors were proposed in this theory, which are autonomy, competence, and relatedness. According to Gopalan et al. (2017), autonomy refers to volition and liberty, competence refers to the feeling of effectiveness and self-confidence when pursuing or accomplishing a task, and relatedness refers to the feeling of being protected and connected in a learning environment.

Keller came up with the ARCS model to improve the motivational appeal of instructional materials in 1984, which was based on the macro theory of motivation and instructional design developed by him in 1979 and 1983 (Keller, 1987). ARCS stands for attention, relevance, confidence, satisfaction. By satisfying these factors, the ARCS model gives us a systematic way to determine and deal with learning motivation (Gopalan et al., 2017).

Bandura (1986) proposed social cognitive theory as an extension of his social learning theory. This theory emphasized the importance of observation, claiming that observing a model can prompt the

viewer to engage in behavior that they already learned (Bandura, 2008). The social cognitive theory described the relationship between behavior, environmental factors, and personal factors (Gopalan et al., 2017). The environmental factors can be classified as social environment and physical environment, social environment refers to family and friends, while physical environment refers to comfort (Bandura, 1997).

Marczewski (2013) came up with the RAMP framework as guidance for designing gamified systems which can improve users' intrinsic motivation. RAMP stands for relatedness, autonomy, mastery, and purpose, and this framework combines the insights of the self-determination theory and drive theory (Staubitz et al., 2017).

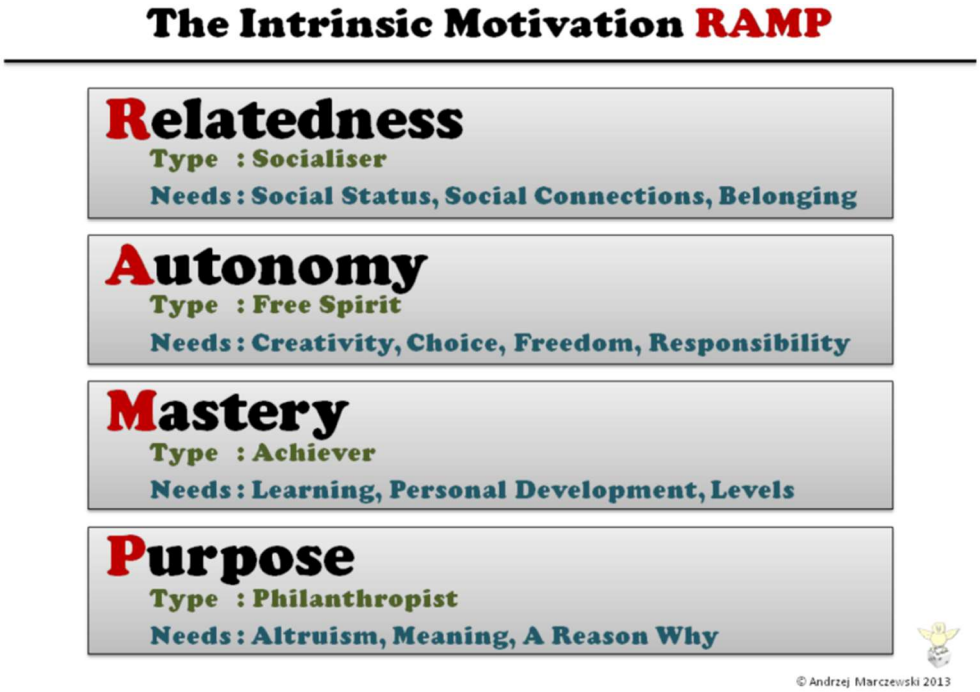

Figure 2.5 RAMP Framework (Marczewski, 2013)

Table 2.10 Motivation Theories and Motivation Factors

Motivation Theories	Proposer	Motivation Factors
reinforcement theory	Skinner (1938)	positive reinforcements, negative reinforcement
hierarchy of needs theory	Maslow (1943)	physiological needs, safety, and security, belongingness and love, esteem, self-actualization
two-factor theory	Herzberg (1959)	motivating factors (achievement, recognition, work itself, responsibility, advancement); hygiene factors (company policy and administration, supervision, salary, interpersonal relationships, working conditions)
theory of needs (learned needs theory)	McClelland (1961)	achievement, affiliation, power
expectancy theory	Vroom (1964)	expectancy, instrumentality, valence
ERG theory	Alderfer (1969)	existence needs (basic material), relatedness needs (love and belongingness, public fame and recognition), Growth needs (self-development)
the ARCS model	Keller (1987)	attention, relevance, confidence, satisfaction
self-determination theory	Deci & Ryan (1985)	intrinsic motivation (challenge, curiosity, control, fantasy), extrinsic motivation (reward, compulsion, punishment); autonomy, competence, relatedness

social cognitive theory	Bandura (1986)	social influences, communication among the community (social environment), comforts (physical environment)
goal-setting theory	Locke (1990)	goal-setting, goal-commitment, goal-setting strategies
RAMP framework	Marczewski (2013)	relatedness, autonomy, mastery, purpose

2.3. User Interface

2.3.1. User Interface Design & Interface Design for Education

User interface is the means by which users interact with content from a machine to accomplish some goal (Blair-Early & Zender, 2008). User interface is critical because it determines how the users interact with products. For example, before Windows System was developed, it was not easy to operate a computer because users had to use the command line to interact with it. Nowadays, with a graphical user interface (GUI) and touch screen, even a child can learn to operate a computer easily.

To design user interfaces with high quality, basic design rules or principles were given by researchers. Mandel (1997) proposed three "golden rules" for interface design: 1) Place the user in control. 2) Reduce the user's memory load. 3) Make the interface consistent. And guided by those rules, detailed design principles were made to help designers to design user interfaces (Sridevi, 2014).

Table 2.11 Golden Rules and Principles for User Interface Design

(Sridevi, 2014)

Golden Rules	Design Principles
Place the user in control	Define interaction modes in a way that does not force a user into unnecessary or undesired actions.
	Provide for flexible interaction
	Allow user interaction to be interruptible and undoable
	Streamline interaction as skill levels advance and allow the interaction to be customized
	Hide technical internals from the casual user
	Design for direct interaction with objects that appear on the screen
Reduce the user's memory load	Reduce demand on short-term memory
	Establish meaningful defaults
	Define shortcuts that are intuitive
	The visual layout of the interface should be based on a real-world metaphor
	Disclose information in a progressive fashion
Make the interface consistent	Allow the user to put the current task into a meaningful context
	Maintain consistency across a family of applications
	If past interactive models have created user expectations, do not make changes unless there is a compelling reason to do so

Also, to guide novice designers to design user interfaces, researchers summarized the process of designing. Chao (2009) claimed human-computer interface design can be divided into three parts, which are structure design, interactive design, and visual design. For structure design steps should be followed as 1) Analysis of User Needs. 2) Analysis of the Purpose of a Task. 3) Carrying out Task Design. For interactive design, the process is: 1) Determining the Design Types of Interaction. 2) Carrying out Interaction Design and Its Principles. For visual design, the process can be: 1) Selecting the color. 2) Processing of graphics and images. 3) Designing font. 4) Designing page layout.

Besides, to design interfaces for educational purposes, guidelines have been given by previous studies. Peters (2014) thinks that to conduct successful e-learning, interface design for learning (User interface design intended to support learning objectives) is as important as learning design/ instructional design (The design of content and activities created to support learning objectives). He claimed that interface design for learning experiences generally comes in one of three layers, namely system design, interface styling, multimedia content. And learning interface designers should work on one or a combination of these levels depending on the project.

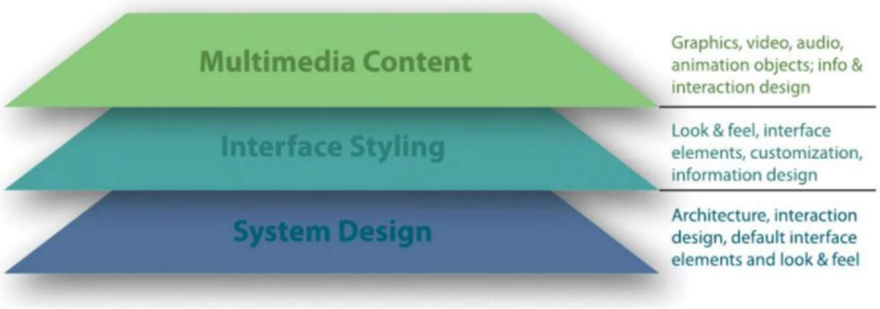

Figure 2.6 Three Layers of Interface Design for Learning Experiences

2.3.2 Motivation Supported User Interface Design

By following those rules, principles, and design process guidelines, the quality of the user interface can be guaranteed. However, to make sure a user interface design is successful, except for the quality assurance, designers should also pay attention to motivating users to return to the interface again and again (Lewis, 2013), thus additional effort should be made.

And compared with other kinds of user interfaces, the instructional user interface is strategically important from the perspective of motivation, because poorly designed interfaces will not intrinsically motivate students to make use of the product or to learn with it (Stoney, & Wild, 1998).

To enhance students' motivation to learn science, Wang, Reeves (2007) developed a web-based learning environment. In that research, four motivational determinants suggested by Malone and

Lepper were employed to develop design strategies, which are challenge, curiosity, control, and fantasy.

Table 2.12 Motivational Determinants and Design Strategies (Wang, Reeves, 2007)

Motivational determinants	Instructional design strategies
Challenge	• Teacher sets goals for each student on the basis of individual progress. • The design of the assignment's difficulty level ranged from easy-to-difficult to encourage students to complete the task.
Curiosity	• The final animation reflects the each student's selections and the interaction among the three conditions (organism, ecology, and physical burial). In order to understand all the conditions of fossil formation, learners have to interact with the program and combine all possible factors to observe results. Thus, the interactive activity can arouse attention and promote curiosity.
Control	• The Web media was adopted as the content deliverer because it can carry multimedia instructional materials and provide an open environment in which learners can access and explore. • The Web-LE promotes direct learning performance by providing explicit and organized selections (see Fig. 1). • The Web-LE has tools that allow learners to control their learning progress and access an online encyclopedia when they need supplemental information (see Fig. 2). • The program provides an environment in which the students' different selections have distinct effects. • The Web-LE enables students to input names and display their names on the screen.
Fantasy	• This program provides realistic graphic simulation and multimedia effects to enhance the sense of fantasy. • The Web-LE features embellished activities to maintain students' intrinsic motivation. • Streaming video technology enables students to observe the scientific processes with high quality video and sound effects. • Special effects such as sound effects and movie progress controls were applied.

Faghih, Azadehfar, Reza, and Katebi (2013) claimed that an e-learning environment should be developed based on the psychology of learners. And to increase motivation in e-learning systems, some suggestions were provided as 1) Using speech interface. 2) Using informal communication style instead of formal. 3) Using animated pedagogical agent (APA). 4) Using a variety of colors in educational

media. 5) Learners have control over the learning environment. 6) Using background music.

An easy approach to motivate users is by applying the concept of 'gamification' or 'social' for interface design (Lewis, 2013). For example, Staubitz et al. (2017) incorporated game elements and designed a gamified MOOCs platform. On this platform, three main game elements were used, namely progress bars, eXperience Points (XP), and badges. Progress bars were designed to help learners to know their learning better by showing what has been done and what still needs to be done. XPs were designed to reward certain learning activities, for example, if a learner answers a question in the forum, he will be rewarded with 1 XP. Learners can check their received points on the progress bars page. Badges were designed to reward learners with certain XPs, and three types of badges were provided, namely bronze, silver, and gold.

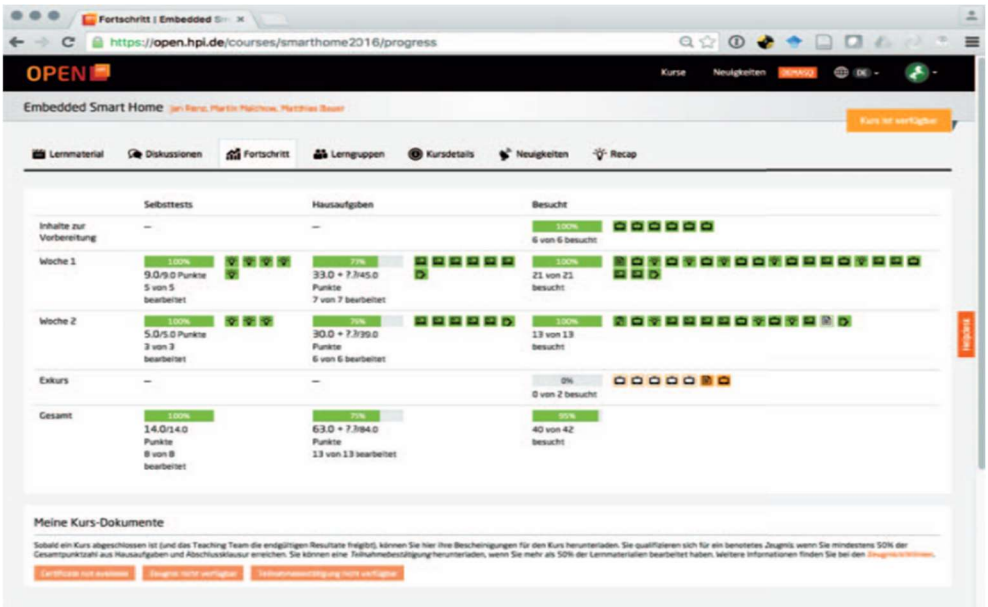

Figure 2.7 Progress Bars (Staubitz et al., 2017)

Table 2.13 Experience Points for Activities (Staubitz et al., 2017)

Activity	Explanation	XP
Answering a forum question	Encourage participants to be active in the forum and answer questions, regardless of the quality of the answer.	1
Answer is accepted by question author (or teaching team)	Additional points for high quality answers. Only one answer can be accepted per question.	30
Question is up-voted	An up-vote on a question indicates either an interest in the question or an approval of the question quality or relevance. In both cases, we reward the author. Each participant can up-vote a question once. Since good questions are likely to be up-voted quite often, we give only few points per vote.	5
User receives an up-vote on an answer	Up-votes are quality indicators. In contrast to questions, quality approval is the only motivation that leads to an up-vote action for answers. Thus, we can reward it higher than an up-vote for a question.	10

Figure 2.8 Bronze, Silver, and Gold Badge (Staubitz et al., 2017)

Vaibhav, Gupta (2014) compared two groups of learners, Group-A studying with a Non-gamified environment and Group-B studying with a gamified environment, to test the effect of gamified environment. In that research, two groups were asked to learn vocabulary words. Group-A used a conventional way of learning by

word lists, while Group-B used a gamified application called "scatter" from quizlet.com. And the result shows that learners have a significantly high pass rate for Group-B (72%) compared with Group-A (44%), which proved the effect of gamification on motivation for the interface.

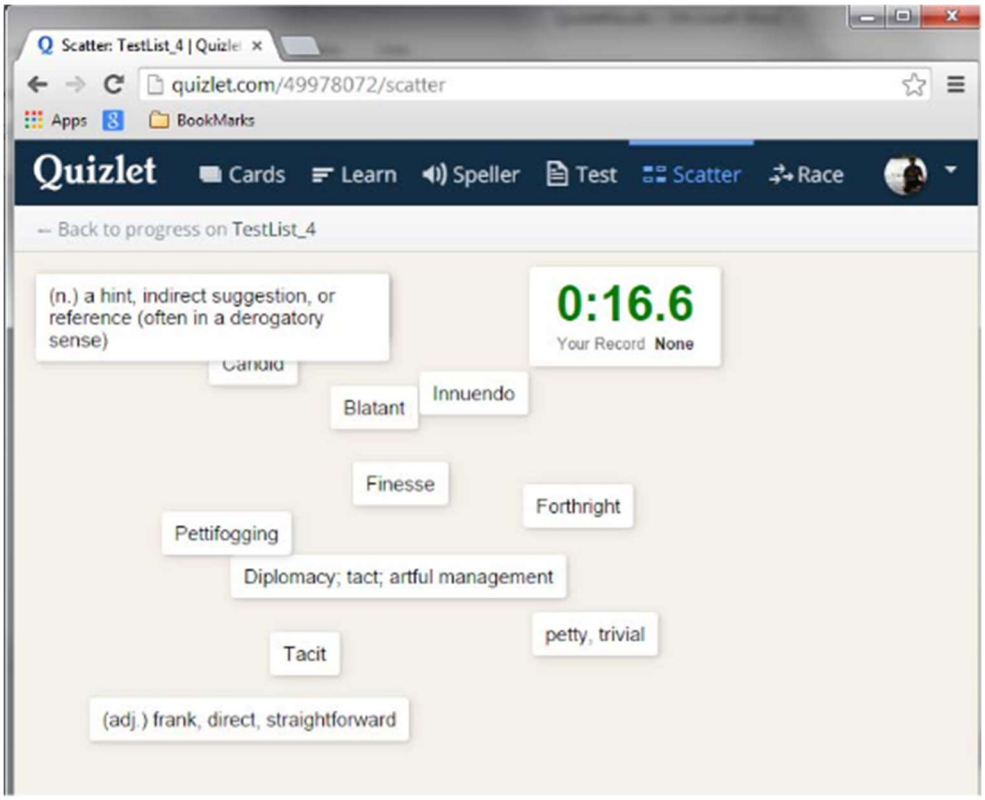

Figure 2.9 "scatter" Tool for Learning on quizlet.com Platform (Vaibhav, Gupta, 2014)

Meanwhile, some researchers concluded the design processes for gamified user interfaces for supporting motivation. For example, Ramakrisnan and Jaafar (2017) proposed a motivation design methodology, and applied it to develop a gamified online knowledge

sharing interface, which was named “i-Discuss”. In the motivation design methodology, a “five steps process” was proposed: 1) Identify the Objective of the Study. 2) Understand the Context of the Study and Target User Action. 3) Selection of Suitable Elements. 4) Setting Experience Points for User Actions. 5) Setting the Rules and Experience Points for Selected Elements. For step 3, game and social design elements were included. And the game elements consist of avatar, badges, leaderboard, playercontrol, feedback, and level. While the social element refers to tagging. Step 4 and 5 provide detailed guidance for giving learners experience points based on activities and rules.

In the real world, there are many motivation-supported user interfaces designed focusing on ‘gamification’ or ‘social’. The reason for this is because most of the time the developers struggle to understand how to motivate users properly, and ‘gamification’ and ‘social’ are the easy answers. But sometimes, an interface containing the elements of gamification or social may fail because the developer doesn’t have foundational psychological knowledge. So to bridge this knowledge gap new frameworks for supporting motivation are required (Lewis, 2013).

Chapter 3. Research Method

3.1. Design and Development Methodology

This research is aimed to design and develop a MOOCs interface that can improve learners' motivation. To achieve this, design guidelines that can guide the designing and developing process are needed. So literature related to motivational strategies, motivation theory, and user interface design were reviewed to derive the design guidelines that can support learners' motivation. Then, MOOCs interface design guidelines were developed based on the general design guidelines.

After the initial version of the MOOCs interface design guidelines was developed, validation tests were conducted to test the internal validity and external validity. First, two rounds of expert review were conducted for the internal validation of the MOOCs interface design guidelines. And then, for the external validation, a MOOCs interface prototype was developed based on the MOOCs design guidelines, and then given to experienced MOOCs learners for two rounds of response tests. During the process, the MOOCs design guidelines went through several rounds of revisions, and at the end, the final version of MOOCs interface design guidelines was developed.

This research follows the design and development methodology. According to Richey & Klein (2007), design and development research is defined as "the systematic study of design, development and evaluation processes with the aim of establishing an empirical

basis for the creation of instructional and non-instructional products and tools and new or enhanced models that govern their development".

According to the definition, design and development research can be classified into two types. Type 1 refers to studies on the design and development of products and tools, aimed at specific contexts, while type 2 refers to model design, aimed at generating general knowledge (Lim, Cho, Jang, & Ha, 2005). The difference between the two research types can be found in table 3.1.

Table 3.1 Two Type of Design & Development Research (Richey & Klein, 2014)

Design & Development Research	
Product & Tool Research	*Model Research*
Comprehensive Design and Development Projects • Instructional Products & Programs • Non-instruction Products & Programs	Model Development • Comprehensive Model Development • Development of Model Component Processes
Specific Project Phases • Analysis • Design • Development • Evaluation	Model Validation • Internal Validation of Model Components • External Validation of Model Impact
Design & Development Tools • Tool Development • Tool Use	Model Use • Study of Conditions Impacting Model Use • Designer Decision-Making Research • Designer Expertise & Characteristics Research

The purpose of this research is to develop a MOOCs interface that can improve learners' motivation. Which is aimed specifically at the context of MOOCs, so type 1 research was conducted to answer the research questions. In this research, the research procedures follow the order of 1) Development of design guidelines based on the result of literature review, 2) Experts review and design guidelines revision, 3) Prototype design and development, 4) Evaluation of learners' responses 5) Design guidelines revision. Among them, procedures 1, 2, and 5 answer the research question "What are the interface design guidelines and interface functions to motivate MOOCs learners to sustain their learning". Procedure 3 and 4 answer the research question "What is the interface to motivate MOOCs learners to sustain their learning". And procedure 4 answers the research question "What are the learner's responses to the interface". The detail of the research activities can be found in figure 3.1.

Figure 3.1 Research Procedures and Activities

3.2. Research Participants

In this research, to assure the internal validity of the MOOCs interface design guidelines, four experts from the area of educational psychology, educational technology, and computer science were invited for two rounds' validation test. The experts have professional knowledge on motivation theory, design and development research methodology, or interface designing, and both of them are interested in MOOCs education. The profile of the experts can be found in table 3.1. Based on the result of the validation test and suggestions given by the experts, the MOOCs interface design guidelines were revised.

Table 3.2 Profiles of Participating Experts

Expert	Research Field	Title	Research Experience	Academic Background
A	Educational Psychology	Associate Professor	7 Years	Ph.D
B	Educational Psychology	Associate Professor	6 Years	Ph.D
C	Computer Science	Associate Professor	17 Years	Ph.D
D	Educational Technology	Assistant Professor	2 Years	Ph.D

And for assuring the external validity of the MOOCs interface design guidelines, a prototype of the MOOCs interface was developed following the MOOCs interface design guidelines developed before, and given to five experienced MOOCs learners for a learner response test. The participating learners are bachelor's or master's students, majoring in Business, Education, or Chemistry Education. The information of the participating learners can be found in table 3.3.

Table 3.3 Information of Participating Learners

Learner	Gender	Education Background	MOOCs Using
A	Male	Bachelor/Business	1hour~3hours per week
B	Female	Master/Education	3hours~7hours per week
C	Female	Ph.D/Education	1hour~3hours per week
D	Female	Master/Education	less than 1 hour per week
E	Male	Bachelor/Chemistry Education	less than 1 hour per week

3.3. Research Tools

3.3.1. Internal Validation Tools

For the internal validation test, the expert validation form (see APPENDIX 1) and expert validation form(2nd) (see APPENDIX 2) were developed by modifying the expert validation form developed by Park (2015) according to the context of this research. The expert validation forms are aimed to evaluate the validity of each design guideline from two aspects, 1) Does the guideline itself make sense for a MOOCs environment, and 2) Whether the match between design principles and design guidelines is reasonable. 4 points Likert scale was used in the expert validation forms and experts were allowed to rate each of the guidelines from 1 to 4 (1: Not at all true, 4: Very true). After the experts finished the evaluation, their opinions on why some of the guidelines were negatively evaluated (score 1 or 2).

3.3.2. Prototyping Tool

Prototyping is a process used in the software Industry. Before developing the functional application, usually, a prototype is first designed and developed to evaluate if the design meets the needs of the end-users. Because the prototype gives the end-users opportunities to access the design at an early stage, designers can get feedback from the end-users, thus avoiding making some mistakes.

To develop the prototype of the MOOCs interface, Figma was used as the prototyping tool in this research. Figma is a web-based

graphics editing and user interface design tool, which can be used to do all kinds of graphic design work from wireframing websites, designing mobile app interfaces, prototyping designs, crafting social media posts, and everything in between. The one main reason that Figma is different from other graphics editing tools is that it works directly on a browser. This means without having to buy multiple licenses or install software, designers can get access to their projects and start designing from any computer or platform (themejunkie, 2021). And it supports team projects, which allows members of a design team to work on a project together at the same time.

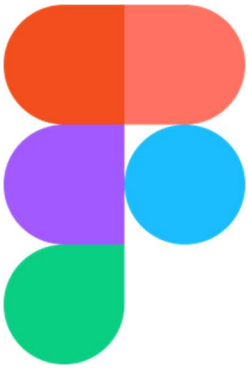

Figure 3.2 Logo of Figma

Prototypes can be classified into three types, namely low-fidelity prototype, mid-fidelity prototype, and high-fidelity prototype (Lim et al., 2015). Because Figma can map interface reaction behaviors to users' actions such as mouse clicking and allow the integration of multiple elements to achieve a complete product presentation (Hu et al., 2016), high-fidelity prototypes can be developed.

Table 3.4 Different Fidelity Levels (Engelberg, Seffah, 2002)

Fidelity	Appearance	Optimal uses	Advantages	Limitations
Low	Rough sketch; highly schematic and approximate. Little or no interactive functionality.	Early design: conceptualizing and envisioning the application.	Low cost: useful communication vehicle; proof of concept.	Limited usefulness after requirements established; limitations in usability testing
Mid	Fairly detailed and complete but ob-jects are presented in schematic or approximate form. Provides simulated interactive func-tionality and full navigation.	Designing and evaluating most interactive aspects, including navigation, functionality, content, layout and terminology.	Much lower cost and time as com-pared to high fidelity; detail is sufficient for usability testing; serves as a reference for the functional specification.	Does not fully communicate the look and feel of the final product; some limitations as a specification document.
High	Lifelike simulation of the final product; refined graphic design. Highly functional, but the back end might be simulated rather than real.	Marketing tool; training tool; simulation of advanced or highly interactive techniques.	High degree of functionality; fully interactive; defines look and feel of final product; serves as a living specification.	Expensive to develop; time consuming to build.

3.3.3. External Validation Tools

After the prototype was developed following the guidance of the design guidelines, it was given to five experienced MOOCs learners for the learner response test. The learner response evaluation sheet (see APPENDIX 3) was developed as a tool to evaluate learners' responses.

Because the survey for evaluating participants' responses to an educational program should be suitable for the intended purpose of evaluation (Lee, 2005). In this research, the purpose of the learner

response test is to evaluate whether the functions developed based on the MOOCs interface design guidelines can improve learners' perceived motivation. To achieve this, 8 tasks were given to the learners first which involve all the functions of the interface, along with 32 questions that related to learners' perception of the general design and each function.

The tasks contain: 1) Creating an account, 2) Taking an assessment and checking course recommendations, 3) Checking the detailed information of a given course, 4) Enrolling in a course with the learning mode "Self-paced", 5) Enrolling in a course with the learning mode "Scheduled", 6) Enrolling in a course with the learning mode "Premiere", 7) Checking personal information page, 8) Checking the dashboards. And the task detail can be found in APPENDIX 3.

After finishing the learning tasks, participating learners were asked to rate each of the given questions from score 1 (Not at all true) to 5 (Very true). Also, in the evaluation sheet, 6 in-depth interview questions are included, which allow learners to share their thoughts about their opinion on the advantages, problems, and suggestions for improvement of the designed MOOCs interface.

Also, after the prototype was revised based on the suggestions given by the participating learners, the revised prototype was given to the same group of learners for the second round learner response test to check if the prototype was properly revised. During this process, the learner response evaluation sheet (2nd) (see APPENDIX 6) was developed aiming specifically for the revised part

of the prototype, which consists of 12 questions that can be rated from score 1 (Not at all true) to 5 (Very true), and interview questions were included to allow the participants share their thought about the revision freely.

3.4. Data Collection and Analysis

3.4.1. Expert Review

The initial version of the MOOCs interface design guidelines was reviewed by 4 experts by using the expert validation form. After the experts got a basic idea about the background of the research, they were then invited to evaluate each of the design guidelines. For the guidelines that were rated negatively, they were allowed to explain the reason and their suggestions for improving the guidelines. And at the end, experts were allowed to share their thoughts freely about the research.

During this process, both quantitative data and qualitative data were collected. For the quantitative data, the content validity index (CVI) and inter-rater agreement (IRA) were calculated to verify the reliability and validity of the response results.

CVI is the most widely used approach for validation in instrument development, which can be computed using the Item-CVI (I-CVI) or the Scale-level-CVI (S-CVI). I-CVI is computed as the number of experts giving a rating of "very relevant" for each item divided by the total number of experts, which ranges from 0 to 1. When I-CVI > 0.79, the item is relevant, between 0.70 and 0.79, the item needs revisions, and if the value is below 0.70 the item needs to be deleted (Zamanzadeh et al., 2015). In this research, I-CVI was used to calculate the content validity index.

IRA is the degree of agreement among independent observers who rate, code, or assess the same phenomenon, and it can be calculated

by dividing the numbers of positively rated items into the numbers of all the items. When IRA is over 0.8, the internal validation can be interpreted as justifiable (Mo, 2020).

For the qualitative data, experts' opinions and suggestions were coded and categorized into several themes, which were used to revise the initial version of the MOOCs interface design guidelines.

3.4.2. Learners' Responses

To test learners' responses, a prototype of MOOCs interface developed based on the revised design guidelines was given to 5 experienced MOOCs learners along with the learner response evaluation sheet. A series of learner tasks were given to the learners, and then they were asked to use the prototype to finish those tasks. After that, learners were asked to evaluate each function offered by the interface in a survey, and give their opinions on the prototype from the perspective of motivation support in an in-depth interview. The learning task, survey, and in-depth interview for each learner took about 2.5 hours.

The quantitative data collected in the survey was used to calculate the mean and standard deviation. Meanwhile, the qualitative data collected from the interview was analyzed based on the content analysis method (Richey & Klein, 2007) after all of the content was transcribed. During this process, open coding was conducted, and major themes and categories were generated. To be more specific, first, important words and phrases were picked out as segments.

Then, the relationship between those segments was established. And at the end, the overall framework was concluded.

By analyzing the qualitative data, 3 categories, namely “Advantages of the MOOCs interface”, “Problems with the MOOCs interface”, “Suggestions for improvement” were generated along with several themes. And the last two categories provide ideas on how the prototype can be fixed and improved. For the problems of the prototype, first, UI/UX-related problems such as inconsistency, improper positioning, improper interaction, and lacking tutorial for novel functions were pointed out by the learners. Second, the learning activity-related problem of lacking homework and exams was found by the learners. For the ways of improvement, first, extra functions can be added to support learning, such as external reminders, and wiki. Second, extra information can be provided for a better user experience, such as adding course syllabus and course level on the course introduction page. Third, the premiere mode selector can be provided in a better way by changing it from simple text to a visualized timetable.

Chapter 4. Findings

4.1. The MOOCs Interface Design Guidelines

This research is aimed to develop a MOOCs interface that can improve learners' motivation. To achieve this, design guidelines that can guide the development of MOOCs interface are needed. To develop the design guidelines, literature related to "motivation", "motivation strategies", "motivation theories", "motivational theories", "interface design", "motivation strategies in E-learning", and "self-determination theory" were reviewed. Considering that intrinsic motivation plays a key role in MOOCs learning (Gottfried et al., 2007), in this research the three factors (autonomy, competence, and relatedness) that can affect intrinsic motivation proposed by Deci and Ryan (1985) were adopted into the framework, besides "satisfaction" from Keller's ARCS (1987) was adopted as the fourth motivation factor of the framework. Based on the 4 motivation factor framework, design principles and guidelines for MOOCs interface design were organized as the initial version of the MOOCs interface design guidelines (see APPENDIX 4). After that, the initial design guidelines went through two rounds of expert review, during this process the initial guidelines were revised (see APPENDIX 5). Then a prototype was developed based on the revised guidelines and tested by 5 learners. In the end, the learners' responses were analyzed and the guidelines were revised again.

4.1.1. The Final Version of the MOOCs Interface Design Guidelines

The final version of the MOOCs interface design guidelines consists of 3 motivational design principles (Autonomy, Competence, and Relatedness) , 12 motivational design guidelines (5 autonomy-supported, 4 competence-supported, and 3 relatedness-supported), and 34 design guidelines developed for MOOCs interface. The details of the final design guidelines can be found in table 4.1.

Table 4.1 Final Version of the MOOCs Interface Design Guidelines

Motivational Design Principles	Motivational Design Guidelines	Proposer	Design guidelines for MOOCs interface	Designed Functions
1. Autonomy-Support: Support the need to feel ownership of one's behavior	1.1 choice Allow learners to make their choice for learning	Katz & Assor (2007); Patall (2013); Gagn□ & Deci (2005); Muñoz-Restrepo, Ramirez & Gaviria (2020)	1.1.1 Allow learners to make choices for their learning mode: self-paced learning, scheduled learning, and premieres (Premieres lets viewers watch and experience a new video together in real-time, which has been used in entertainment platforms such as YouTube, yet has not been adopted by main MOOCs platforms).	Learning Mode Choice
			1.1.2 Allow learners to choose if they want to join a learning group, and what kind of group (local-based, career-based, or random) they want to join. (Also supports "3.1 love and belongingness")	Learning Group
			1.1.3 Offer a variety of learning activities such as individual activities, group activities so that the learners can choose from them. (Also supports "1.4 interest")	Learning Activities

			1.1.4 Allow premiere mode learners to choose their preferred premiere time by offering them a visualized time selector.	Time Selector
	1.2 goal Design so that learners can set their own learning goal thus achieving it.	Locke (1990); Shi & Cristea (2016); Gagn (2018)	1.2.1 Give learners the choice to set their goals so that the image of learning is formed intrinsically rather than extrinsically.	Goal Setting
			1.2.2 Provide goal achievement information on pages such as dashboards and learning content so that learners who set goals can check their goal achievement.	Dashboard /Reminder
			1.2.3 Allow learners to set up goal achievement reminders by Email and SNS.	External Reminder
	1.3 purpose / explanatory rationale Reveals learners the "hidden value" and "personal relevance" to make	Marczewski (2013); Muñoz-Restrepo, Ramirez & Gaviria (2020) Vansteenkiste et al. (2018)	1.3.1 Give learners the option to write down their motivation for course enrollment so that the image of learning can be formed intrinsically rather than extrinsically. (Also supports "1.1 choice")	Learning Purpose
			1.3.2 Present learners their recorded motivation for course enrollment in the learning pages so that learners do not forget their initial motivation.	Reminder

	them think they learn because there is a reason		1.3.3 When recommending learning content or learning activities to learners, make sure to provide their values and personal relevance.	Recommendation/Course Introduction
			1.3.4 When providing feedback, make sure to provide the reasons for it.	Feedback
	1.4 interest Design so that learners can engage in learning activities that fit their hobbies	Renninger & Hidi (2015)	1.4.1 Offer course recommendations based on the courses that the learner likes.	Recommendation
			1.4.2 Offer chances for learners to participate in learning activities that fit their hobbies by providing a variety of individual and team activities such as mind map making, note-taking, wiki, exams, and homework. (Also supports "1.1 choice")	Learning Activities
	1.5 invitational language Encourage learners' initiative and behavior change	Reeve, Cheon (2021)	1.5.1 When recommending learning content or learning activities to learners, avoid using strong language, and use invitational language instead.	Recommendation

	by relying on volition-rich language (e.g., "You might want to …," "You might consider … ")		1.5.2 Use invitational language as much as possible when providing feedback.	**Feedback**
2. Competence-Support: Support the need to produce desired outcomes and to experience mastery	2.1 self-actualization / scaffolding Help learners to grow and develop to their fullest potential	Maslow (1943); Herzberg (1959); Alderfer (1969); McLeod (2018) Muñoz-Restrepo, Ramirez & Gaviria (2020)	2.1.1 To provide more precise support, allow learners to set up their careers when registering for an account.	**Register**
			2.1.2 Inform learners when enrolling in improper courses based on their profile by offering explanatory rationales. **(Also supports "1.3 explanatory rationale", "1.5 invitational language")**	**Course Enrollment**
			2.1.3 Offer learning paths for learners based on their career goals **and abilities.**	**Learning Path**

			2.1.4 Offer support for social regulated learning (planning, monitoring, evaluating) to promote collaborative learning of online communities.	Team Activity Support
			2.1.5 Provide learners with additional learning material based on their ability and learning activities.	Dashboard
			2.1.6 Provide assistance to enable learners to set appropriate goals.	Goal Setting
	2.2 achievement Allow learners to feel and demonstrate their achievements	Herzberg (1959); McClelland (1965)	2.2.1 Offer learners statistics results of learning activities (weekly, monthly, and yearly) through a dashboard.	Dashboard
			2.2.2 Offer choices for learners to share their achievements with others within the MOOC platform and through SNS.	Dashboard
			2.2.3 Show progress change by using a pop-up window after each learning activity.	Feedback

	2.3 mastery Make learners feel that their abilities are increasing through learning activities	Marczewski (2013)	2.3.1 Offer learners a keywords checklist at the end of each chapter, by which the learners can have an intuitive idea of what they have learned.	Keywords Checklist
			2.3.2 Inform learners of their changes in terms of ability (e.g. numbers of keywords) and learning activity attendance through a dashboard.	Dashboard
	2.4 positive feedback Provide positive feedback to help learners feel responsible for their successful performance	Gagn & Deci (2005)	2.4.1 Provide positive feedback as much as possible, while when negative feedback is inevitable, provide it in an informative way.	Feedback
3. Relatedness–Support: Support the need to feel connected to others	3.1 love and belongingness Allow learners to join a group and feel a sense of belonging	Maslow (1943); Herzberg (1959); McClelland (1961); Alderfer (1969)	3.1.1 Organize various types of online communities (e.g. group based on location, career goal), and make it can be accessed easily. (Also supports "1.1 choice")	Learning Group
			3.1.2 Show learners successful learning cases of other learners in the same group.	Dashboard
			3.1.3 Provide like–button and emoticons to help learners share their emotions with each other, thus feeling a sense of belonging. (Also supports "1.1	Chatting Window/Group Activity/ Team

			choice”)	Activity
	3.2 social environment Allow learners to learn and construct knowledge through communication in a community	Bandura (1999); Gopalan et al. (2017); Shi & Cristea (2016)	3.2.1 Offer various communication spaces (e.g. comment space, question space, note space, group activity space) with search functions to promote learners’ communication.	Chatting Window/Group Activity/Team Activity
			3.2.2 Foster interaction between learner and instructor by allowing the learners to evaluate the courses after each chapter and show the result to both the learners and the instructor. (Also supports “1.1 choice”)	Course Evaluation
	3.3 task-oriented environment Facilitate cooperation between students by creating a task-oriented environment	Mayo (2005)	3.3.1 Offer options for learners to take team assignments. (Also supports “1.1 choice”)	Team Assignment
			3.3.2 Provide options for creating and sharing mind maps, notes with group members. (Also supports “1.1 choice”)	Mind Map/Note

To support learners' autonomy, 5 design guidelines were derived from existing literature. Which are "choice", "goal", "purpose", "interest", and "invitational language". "Choice" is aimed at helping the learners build a sense of ownership in learning by offering them choices (Katz & Assor, 2007; Patall, 2013; Gagn□ & Deci, 2005; Muñoz-Restrepo, Ramirez & Gaviria, 2020), and letting the learners control their own work (McClelland, 1961; KHURANA, JOSHI, 2017). However, giving learners choice does not mean letting them do whatever they want. Not only do goals need to be attained, but also rules need to be followed (Gagn□, 2018). "Goal" is aimed to help learners set their own goal, thus feel more responsible and more likely to achieve it. "Purpose" is aimed to help learners build a feeling that when they learn, there is a reason (Marczewski, 2013) by revealing them the "hidden value" and "personal relevance". Previous studies in learning motivation have shown that when learners perceive that a lesson has personal value or relevance, they tend to engage more, make more efforts, thus achieve more (Muñoz-Restrepo, Ramirez & Gaviria, 2020). Neuroscience provides evidence that people are born to think the pursuit of their interest rewarding (Renninger & Hidi, 2015). And "interest" is aimed to make the learners engage in learning spontaneously by offering them learning activities that fit their hobbies. "Invitational language" is the last autonomy-supported guideline, which aimed to encourage learners' initiative and behavior change by using volition-rich language. Previous studies have shown that when instructors make a request or address learners' problems, both the content and tone of the

instructor’s language are important. And compared with preemptive pressuring language (e.g. “you must”, “you have to”), volition-rich language (e.g. “you might want to”, “you might consider”) are more helpful in terms of helping learners overcome problems of inertia (Reeve, Cheon, 2021).

To support learners’ competence, 4 design guidelines were derived from existing literature. Namely, “self-actualization”, “achievement”, “mastery”, and “positive feedback”. “Self-actualization” refers to helping the learners to grow and develop to their fullest potential. One of the most common ways to achieve this in the context of education is called scaffolding, which refers to the temporary assistance instructors give to learners in order to help them complete a task that the learners would not be able to achieve on their own (Muñoz-Restrepo, Ramirez & Gaviria, 2020). “Achievement” is aimed to offer opportunities to the learners to make them feel or demonstrate their achievements. People want their achievement to be recognized by others (Herzberg, 1959) and they can be motivated by achievement-need, but not impossible challenges (McClelland, 1965). “Mastery” is aimed to make the learners feel that their abilities are increasing through learning activities. The path to mastery is a concept that is often used in video games, where the challenge is increased as the player's level of skill increases. Because it is important to us that we feel our skill is increasing in direct proportion to the level of challenge (Marczewski, 2013). The last competence-supported guideline is “positive feedback”, which helps learners feel responsible for their successful

performance. Previous studies have shown that positive feedback is helpful for facilitating intrinsic motivation by promoting a sense of competence (Fisher, 1978; Ryan, 1982), and effective feedback must be descriptive (Muñoz-Restrepo, Ramirez & Gaviria, 2020).

To support learners' relatedness, 3 design guidelines were derived from existing literature. Namely, "love and belongingness", "social environment", and "task-oriented environment". "Love and belongingness" is aimed to help learners join groups thus feeling a sense of belonging. As one of the human beings' basic needs (Maslow, 1943), human emotions need to affiliate with and be accepted by members of a group. In the context of education, "instructors who share warm, personal interactions with learners, who respond to their concerns in an empathic manner and who succeed in establishing a relationship of mutual trust and respect with the learners are more likely to inspire them in academic matters than those who have no personal ties with the learners (Dörnyei, 2001)". "Social environment" refers to allowing learners to learn and construct knowledge through communication in a community. Social techniques become increasingly popular in e-learning because they can attract learners to interact with peers, which lead to not only promoting learners' learning activities participants but also motivating learners to create learning content (Shi & Cristea, 2016). The last relatedness-supported guideline is "task-oriented environment". By offering a task-oriented environment, the cooperation between the learners is more easily conducted, thus fostering relatedness (Mayo, 2005).

4.1.2. The Results of the Expert Review

1) The Results of the First Round Expert Review

The initial version of the MOOCs interface design guidelines developed through literature review (see APPENDIX 4) were reviewed by 4 experts to ensure the initial validity. The experts have professional knowledge in motivation theory or interface design, two with PhDs in educational psychology, one with PhDs in educational technology, and one with PhDs in computer science. After knowing the background of the research, the experts were asked to fill the "Expert Validation Form" (see APPENDIX1) that contains questions related to the validity of each design guideline from the perspective of 1) Does the guideline itself make sense for MOOCs environment, and 2) Whether the match between design principles and design guidelines is reasonable. The experts were allowed to rate each guideline from a score of 1 to 4. And after the survey, an in-depth interview was conducted to get more specific information on why some of the guidelines got lower ratings and their suggestions for improving the MOOCs interface design guidelines.

The validation result for the initial version of the design guideline can be found in table 4.2. The mean of each guideline ranges from 2.75 to 4.0, and the CVI ranges from .50 to 1.0 with the IRA equal to .78. Because the CVI of some design guidelines and the IRA is smaller than 0.8, the initial version of the MOOCs interface design guidelines needs to be revised.

Table 4.2 Validation Result of the Initial Design Guideline

Guideline	Expert				M	SD	CVI	IRA
	A(EP)	B(EP)	C(CS)	D(ET)				
1.1	4	4	4	4	4.00	.00	1.0	
1.2	4	3	4	3	3.50	.50	1.0	
1.3	3	3	3	3	3.00	.00	1.0	
1.4	3	3	3	3	3.00	.00	1.0	
1.5	4	3	4	3	3.50	.50	1.0	
1.6	4	4	4	3	3.75	.43	1.0	
1.7	4	3	4	3	3.50	.50	1.0	
1.8	4	3	3	3	3.25	.43	1.0	
2.1	4	3	3	3	3.25	.43	1.0	
2.2	4	3	4	3	3.50	.50	1.0	
2.3	4	3	4	3	3.50	.50	1.0	
2.4	4	4	4	4	4.00	.00	1.0	
2.5	2	4	3	3	3.00	.71	.75	
2.6	4	4	4	4	4.00	.00	1.0	.78
2.7	4	4	3	2	3.25	.83	.75	
2.8	4	4	4	4	4.00	.00	1.0	
3.1	4	4	3	3	3.50	.50	1.0	
3.2	4	4	4	3	3.75	.43	1.0	
3.3	4	4	4	3	3.75	.43	1.0	
3.4	4	4	3	4	3.75	.43	1.0	
4.1	4	4	2	1	2.75	1.30	.50	
4.2	4	4	4	3	3.75	.43	1.0	
4.3	3	4	4	3	3.50	.50	1.0	
4.4	3	3	4	3	3.25	.43	1.0	
4.5	4	3	3	2	3.00	.70	.75	
4.6	4	4	3	2	3.25	.83	.75	
4.7	4	4	3	2	3.25	.83	.75	

2) Design Guidelines Revision

The Experts gave their suggestions for how the design guidelines can be improved during the in-depth interviews. And the qualitative data collected from the interview was analyzed to find out how to revise the initial guidelines. By coding and classifying the suggestions, they were concluded into three categories, namely "choice of words", "content", and "structure", and the detail can be found in table 4.3. Based on the suggestions, the initial guidelines were revised, the revised MOOCs interface design guidelines are shown in APPENDIX5.

Table 4.3 Experts' Suggestions and Revising Activities

Category	Experts' Suggestions	Revising Activities
Choice of Words	Terminology is not used consistently	For terms with similar meanings, choose one unified term (e.g. "students" -> " learners", "let" ->" allow")
	Design guideline 2.5 "restrict" that related to motivation factor competence may conflict with the other motivation factor "autonomy"	Change the word "restrict" to "inform".
Content	Design guidelines related to the design principle "goal", "purpose" may decrease the level of autonomy, rather than compulsory, this should be an option for learners.	Change the guidelines to provide learners alternatives and allow them to choose freely.
	Guidelines should be described in detail, but some of the design guidelines are too vague and may lead to misunderstanding.	Include detailed functions and how to achieve them in the guidelines.
	To help users to achieve self-actualization, creating and providing informative feedback are critical.	Add design guidelines to provide informative feedback.
	Compared to offering groups function to learners, it is more important to promote their collaborative learning	Add design guidelines to facilitate group learning.

	Design guideline 2.5 is more close to the principle of “self-actualization”.	Put guideline 2.5 in the category “self-actualization”.
	Design guideline 2.6 is more close to the principle “mastery”.	Put guideline 2.6 in the category “mastery”.
	The design principles “power” and “choice” are very similar.	Delete the design principle “power”.
Structure	The structure is confusing.	Change the framework to design principles, design guidelines, and design guidelines for MOOCs interface.
	Satisfaction can be achieved by supporting autonomy, competence, and relatedness.	Delete motivation factor “satisfaction” and re-consider the related design guidelines.

3) The Results of the Second Round Expert Review

The revised design guidelines were given to the same group of experts for the second round of expert review. This process is conducted by using the same way as the first round of expert review. The validation result of the survey can be found in table 4.4. This time the mean of each guideline ranges from 3.25 to 4, which is much improved compared with the result of the first round expert review, where the result ranges from 2.75 to 4. And both the CVI and IRA reached 1.0, which are greater than .80. And it means the internal validity of the guidelines has been proved. So, the guidelines can be used for the prototype designing

Table 4.4 Validation Result of the Revised Design Guidelines

Guideline	Expert				M	SD	CVI	IRA
	A(EP)	B(EP)	C(CS)	D(ET)				

1.1.1	4	4	4	4	4	.00	1.0	
1.1.2	4	4	4	4	4	.00	1.0	
1.1.3	4	4	4	4	4	.00	1.0	
1.2.1	4	4	4	3	3.75	.43	1.0	
1.2.2	4	3	4	4	3.75	.43	1.0	
1.2.3	3	3	4	4	3.5	.50	1.0	
1.3.1	3	3	3	4	3.25	.43	1.0	
1.3.2	3	3	4	4	3.5	.50	1.0	
1.4.1	4	3	4	4	3.75	.43	1.0	
1.4.2	4	4	4	3	3.75	.43	1.0	
1.5.1	4	4	4	4	4	.00	1.0	
1.5.2	4	4	4	4	4	.00	1.0	
1.6.1	4	3	4	4	3.75	.43	1.0	
1.6.2	4	4	4	4	4	.00	1.0	
2.1.1	4	3	3	4	3.5	.50	1.0	
2.1.2	3	4	4	4	3.75	.43	1.0	
2.1.3	4	3	4	4	3.75	.43	1.0	1.0
2.1.4	4	3	4	4	3.75	.43	1.0	
2.1.5	4	4	4	4	4	.00	1.0	
2.2.1	4	4	4	4	4	.00	1.0	
2.2.2	4	4	4	4	4	.00	1.0	
2.2.3	4	4	4	4	4	.00	1.0	
2.3.1	4	4	4	4	4	.00	1.0	
2.3.2	4	4	4	4	4	.00	1.0	
2.4.1	4	4	4	4	4	.00	1.0	
2.4.2	4	4	4	4	4	.00	1.0	
3.1.1	4	4	4	4	4	.00	1.0	
3.1.2	3	3	4	4	3.5	.50	1.0	
3.1.3	4	4	4	4	4	.00	1.0	
3.2.1	4	4	4	3	3.75	.43	1.0	
3.2.2	4	4	4	3	3.75	.43	1.0	
3.3.1	4	3	4	4	3.75	.43	1.0	
3.3.2	4	4	4	4	4	.00	1.0	

4.2. Prototype of the MOOCs Interface

After the MOOCs interface design guidelines got validated by experts, those design guidelines were followed to create a MOOCs interface prototype to support learners' motivation.

In this research, Figma was used to create a high-fidelity prototype. Figma is a prototyping tool primarily based on the web, with a powerful collaboration feature that can be very helpful for teamwork. The reason Figma was chosen over other tools in this research is that it offers a variety of plugins to help the design, also Figma is web-based which means it can be easily operated on different devices with web browsers and designers don't need to worry about losing their file when their device gets broken.

The prototype will be introduced from the perspective of MOOCs learners. Because learners can choose from one of the three learning modes, namely self-paced, scheduled, and premiere for each course, the introduction will be in the order as 1) Overview of the prototype 2) Register an account. 3) Skill assessment. 4) Enrollment suggestion. 5) Self-paced mode. 6) Scheduled mode. 7) Premiere mode. 8) Learning dashboard.

Considering the scheduled mode and the premiere mode don't exist in traditional MOOCs platforms, before diving into the details of the prototype, it is necessary to have a look at how traditional MOOCs platforms provide learners with learning mode and how those two new learning modes work.

When enrolling in a course from edx, learners can find out the learning mode of the course on the enrollment page. edx offers two kinds of learning modes, namely self-paced, instructor-paced. The self-paced mode is a way that learners can get access to all the learning resources of a course from the first day. While the instructor-paced mode is a way that course resources get published periodically under the control of the instructors. By analyzing the enrollment process from the perspective of a MOOC learner, two main problems were found: 1) The learning mode is decided by the instructors, not the learners. For example, if a learner wants to enroll in "Python Basics for Data Science" shown in figure 4.1, the learner has to study the course in self-paced mode, and if a learner wants to enroll in "Bridging differences" shown in figure 4.2, the learner has to study the course in instructor-paced mode. 2) For instructor-mode courses, learners that don't enroll in the course at the beginning have to face an awkward situation that the due time set by the instructor has passed. For example, Figure 4.3 shows an example that when a learner enrolls in a course in November, the deadline of the learning activity "Practice Problem Set" has passed in October.

Table 4.5 Two different learning modes that edx offers (edx help center, 2021)

What's the difference?	**Self-paced**	**Instructor-paced**
Content availability	Everything available as soon as the course starts	Content may be published periodically
Due dates on assessments	Flexible (read more)	Fixed
Certificates available	As soon as you pass	After the course ends
Course duration (read about end dates)	Several months or years	Weeks or months

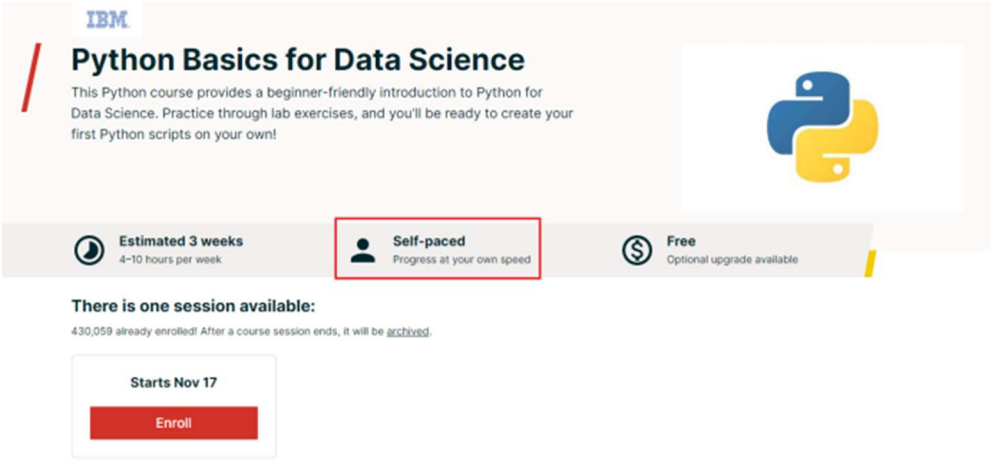

Figure 4.1 Self-paced Course

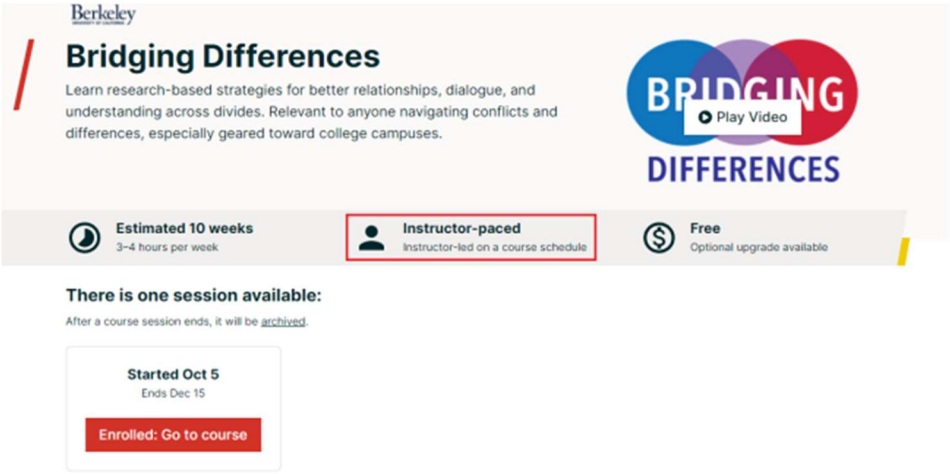

Figure 4.2 Instructor-paced Course

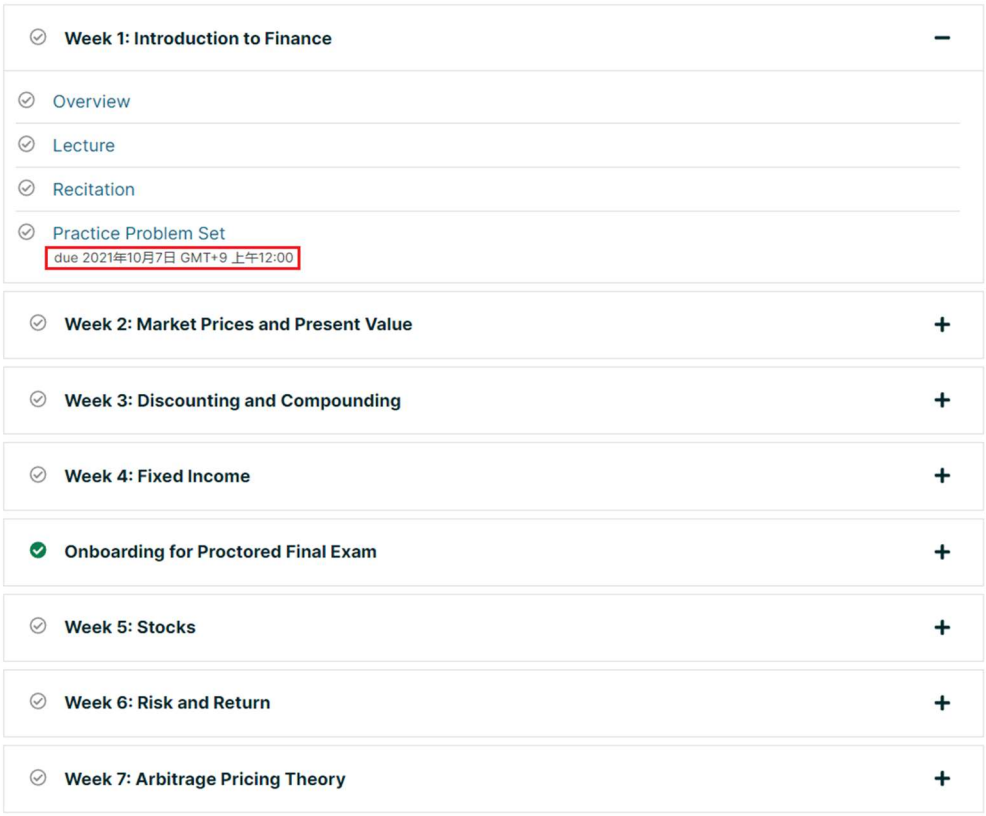

Figure 4.3 Due Setting of an Instructor-paced Course

Compared with edx, Coursera and Udacity are different considering both of them don’t show learners what kind of mode a course is on the enrollment page because they only offer self-paced mode for learners.

On the contrary, Chinese MOOCs platforms take a different approach for providing learners with diverse learning modes. Both xuetangX and icourse163 offer learners self-paced mode and instructor mode for a course. The way they achieve this is by making old sessions of a course available and learners can learn by self-paced mode, meanwhile, the newest session of a course is instructor-paced. Figure 4.4 shows how icourse163 provides learners self-paced and instructor-paced at the same time. However, because the self-paced mode is achieved by reusing the old version of a course, learners cannot get access to the updated version of a course.

Figure 4.4 Learners Can Enroll in a Course Self-paced or Instructor-paced

The comparison of those platforms from the perspective of providing learners learning mode options can be found in table 4.6 shown below.

Table 4.6 Learning Mode Offering of the Existing MOOCs Platforms

	Learning mode	Characteristic	Problems
edx	self-paced, instructor-paced	1. self-paced mainly 2. each course only provides one way of enrollment	1. instructors decide courses' mode, not learners. 2. For instructor-paced mode, learners who enroll after the course's start day can get confused because of the wrong due setting.
Coursera	self-paced	self-paced only	Due time is set by the system in default.
Udacity	self-paced	self-paced only	Due time is set by the system in default.
xuetangX	self-paced, instructor-paced	instructor-paced mainly	self-paced courses are old version courses
icourse163	self-paced, instructor-paced	self-paced and instructor-paced almost even	self-paced courses are old version courses

Compared with those traditional MOOCs platforms, three learning modes, namely self-paced mode, scheduled mode, and premiere mode are provided to MOOCs learners when they enroll in a course using the platform developed in this research. Self-paced mode is the same as what traditional MOOCs platforms such as edx are

providing. Scheduled mode is different from instructor-paced mode, course resources are opened weekly based on learners' enrollment time, which leads to the result that no matter when a learner enrolls in a course, he can always get his personalized due settings. For premiere mode, the instructors can set a few options of premiere time for learners to choose from, learners can join in the premiere with peer learners, course assistants, and instructors to have a more interactive learning experience. With this knowledge in mind, it is time to have a look at the MOOCs prototype designed in this research.

1) Overview of the prototype

Figure 4.5 shows the main page of the MOOCs interface. On the top, there is a navbar that contains "Main", "Course", and "Organization" buttons, and by clicking it learners can switch from the main page, course list page (see Figure 4.6), and organization list page (see Figure 4.7). On the right side of the navbar, the profile photo with a username can be found, and by clicking this part, users can easily get access to personal information.

On the hero section of the main page, a skill assessment button "Assess my skills" is provided, by clicking it learners can take an assessment and get their personalized learning path recommendation.

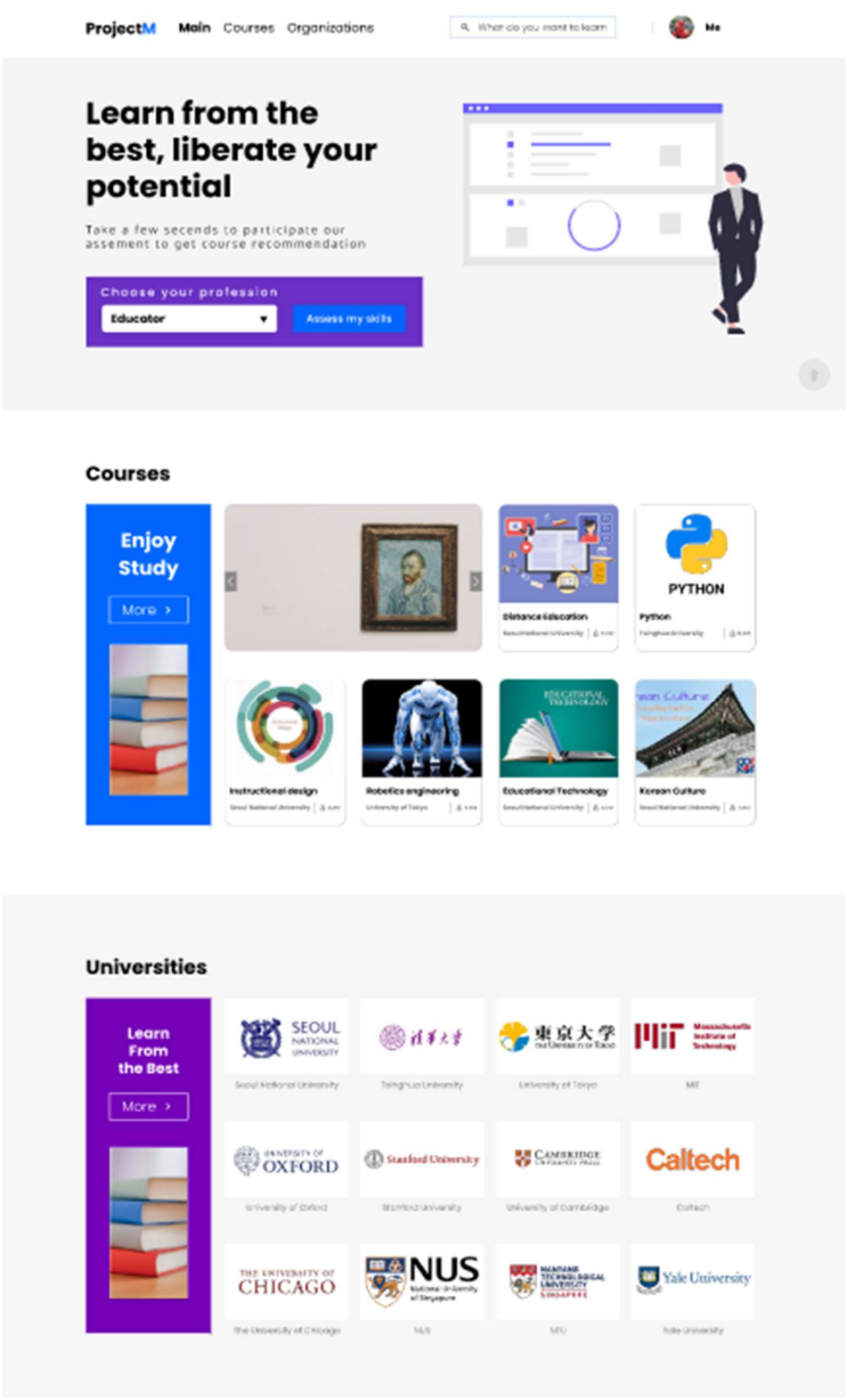

Figure 4.5 Main Page

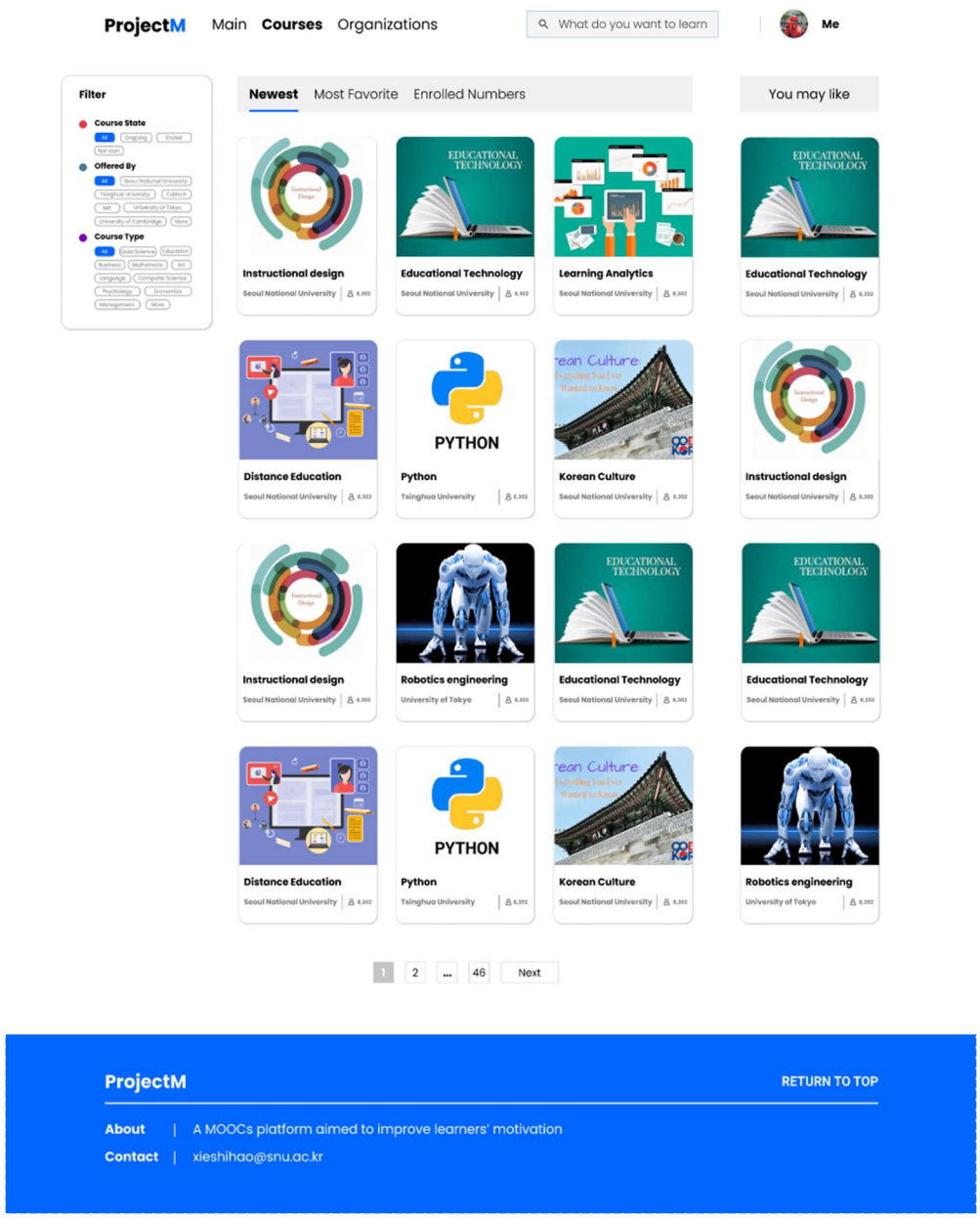

Figure 4.6 Course List Page

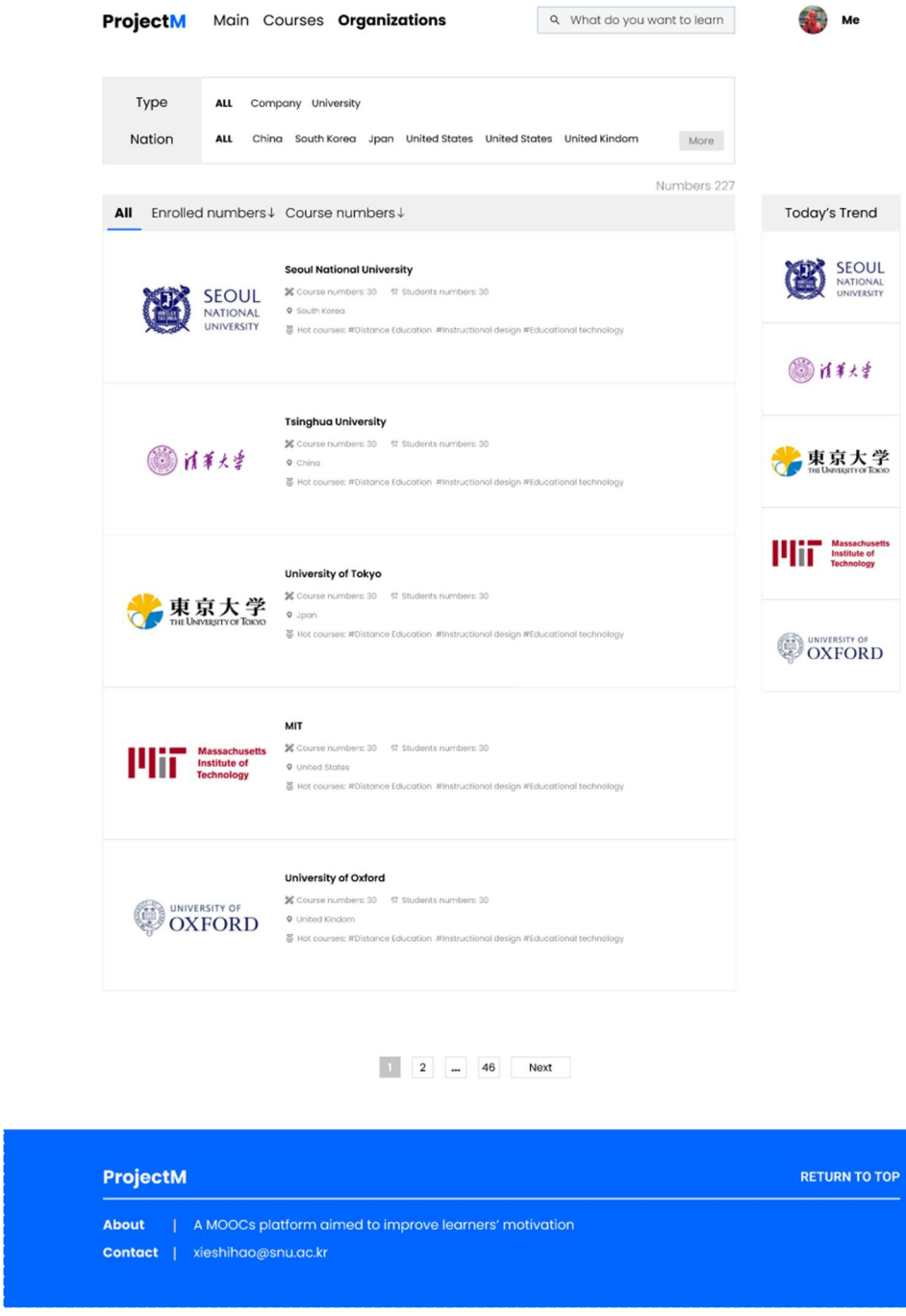

Figure 4.7 Organization List Page

2) Register an account

Registering an account is an inevitable process for most online services. Compared with traditional MOOCs platforms like edx, learners need to input extra information which is their career goal. This information is essential for later processes such as skill assessment and group making, so it is not skippable.

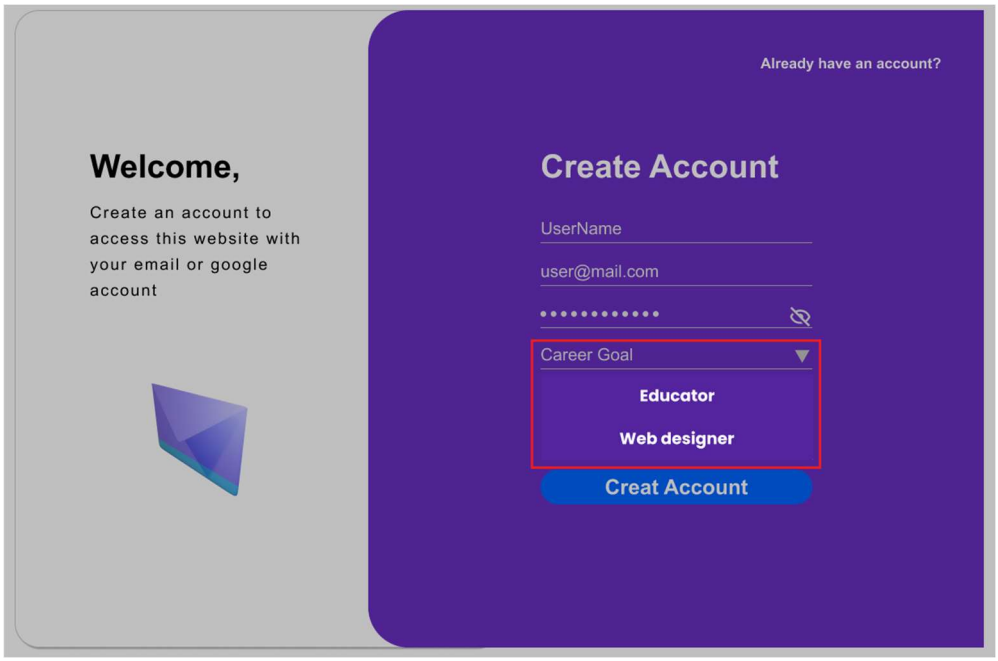

Figure 4.8 Career Goal Setting When Register an Account

3) Skill assessment

To use this MOOCs platform, the first thing a learner is suggested to do is take a skill assessment based on the career goal. After finishing a certain amount of questions generated from different courses, the system will know which course contains knowledge that the learner doesn't have. With every courses' prerequisite

information, the computer can calculate the learner’ s every possible learning path. Also, based on other learners' learning data, the system can recommend the best learning path to the learner.

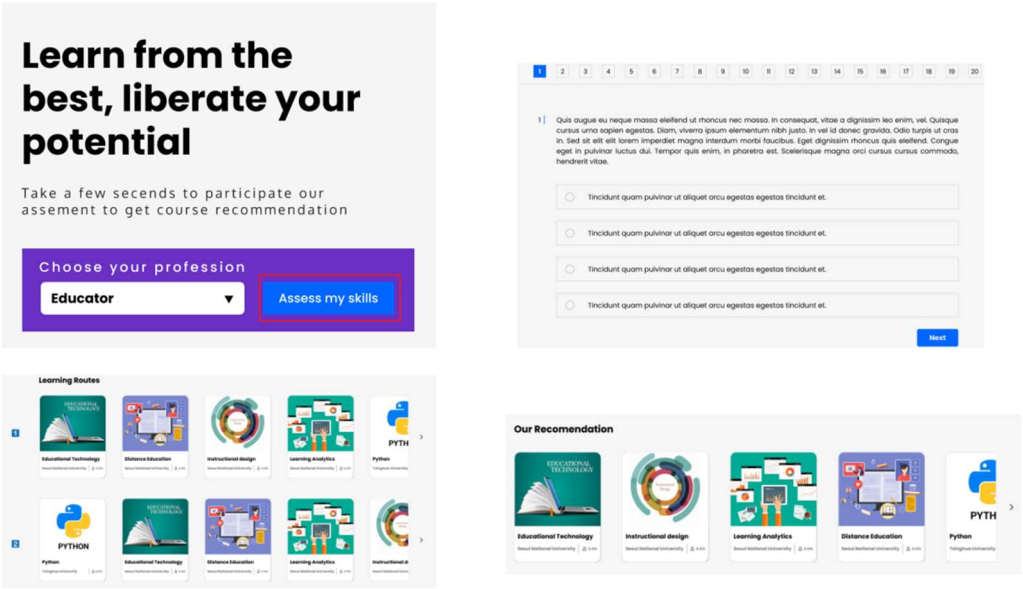

Figure 4.9 Process of Skill Assessment and Learning Path Recommendation

4) Enrollment suggestion

Some functions are designed to help learners decide if they want to enroll in a specific course. The first one is the mind map function. Learners can refer to mind maps created by other learners to have an overview of what they can learn from that course. The second one is the course introduction function. Instructors can leave some important information such as what the learners will benefit from learning this course. The third one is the reminder function. When a learner enrolls in an improper course, a popup window will show the

learner why the course is not suitable for him/her, and suggestions will be provided instead.

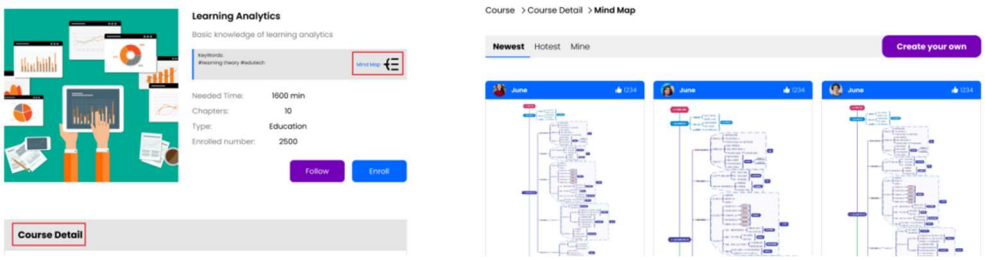

Figure 4.10 Learning Map Shared by Other Learners

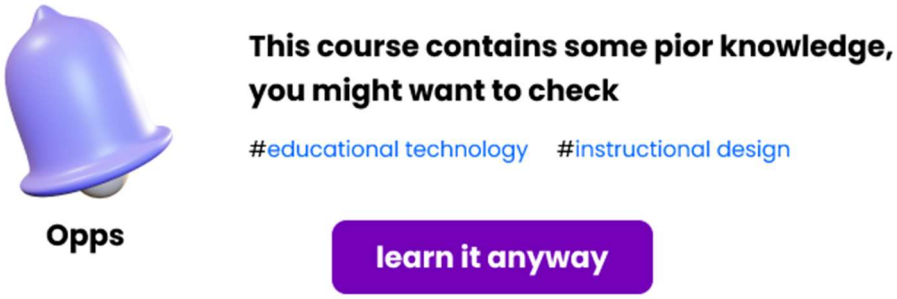

Figure 4.11 Course Enrollment Reminder

5) Self-paced mode

As mentioned before, the self-paced mode is a way that opens every learning resource to learners at once and lets them control their own learning pace. Although this learning mode can be found in every MOOCs platform investigated in this research, it is slightly different here that learners need to do some setting work before starting the learning.

Firstly, learners can choose to set their learning goals (see Figure 4.13). Considering self-paced mode requires learners to control their learning pace, a pre-set learning goal can help them to monitor their learning process, thus more likely to succeed in self-regulated learning. For this process, learners can set what days they want to learn during a week, along with a day's learning load. In order to avoid learners setting their learning load too low or too high, the system provides them with a recommendation. Based on learning days and a day's learning load, the system will calculate an expected completion time, which can be useful if a learner needs to finish a course within a limited time. At last, learners are allowed to write down their learning purpose for course enrollment, so that the image of learning can be formed intrinsically rather than extrinsically, and this purpose will be shown on the learning pages as a reminder to motivate them to learn.

Secondly, learners can choose if they want to join a learning group (see Figure 4.14), which contains 20~30 peer learners. A group can be location-based or career goal-based. When a learner chooses to join a group, he/she will be a member of a group that contains learners who 1) chose self-paced mode. 2) enrolled in the course at a close timeline.

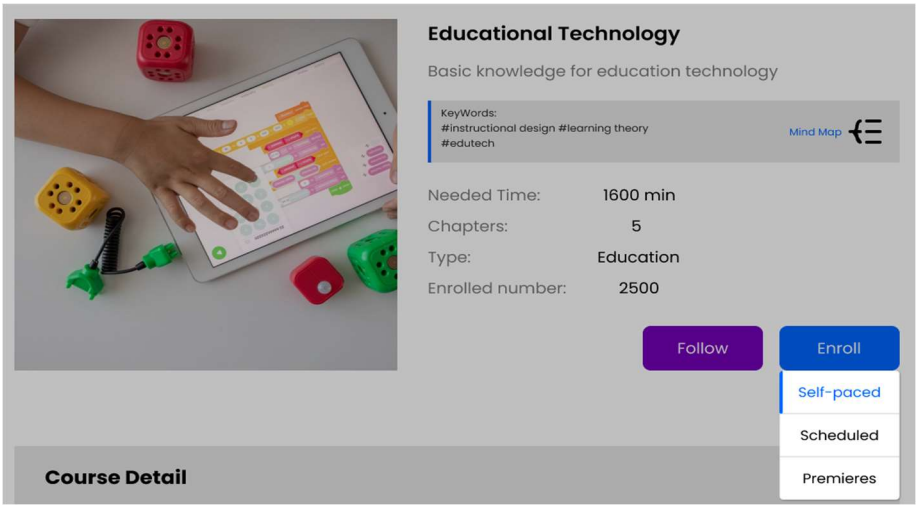

Figure 4.12 Self-paced Mode Choice

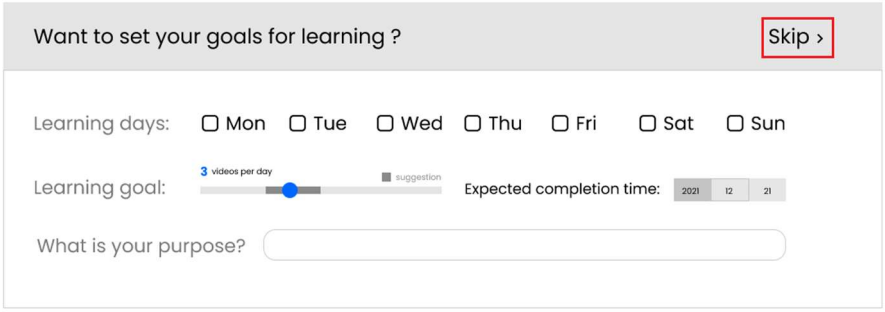

Figure 4.13 Self-paced Mode Goal Setting

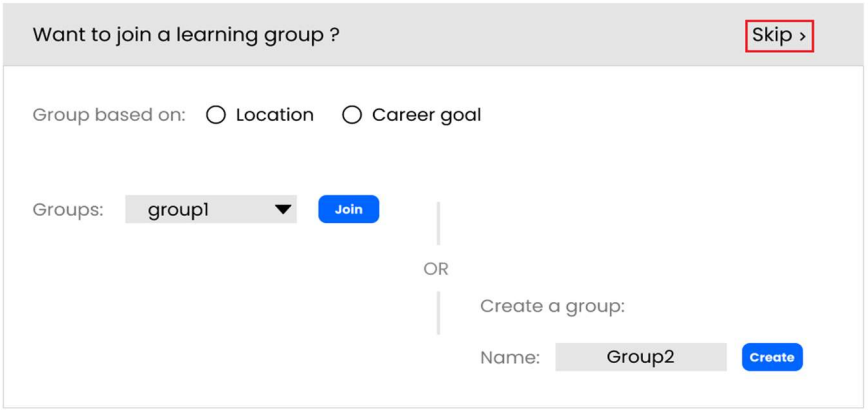

Figure 4.14 Self-paced Mode Joining a Group

After learners finish their set, they can move to the course detail page (see Figure 4.15). Because this is the self-paced mode, learning material from chapter1 to the last chapter is open to the learners. At the top, the learning purpose set by the learner is shown in the color red. In the middle, the days' due calculated based on learners' setting is shown in color red with an alarm icon. On the right side of the page is a chatting window (see Figure 4.16) where group members can communicate with each other in real-time.

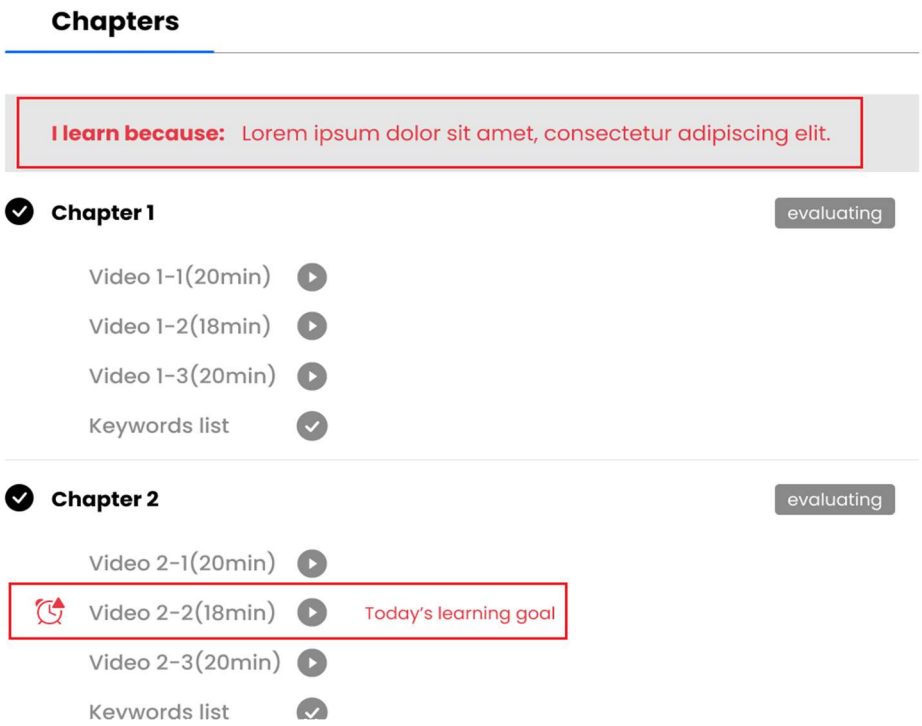

Figure 4.15 Course Detail Page of Self-paced Mode

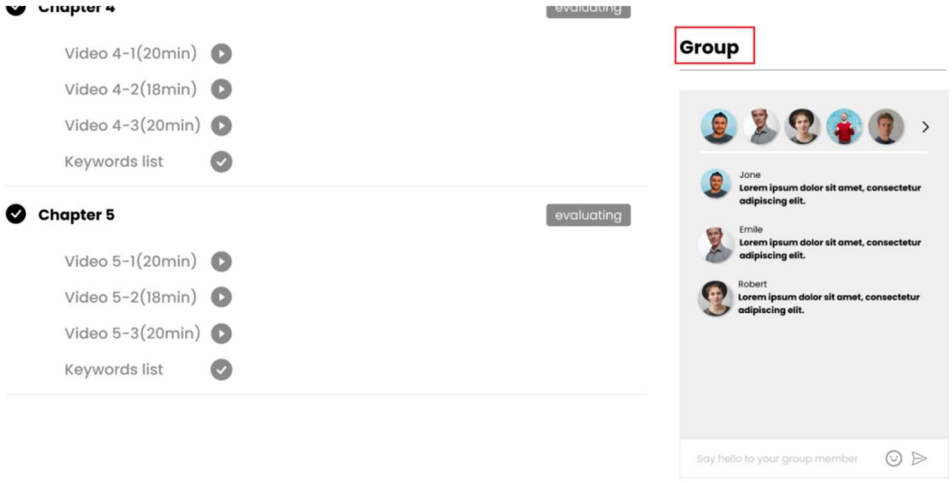

Figure 4.16 Group Chatting Window

Then is the learning page. At the top, video play takes most of the place. At the left bottom, there is a button that can be clicked and will turn into a function bar (see figure 4.17). Basically, two functions are provided to learners when watching a video. One is mind map making, another is note-taking. Figure 4.17 shows where to find the note-taking button and how learners take notes during the learning process. It is a popup window, on the left side is a screenshot of the video, and on the right side is the space where learners can write down their notes. Also, learners can choose to make their notes public or private by clicking the button on the top.

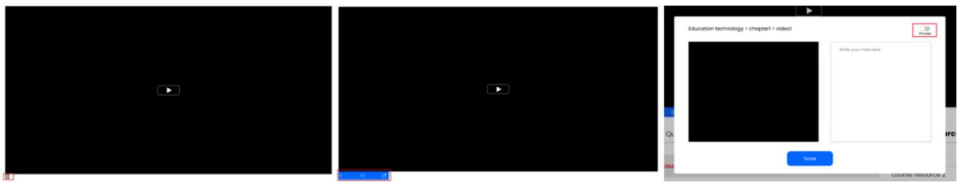

Figure 4.17 Note-taking Function

When learners have questions, they can click the “Questions” on the function bar (see figure 4.18). They can post their own questions, also they can try to search if any other learners have posted similar questions by using the search function. Also, questions posted by other learners are listed on this page, and if the question has been solved, there will be a solved mark behind the question. The right side of Figure 4.18 shows the question detail page, where the question can be answered and contains all of the answers posted by other learners.

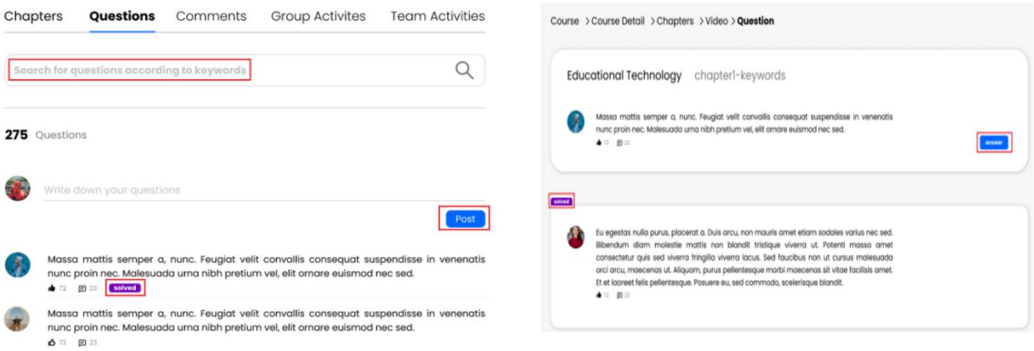

Figure 4.18 Question Search and Answer

Apart from the space for sharing questions, comments space is also provided for learners (see Figure 4.19) to allow them to share their emotional feelings during the learning process.

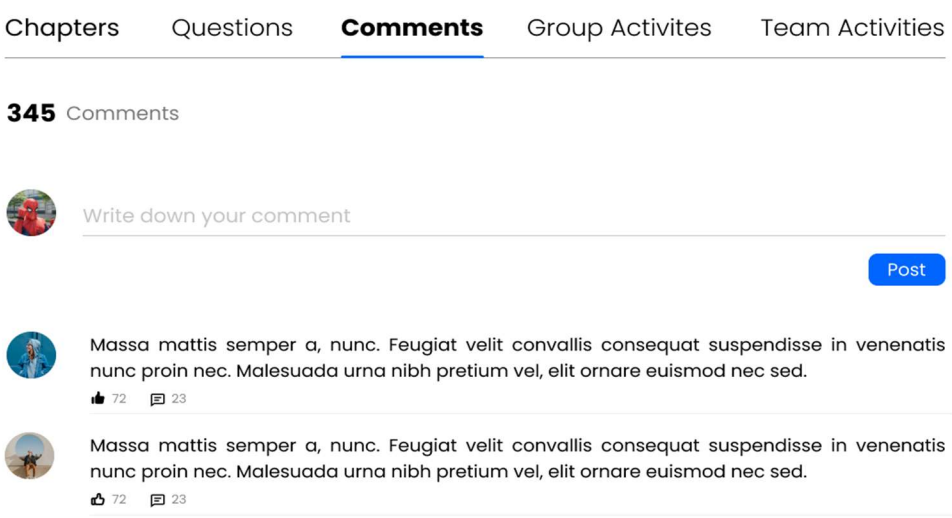

Figure 4.19 Separated Comments Window for Emotional Expression

The group activities page is a space for group members to interact with each other. Here not only shows group members' mindmaps and notes but also shows group members' questions and comments (see Figure 4.20).

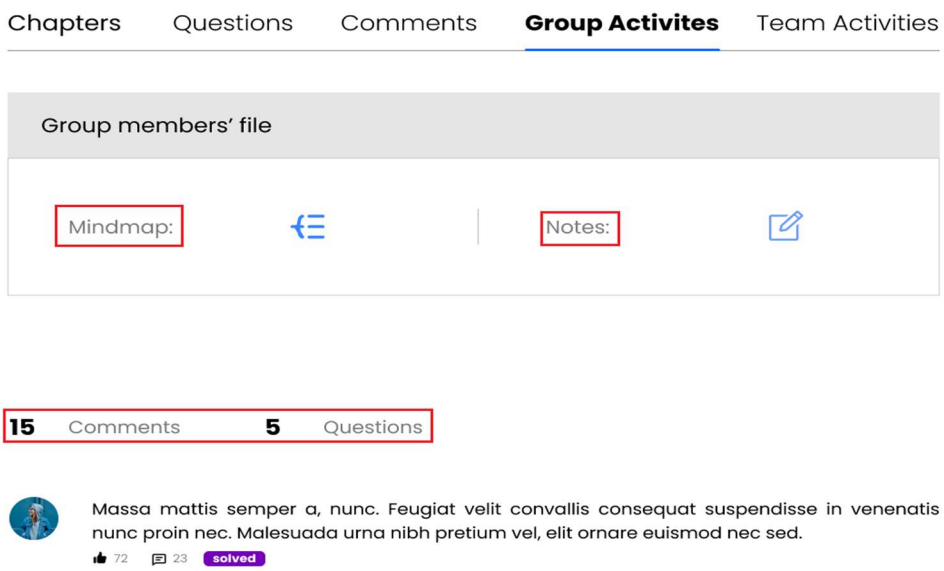

Figure 4.20 Group Activity Space

At the end of each chapter, a keyword list is provided to learners as a method to quickly review what they learned from that chapter. Learners can check the keywords that they know already, and the explanations of those unchecked keywords will be shown on the next page.

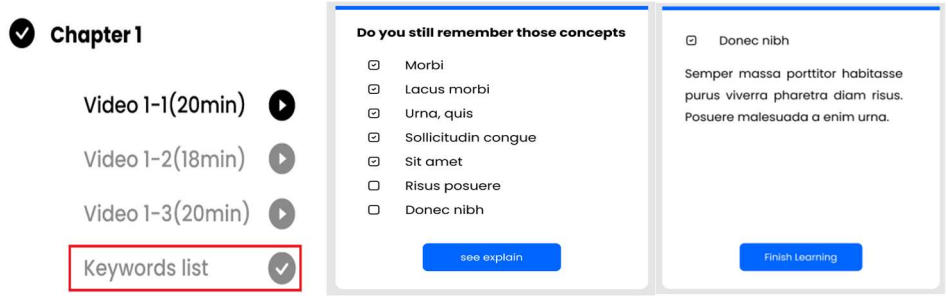

Figure 4.21 Keyword Checklist for Quick Self-assessment

After learners finish a chapter's learning, a popup window containing learning statistic information will be shown to the learners (see figure 4.22). The information consists of changes of keywords percentage, learning progress improvement over learning route, and learning activities compared with other learners' average.

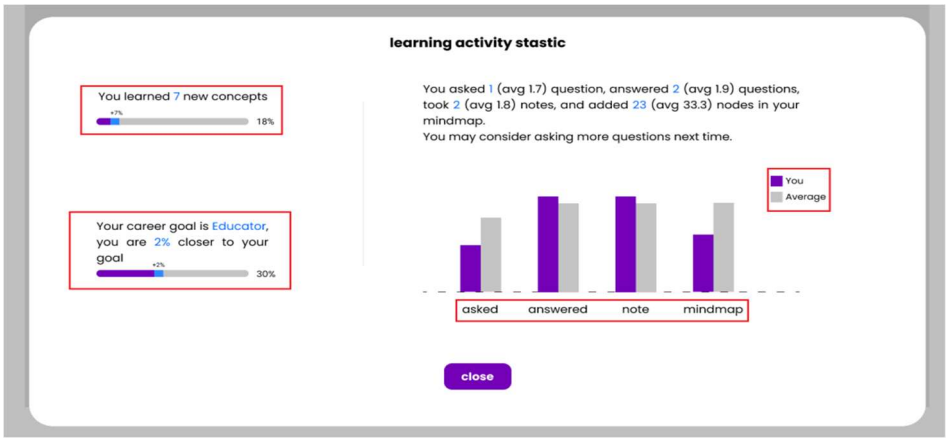

Figure 4.22 Informative Feedback for Learning

Also, the learners who finished a chapter's learning can evaluate that chapter (see figure 4.23 and figure 4.24). Learners are allowed to rate the chapter from the perspective of course, teacher, and difficulty, also a short comment can be left. After the evaluation, the evaluation result of all the learners will be shown.

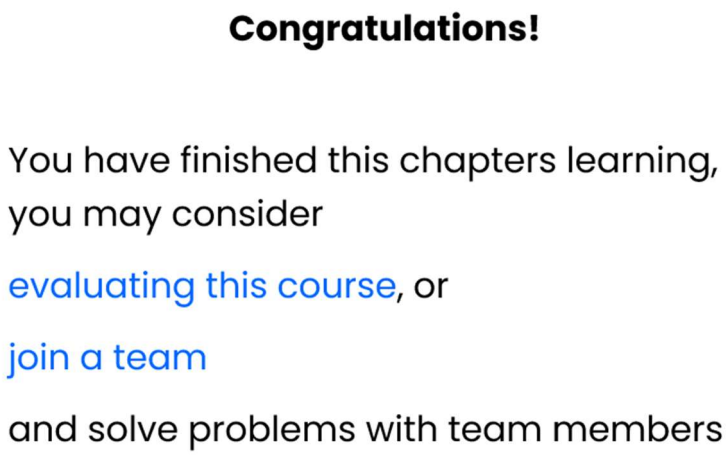

Figure 4.23 Course Evaluating Entrance

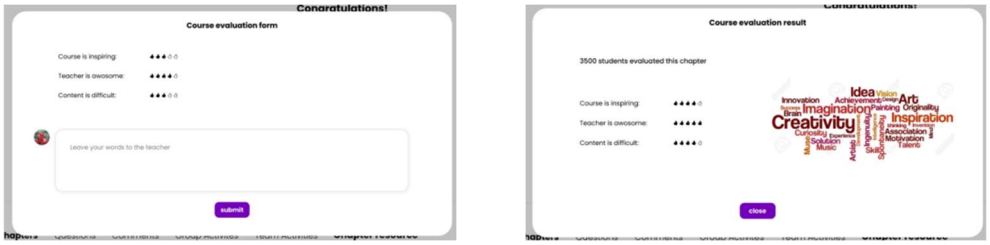

Figure 4.24 Course Evaluating and Result

For learners who want to challenge themselves, they can go to the team activities section to take a team assignment. A learner can join an existing team or create a new team to be a team leader. When creating a team, the team leader needs to upload his/her ZOOM

meeting link along with Google Docs link for later teamwork (see figure 4.25).

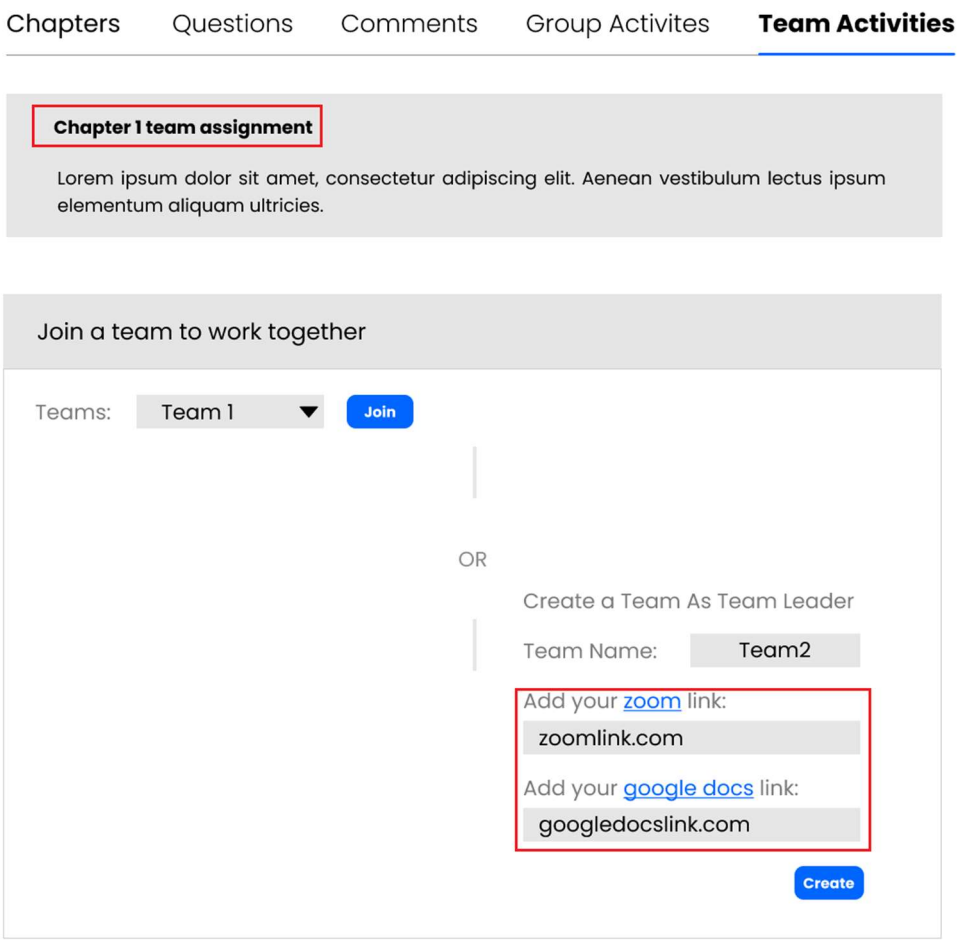

Figure 4.25 Team Assignment

After the team is settled, a page containing team information, team activity support, and team submit will be shown to the learners. The team information section (see figure 4.26) consists of team members' information, ZOOM link and Google docs link shared by the team leader, team members' mindmap, and team members' notes.

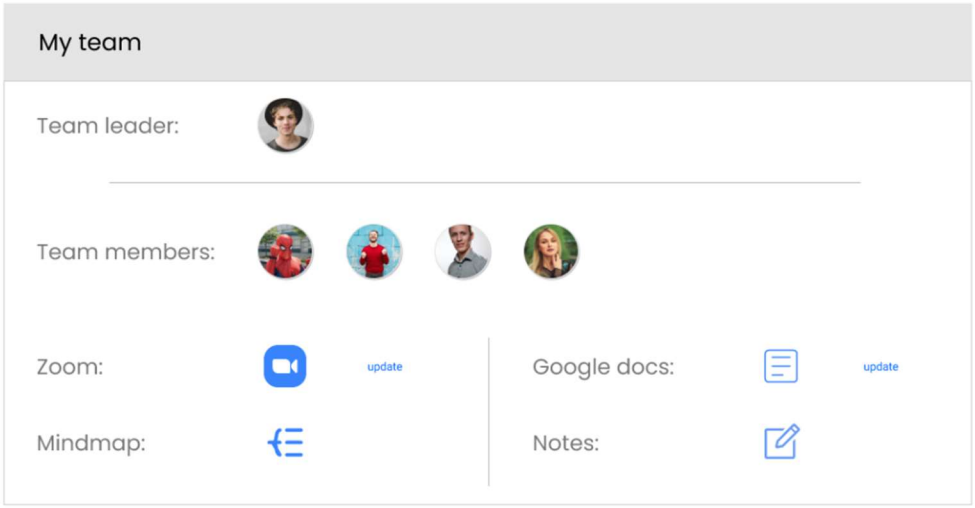

Figure 4.26 Team Information

The team support section (see Figure 4.27) consists of two columns of files that support planning, monitoring, and evaluating. The first column is a list of learners' personal files, where they can write down their own works on the planning file (see Figure 4.28), markdown works that have been finished on the monitoring file (see Figure 4.29), and evaluate team members on the evaluating file (see Figure 4.30). The second column contains files that show the statistical results of all team members' personal files.

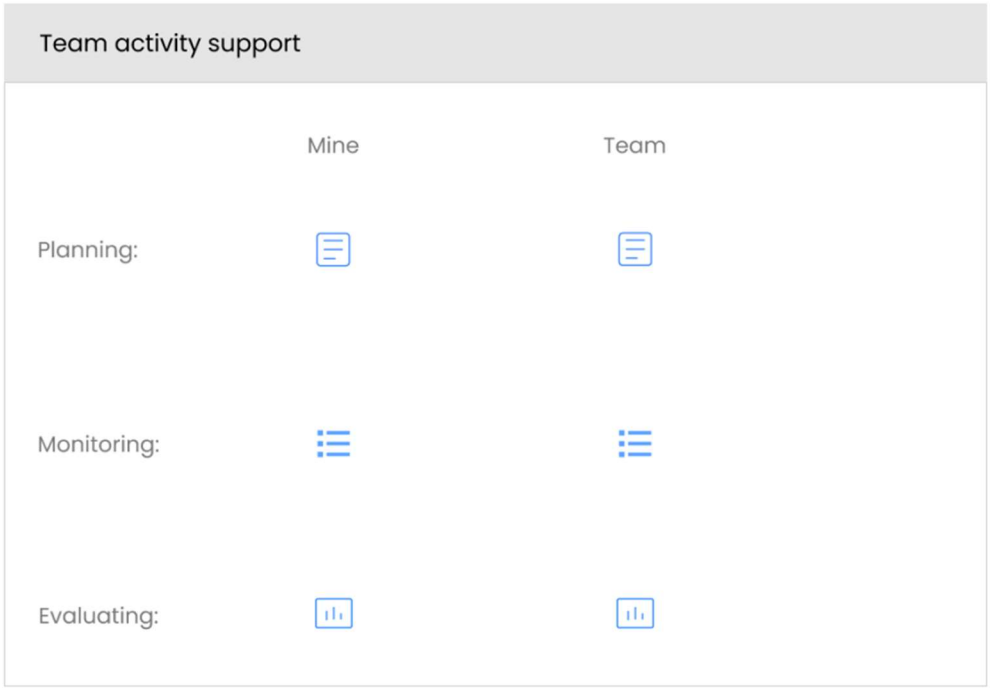

Figure 4.27 Team Activity Support Function

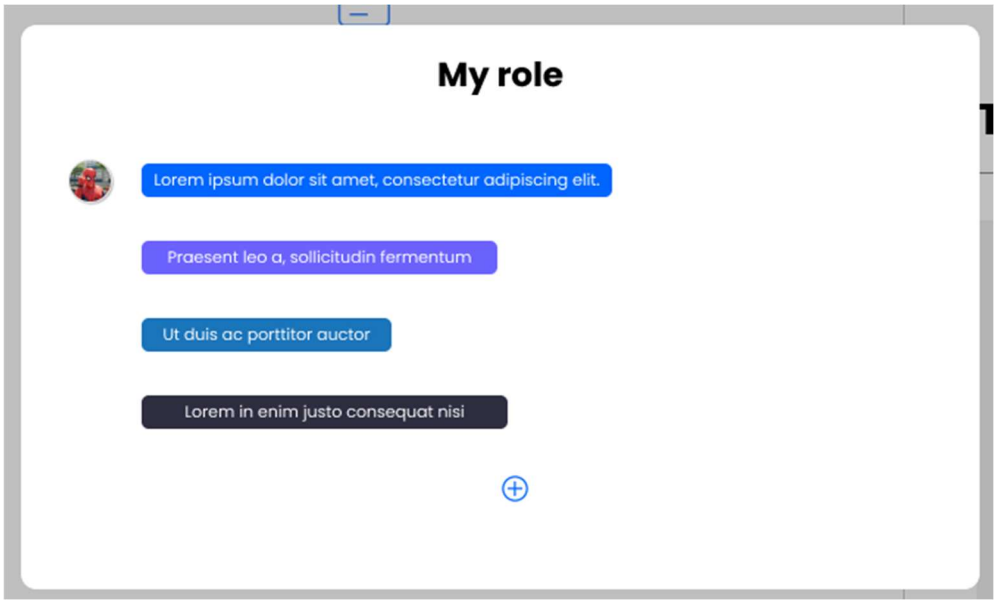

Figure 4.28 Learners Can Set Their Plans

Figure 4.29 Learners Can Check Their Finished Items

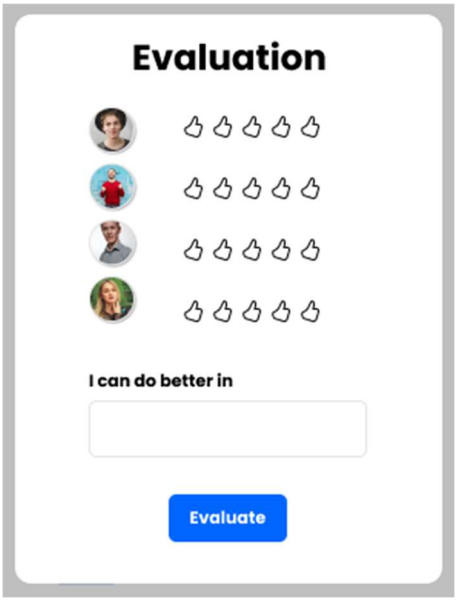

Figure 4.30 Learners Can Evaluate Team Members

The section of team submit is a place where the team members can submit their teamwork assignments. Learners can download or update the team assignment file. The information of the last submitting time and the profile of the submitter will be shown on this page.

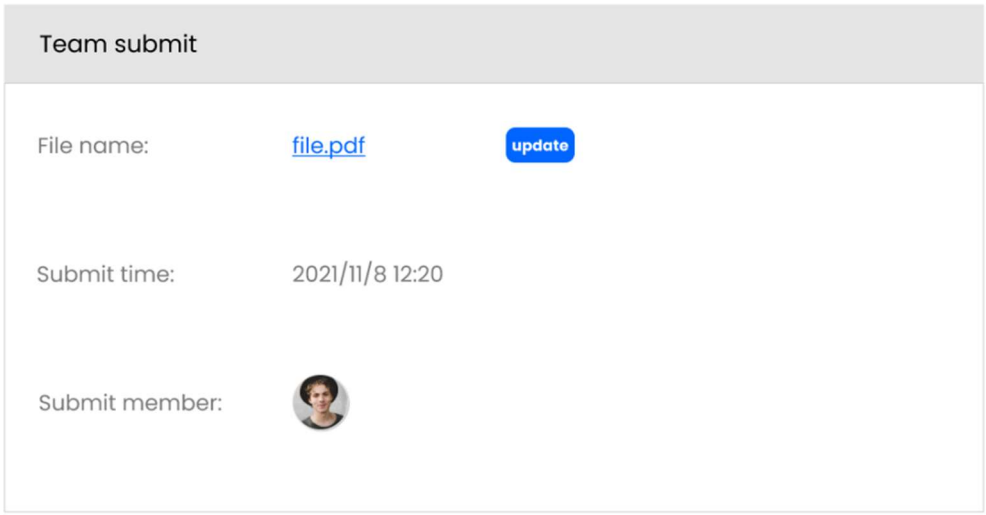

Figure 4.31 Assignment Submitting

6) Scheduled mode

Scheduled mode is a way that learners get access to new learning materials weekly based on their enrollment time. Compared with the self-paced mode, the setting part is slightly different, where learners cannot set their days' learning load because learners only need to finish one chapters' learning in a week. Learners can choose their preferred learning days in a week, and the system will calculate their everyday learning goal by dividing one weeks' learning load equally, and the result will be shown on learners' learning pages (see Figure 4.34). Also, like the self-paced mode, learners are allowed to write down their learning purpose and join a learning group consisting of learners who enrolled in the course with scheduled mode.

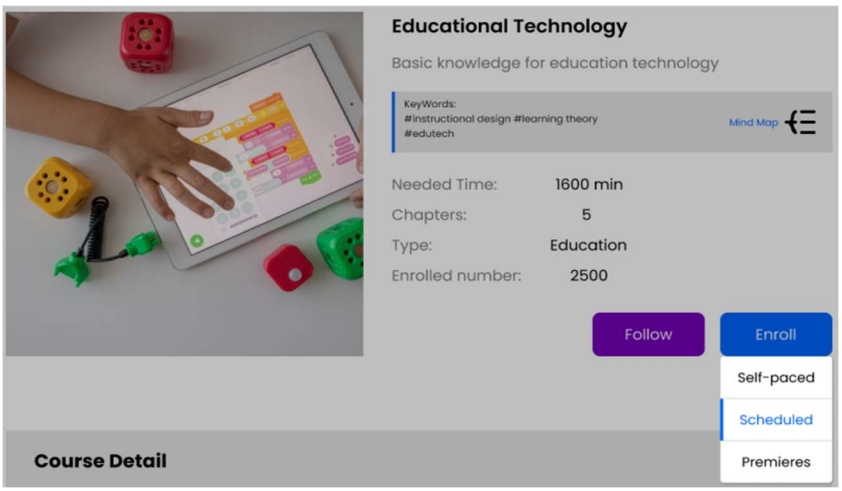

Figure 4.32 Scheduled Learning Mode Choice

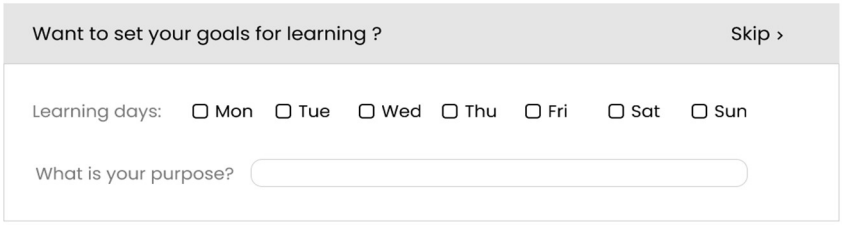

Figure 4.33 Goal Settings for Scheduled Mode

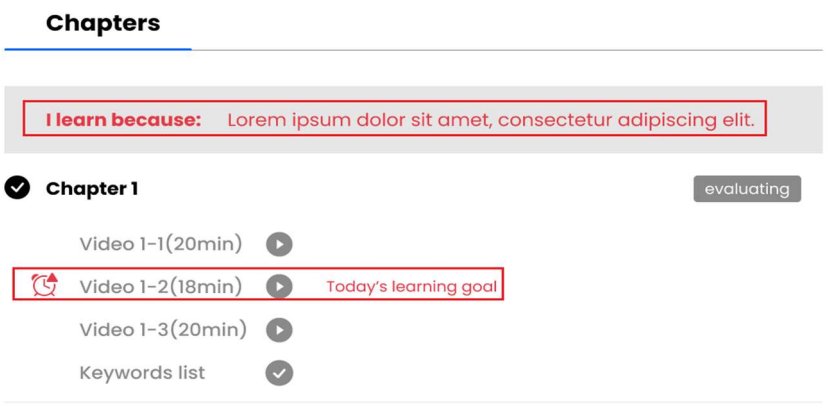

Figure 4.34 Learning Goal Reminder

7) Premiere mode

Premiere mode is a way that learners can choose a premiere time set by instructors and join the premiere with peer learners, course assistants, and instructors to learn together, thus getting a more interactive learning experience.

For the course setting, compared with the other two learning modes, the different part is that learners only need to choose the premiere time, and the same part is that they can write down their learning purpose and choose to join a learning group which consists of learners who enrolled in the course with premiere mode.

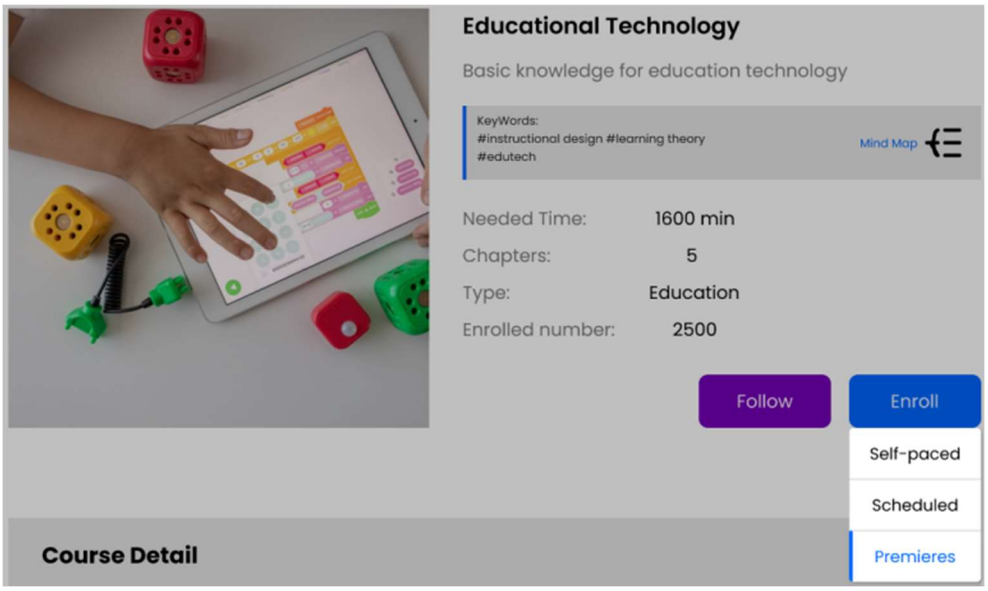

Figure 4.35 Premiere Learning Mode Choice

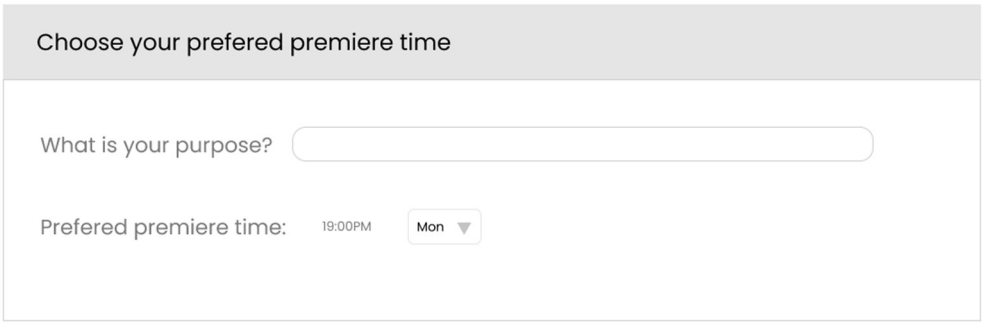

Figure 4.36 Premiere Time Settings

The learning pages are also slightly different from the other two learning modes. One difference is that during the premiere, there will be a premiere mark on the lesson list (see Figure 4.37), learners can click the premiere button to join the premiere. One thing that needs to be noticed is that if learners missed the premiere, they can learn by watching videos like other learning modes.

The other difference is that the video play page is designed differently to bring a more interactive learning experience to learners (see Figure 4.38). Learners can check how many learners are learning, and chat with peer learners, course assistants, and instructors in real-time.

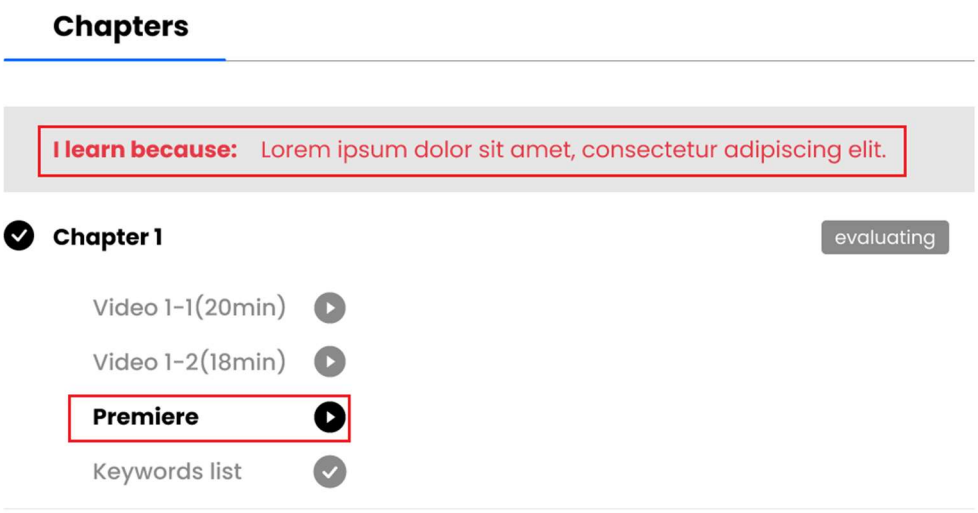

Figure 4.37 Premiere Entrance

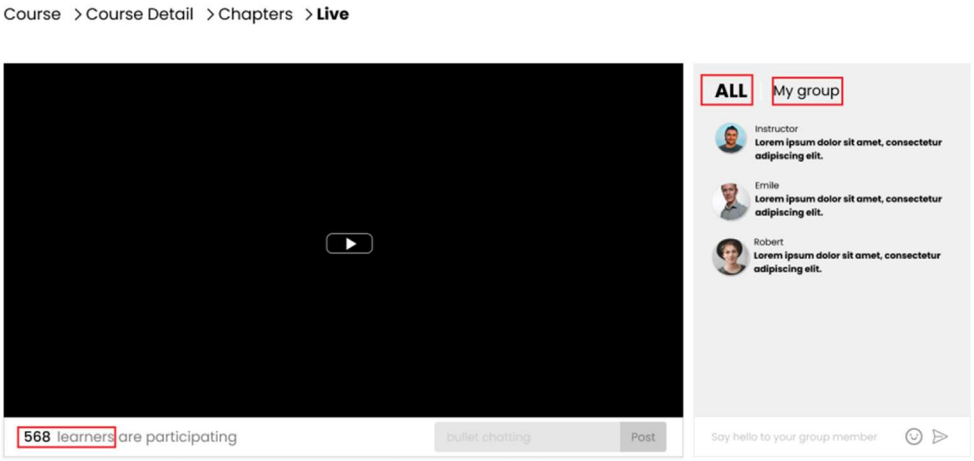

Figure 4.38 Premiere Learning Page

8) Learning dashboard

Learners can easily reach their dashboard. By just clicking the profile photo on the top right corner of the page, the dashboard button can be found on the popup window (see Figure 4.39).

The dashboard shows the information of learners' learning activities. On the top part of the dashboard, a bar is given to the learners to choose from all courses or just a specific course. And, learners can switch the dashboard from weekly to monthly or yearly (see Figure 4.40). Also, learners are allowed to make their dashboard information public or private to other learners, and they are allowed to share their learning information through SNS if they want.

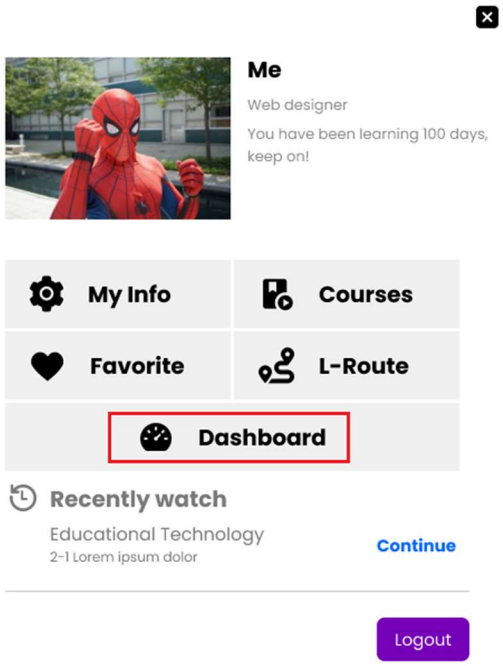

Figure 4.39 Dashboard Entrance

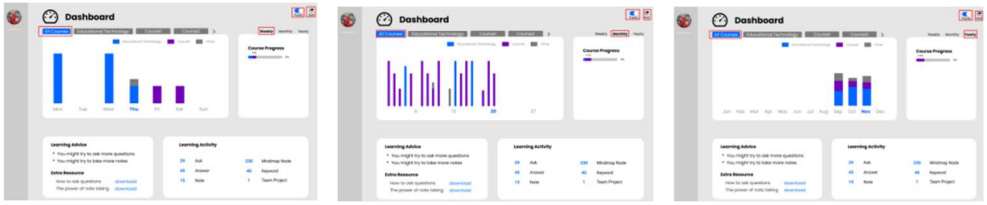

Figure 4.40 Dashboards for All Courses (weekly, monthly, yearly)

As mentioned before, three learning modes are provided to learners. With the “all courses” dashboard and three learning modes corresponding dashboard, besides “weekly”, “monthly”, and “yearly” being considered, 12 (4*3) different dashboards were designed in total. Here, an example of the dashboard that shows the weekly learning data of a self-paced course called “Educational Technology” (see Figure 4.41) will be introduced in detail.

The left side shows all group members’ profile photos, by clicking which, learners can check group members’ learning data. On the right side, 5 areas with white backgrounds contain different information. The first area is a chart that shows learners’ daily learning time compared with planned learning time. The second area is a place that shows learners’ course progress and weekly goal achieving progress. The third area is a place that provides learners personalized learning advice with extra learning resources. The fourth area is a place that shows the counting results of all learning activities during the week. The fifth area shows the weeks’ learning model at that time point, the learning model is selected by calculating the weighted summation of all learning activities.

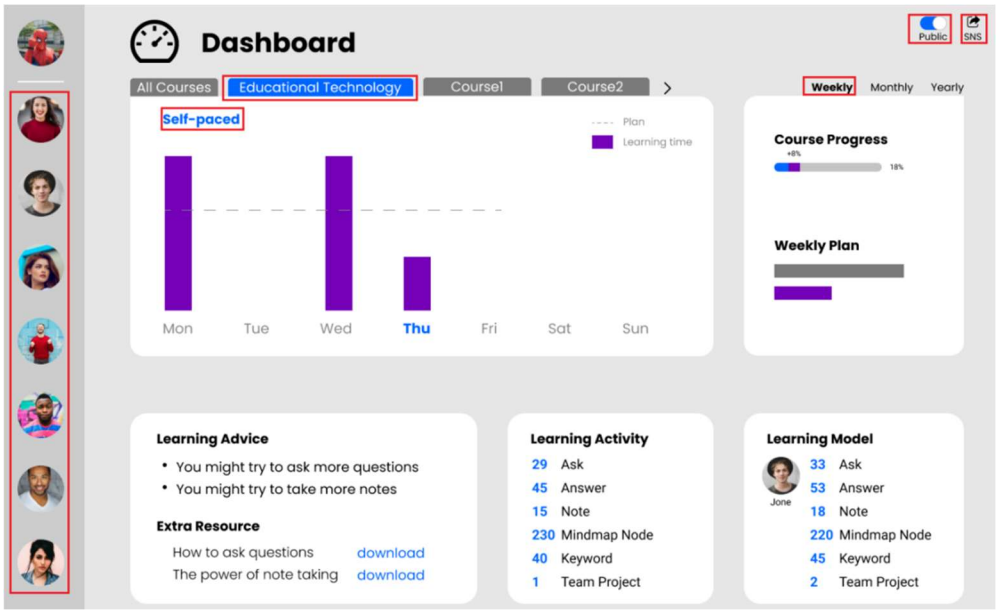

Figure 4.41 Dashboard for Self-paced Course "Educational Technology"

4.3. Learners' Responses to the MOOCs Interface

To answer research question 3 "What are the learners' responses to the interface?", learners' responses to the MOOCs interface were tested. The purpose of this process is to investigate whether the developed MOOCs interface can support MOOCs learners' learning motivation from the perspective of perceived autonomy, competence, and relatedness. During this process, 5 MOOCs experienced learners were invited to use the prototype, and after that, each of them was invited to take a survey along with an in-depth interview.

To make sure that the learners try every function that the interface provides, a series of tasks were given to them at the beginning, which contains: 1) Register an account, 2) Assess the skill and check the course recommendation, 3) Check the detailed information of a given course, 4) Enroll in a course with the self-paced mode, 5) Enroll in a course with the scheduled mode, 6) Enroll in a course with the premiere mode, 7) Check the personal information page, and 8) Check the dashboard. As the participating learners worked on the tasks, the way they used the interface was observed. They were also allowed to ask questions when they encountered problems while using the interface, and these questions were recorded and used later in the interview phase.

4.3.1. Learners' Response to the MOOCs Interface (First Usability Test)

4.3.1.1. Survey

The survey contains 31 questions in total, which includes general questions (5), autonomy-related questions (10), competence-related questions (9), relatedness-related questions (7). Learners were asked to answer each of the questions by choosing from 1 to 5 (1: not true, 5: very true). The descriptive statistical analysis result is shown in table 4.7.

Table 4.7 Result of Learners' Responses (1st)

Question Type	Question Number	M	SD
General	5	4.44	.58
Autonomy-related	10	4.40	.67
Competence-related	10	4.52	.71
Relatedness-related	7	4.66	.48

From the statistical analysis result, we can argue that learners are quite satisfied with the general design of the MOOCs interface (M=4.44, SD=.58). And all of the learners' perceived autonomy (M=4.40, SD=.67), perceived competence (M=4.52, SD=.71), and perceived relatedness (M=4.66, SD=.48) reached a high score,

which shows the value of the interface designed in this research. It can be noticed that the relatedness-related questions get the highest score among these four categories, which is consistent with the result of the interview, where a lot of the learners agreed that the interface is highly interactive by enhancing group and team interaction.

Table 4.8 Learners' Perceptions of the MOOCs Interface

Questions	M	SD
1. This interface is more effective for learning compared to platforms such as Coursera, edX, Udacity, xuetangX, icourse163.	4.4	.55
2. This interface can help to motivate and maintain learning compared to platforms such as Coursera, edX, and Udacity.	4.0	.71
3. By using this interface, learning is more interesting.	4.4	.55
4. I want to learn by using this interface more practically.	4.8	.45
5. I want to recommend this interface to my friends.	4.6	.55

Table 4.8 shows learners' detailed responses to the general design of the MOOCs interface. The result shows that learners highly evaluated the interface in terms of learning efficiency (M=4.4, SD=.55), learning motivation (M=4.0, SD=.71), and learning interests (M=4.4, SD=.55). Also, when the learners were asked

about whether they want to use the interface in real life, both of them showed a positive attitude (M=4.8, SD=.45), and want to recommend it to more people to use (M=4.6, SD=.55).

Table 4.9 Learners' Perceptions of Autonomy

Questions	M	SD
1. Choosing a learning mode helps me to have a sense of ownership in learning.	4.6	.55
2. Choosing to join a group or not helps me to have a sense of ownership in learning.	4.2	.84
3. Choosing learning activities helps me to have a sense of ownership in learning.	4.0	1.22
4. Setting my own goal helps me to have a sense of ownership in learning.	4.4	.55
5. When I set my goal, the assistance provided is useful.	4.6	.55
6. Goal-achieving information helps me to have a sense of ownership in learning.	4.6	.55
7. Writing down my learning purpose and reminding me of it helps me to have a sense of ownership in learning.	4.2	.45
8. Choosing learning activities that I like helps me to engage in learning.	4.2	.84
9. Invitational language (e.g. "You might") doesn't make me feel forced to do something.	4.6	.55
10. Getting informed of the value of learning and its relevance helps me to have a sense of ownership in learning.	4.6	.55

Learners' responses to autonomy-related questions are shown in table 4.9. The mean value of each question's answer is from 4.0 to 4.6, so the interface developed in this research can be considered as highly autonomy supported. Allowing learners to choose from one of the three learning modes (self-paced, scheduled, and premiere) when enrolling in a course is one of the unique features of this MOOCs interface compared to existing ones. And the question related to choosing learning mode is one of the most highly evaluated items (M=4.6, SD=.55), which shows that providing a choice of learning modes can help MOOCs learners gain autonomy towards learning.

Table 4.10 Learners' perceptions of competence

Questions	M	SD
1. Learning path recommendation based on my career goal is helpful for developing to my fullest potential.	4.8	.45
2. Learning support when collaborating with group members is helpful for developing to my fullest potential.	4.0	.00
3. Additional learning material is helpful for developing to my fullest potential.	4.6	.55
4. The statistical result of learning activities (weekly, monthly, yearly) shown on the dashboard makes me feel a sense of achievement.	4.8	.45
5. Sharing my learning record within the platform or through SNS is helpful for demonstrating my achievements.	4.2	1.30

6. The pop-up window that shows the progress change after each learning activity makes me feel a sense of achievement.	5.0	.00
7. Keywords checklist makes me feel my ability is increasing because of learning activity.	4.6	.55
8. The dashboard that shows concepts I have learned and the changes of my learning activity over time makes me feel my ability is increasing.	4.8	.45
9. Positive informative feedback makes me feel responsible for my success.	4.2	1.30

The competence-related questions are rated from 4.0 to 5.0, which shows that learners have a positive perception of the interface in terms of competence support. Among those questions, it is worth noting that the pop-up window design got the highest score (M=5.0, SD=.00). All of the learners think that the feedback information shown in the pop-up window after finishing a course can help them feel a sense of achievement. Another two questions (question 4, question 8) that related to the dashboard got the second-highest score (M=4.8, SD=.45), which demonstrate the importance of learning dashboard to learners' competence perception.

Table 4.11 Learners' perceptions of relatedness

Questions	M	SD
1. Joining online communities makes me feel a sense of belonging.	4.6	.55
2. Showing successful learning cases in a group makes me feel a sense of belonging.	4.4	.55
3. Using like-button, and emoticons to express emotions to group members helps me feel a sense of belonging.	4.6	.55
4. Diverse communication spaces with search functions help me communicate with others.	4.8	.45
5. Evaluating courses after each chapter is a good way to communicate with the instructor.	4.8	.45
6. Taking a team assignment makes me feel connected with others.	4.8	.45
7. Sharing mind maps, notes with group members makes me feel connected with others.	4.6	.55

Last are the questions related to learners' perceptions of relatedness. The mean value of each questions' score is from 4.4 to 4.8, which means learners showed a highly positive attitude to this MOOCs interface in terms of relatedness support. Especially, the course evaluating the function for learner-instructor interaction (M=4.8, SD=.45), communication space for group members' interaction (M=4.8, SD=.45), and team assignment to improve team members' interaction (M=4.8, SD=.45) were the highest-rated items, which shows the key role of interaction in relatedness support.

4.3.1.2. In-depth Interview

To understand learners' specific personal perceptions of the MOOCs interface developed in this research, the survey was followed by a personal in-depth interview for each of the participating learners. In the interviews, learners were asked about the platform's strengths, problems, and ideas for improvement. The content of the interviews was organized and open coded, and the coding result was organized into four categories as follows: 1) Advantages of the MOOCs interface. 2) Problems with the MOOCs interface. 3) Suggestions for improvement.

1) Advantages of the MOOCs interface.

The advantages of the MOOCs interface can be concluded into 5 main categories (see Table 4.12): UI/UX, novel meanwhile helpful functions, autonomy support, competence support, and relatedness support.

For the advantages in terms of UI/UX, learners showed positive attitudes toward the design because the interface is simple, clear, and with beautiful color matches. And learners think the interface provides functions that are easy to use, which includes the visualized learning date in the dashboard, and the keywords checklist at the end of each chapter.

Learners also showed great interest in the novel functions provided in this interface, and think those functions are helpful for their learning. For example, the three learning modes that learners are free

to choose, class-like learning group, small team for team assignment, and course evaluating.

Another advantage is related to autonomy support. Learners think positively that different learning modes are offered in the platform that they can choose their favorite one based on their situation when enrolling in a course. And because during the learning, learners are allowed to make a lot of choices, which makes the learners highly proactive and feel responsible for their learning.

Advantages related to competence support, and relatedness support are most frequently mentioned by the learners. For competence support, learners think the scaffolding offered (e.g. learning route, extra learning resource, and goal setting support) is helpful for their learning. Also, because they are allowed to make choices for their learning style and learning pace, adaptive learning is more likely to be achieved. For relatedness support, learners think this platform is highly interactive. For example, some learners think the premiere learning mode makes it possible for real-time interaction. Some learners think allowing learners to join groups and teams can enhance MOOCs learners' interaction. And some learners think the platform provides effective ways for knowledge sharing.

Table 4.12 Advantages of the MOOCs Interface

Categories	Learners perception	Details	Frequency
UI/UX (5)	Beautiful design	The interface is simple, clear, and with beautiful color matches.	1
	Easy to use	Using a keywords checklist is a simple way for self-examination and consolidating knowledge.	1
		Learning results are clear thanks to the data visualization after learning and when using the dashboard.	3
Novel meanwhile Helpful Functions (6)	Providing learners with more learning modes	Scheduled mode is a good alternative for instructor-paced mode used in existing MOOCs platforms.	1
		Premiere mode leads to responsibility for learning because you have an appointment with the instructors.	1
	Learning group	It is very helpful to be able to create study groups.	1
		Showing me the group learning model’s learning activity is helpful for my learning.	1
	Team	Joining a team provides opportunities for cooperative learning.	1
	Course evaluating	Allowing learners to evaluate the course is very helpful for learning.	1

Autonomy Support (3)	Providing choices	I feel very happy that I can choose my favorite learning mode.	2
		This platform provides me with a lot of choices, which makes me highly proactive and feel responsible for their learning.	1
Competence Support (9)	Scaffolding	The learning path recommendation is helpful for learning.	3
		Providing suggestions for weakness improvement is helpful for learning.	1
		Setting a learning goal when enrolling in a course makes learning objective focused, and easy to track.	1
	Achieving adaptive learning	I can find a learning mode that suits my own learning style.	2
		I am happy that I can adjust the learning goal to fit my own pace.	2
Relatedness Support (8)	Interactive learning	This platform is highly interactive.	2
		Premiere learning mode makes it possible for real-time interaction.	3
		Group and team can enhance MOOCs learners' interaction.	2
		This platform provides effective ways for knowledge sharing.	1

2) Problems with the MOOCs interface.

Learners also pointed out the problems with the MOOCs interface designed in the research. The problems can be concluded into two main categories: UI/UX-related problems, and learning-related problems.

For UI/UX-related problems, the inconsistency of icon use and word choice was pointed out by some learners. And the improper positioning of the group chatting window, professors' introduction, team activity, and function bar of the video player are also not negligible. Besides, the wrong way of interaction for the learning routes recommendation page, and lack of tutorial information for novel functions are also problems that need to be fixed.

For the learning-related problem, all of the learners pointed out that there is no homework and exams offered in the interface, which was considered the most critical issue to be solved in this research.

Table 4.13 Problems with the MOOCs Interface

Categories	Learners perception	Details	Frequency
UI/UX	inconsistency	On the keyword explain page the check icon is set checked, which is inconsistent with the checklist page.	2
		Choice of words needs to be consistent.	1
	improper positioning	The group chatting window is difficult to access.	3
		Professor introduction and teachers' words should be shown on the course introduction page.	2
		The team activity page needs to be redesigned to make it clear when the page jumps.	3
		Note function is hidden and not convenient to be used.	1
	improper interaction	Learning routes recommendation is designed slidable, which is OK for mobile devices, but for PC users, click function should be added.	1
	novel function(tutorial needed)	Novel functions should be explained in detail.	1
Learning	lacking some learning elements	No homework and exams.	5

3) Suggestions for improvement.

At the end of the in-depth interview, the learners were asked their thoughts about how this MOOCs interface can be improved. Their suggestions can be concluded into two categories, one is related to adding something to the interface, another is related to changing something of the interface. The details for the functions that need to be added and need to be changed are shown in table 4.14.

Table 4.14 Suggestions for Improvement

Categories	Details	Frequency
Add	course syllabus	1
	course level	1
	reminder messages from MOOCs platforms (email, SNS)	2
	wiki function	1
Change	visualized timetable for premiere mode	1

4.3.1.3. Interface Revision

After the evaluation of the MOOCs interface by learners, the prototype was revised based on those collected opinions related to the problems and suggestions for improvement. Specifically, the prototype was revised in the following ways: 1) Ensuring consistency, 2) Re-positioning, 3) Modifying the improper interaction, 4) Adding explanation for novel functions, 5) Adding exam and homework, 6) Categorizing the course information, 7) Adding wiki and reminder, and 8) Visualizing the premiere time selector.

1) Ensuring Consistency

The check icon used on the "keyword explain page" was changed to unchecked to be consistent with the checklist. And for team activity, the title of the "my plan page" was changed from "My role" to "My plan" to be consistent with the team plan page. For the video playing page of premiere mode, the title was changed from "live" to "premiere".

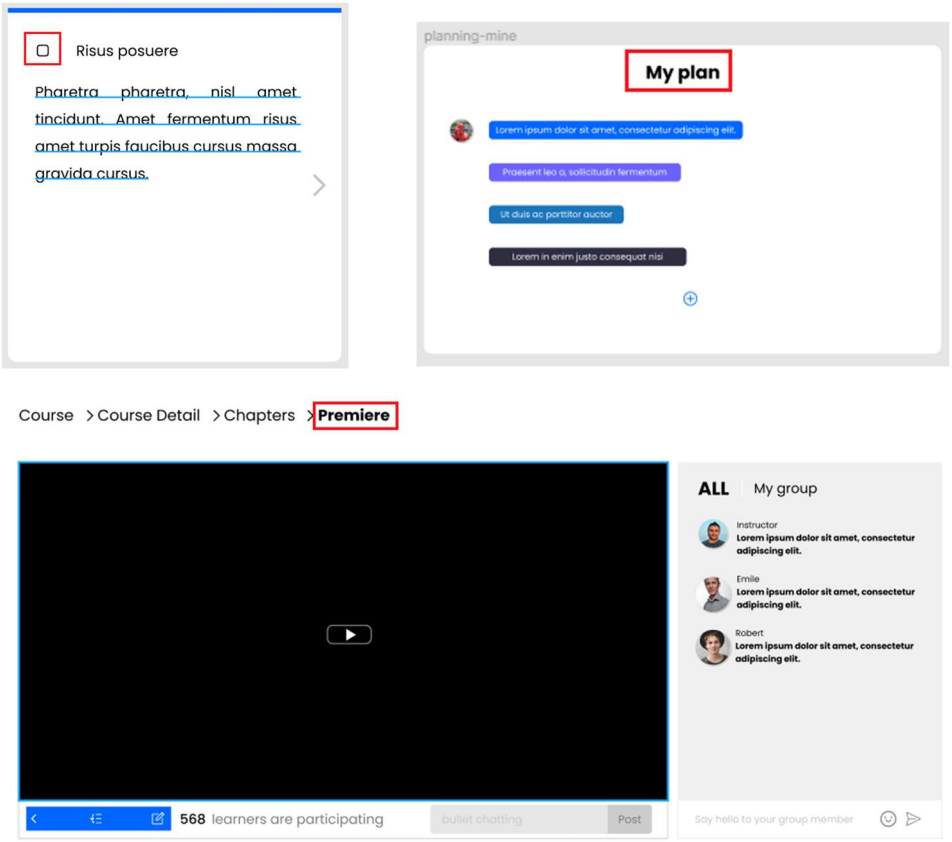

Figure 4.42 Change the Icon and Choice of Words

2) Re-positioning

The group chatting window was repositioned to be closer to the top of each page so that it can be more easily accessed by learners. The teacher's words on lesson pages were removed, instead, this information was added to the course introduction page. The "congratulation information" on the team activity page was deleted to allow the team activity information positioned on the top. The default state of the video function bar was changed from hidden to display to make the note-taking function more convenient to use.

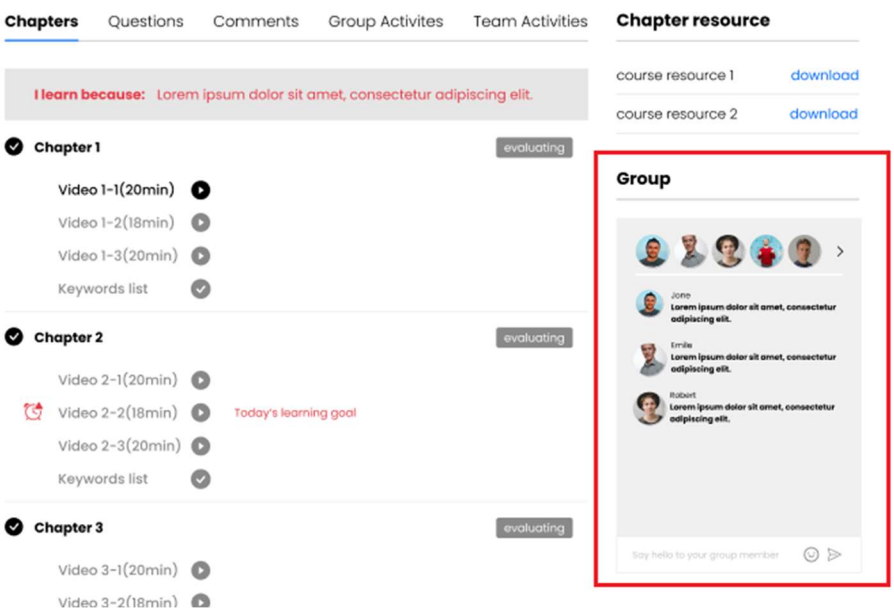

Figure 4.43 Repositioning the Group Chatting Window

Figure 4.44 Repositioning the Teacher’s Information

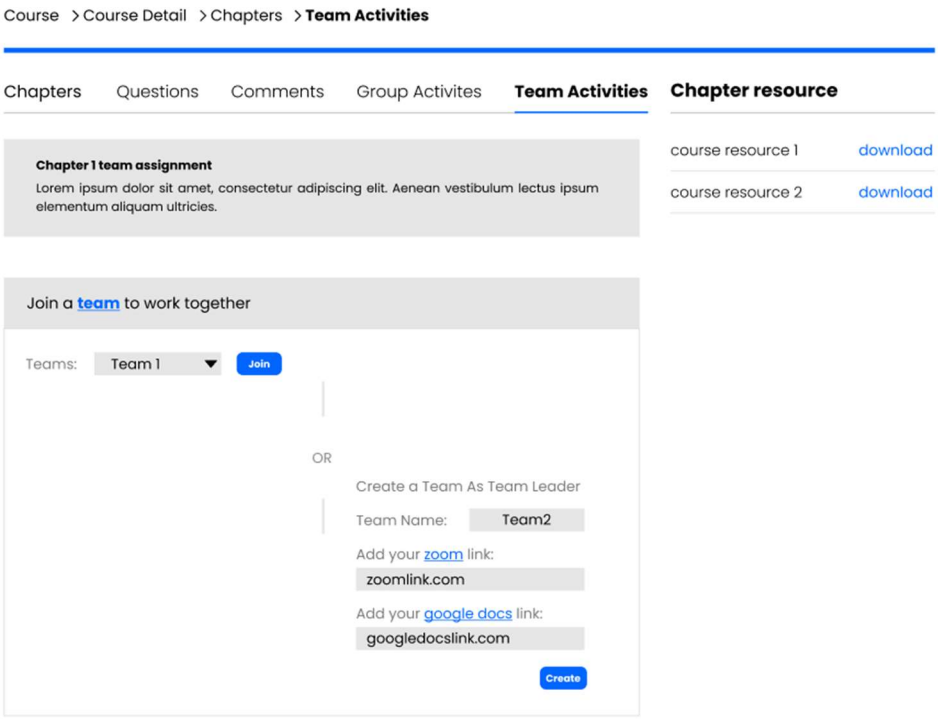

Figure 4.45 Repositioning the Team Activity Window

Figure 4.46 Repositioning the Video Function Bar

3) Modifying the Improper Interaction

One complaint from the learner is that the learning routes recommendation was slidable, which is good for mobile device users, but not appropriate for PC users. So, the way of interaction was redesigned to meet the needs of PC users. To achieve this, the layout of courses from each learning route was changed from horizontally to vertically.

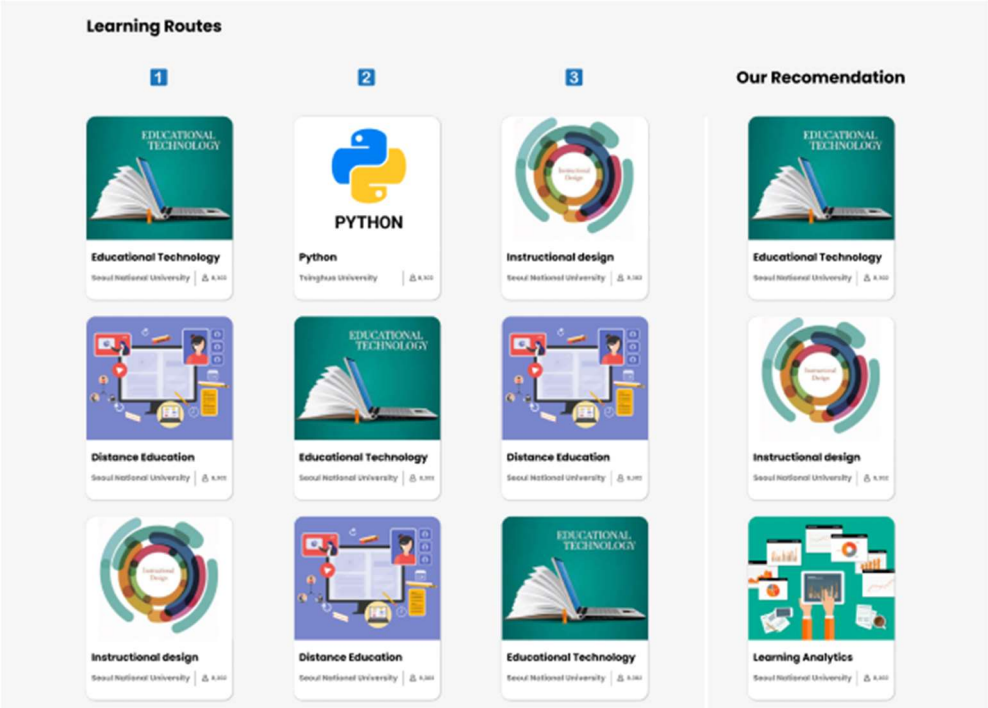

Figure 4.47 Change the Interaction from Sliding to Scrolling

4) Adding Explanation for the Novel Functions

Extra information related to novel functions was added to the interface in order to make it friendlier for new users. For example, when learners choose their learning modes, explanations about the three learning modes and information of recommended learners were added. Also, explanations about the learning goal, learning group, team, and premiere time were added.

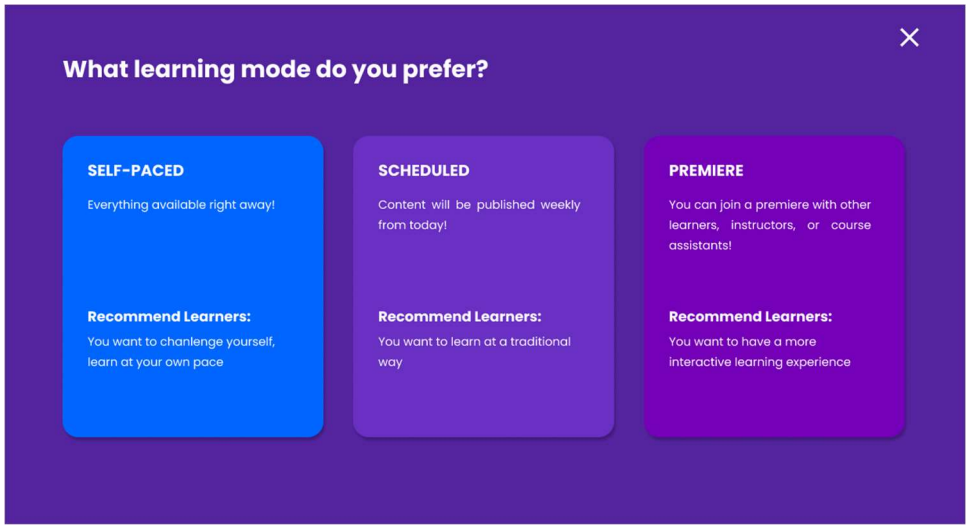

Figure 4.48 Add Introduction for Learning Mode

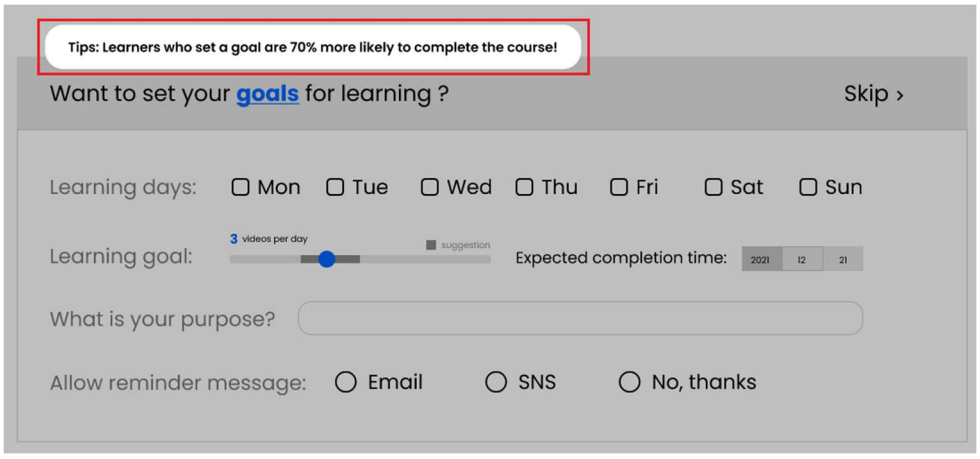

Figure 4.49 Add Information for the Benefit of Setting A Goal

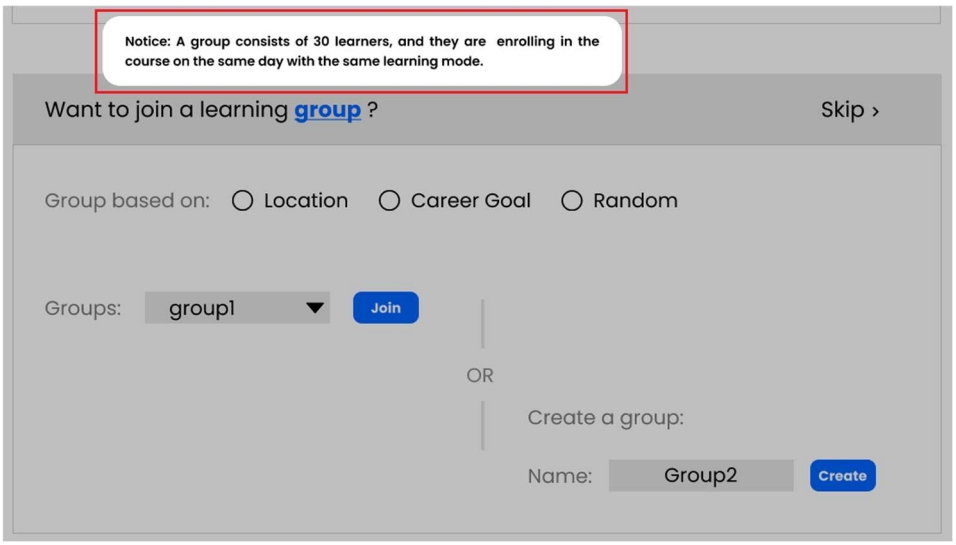

Figure 4.50 Add Introduction for Learning Group

Figure 4.51 Add Introduction for Team

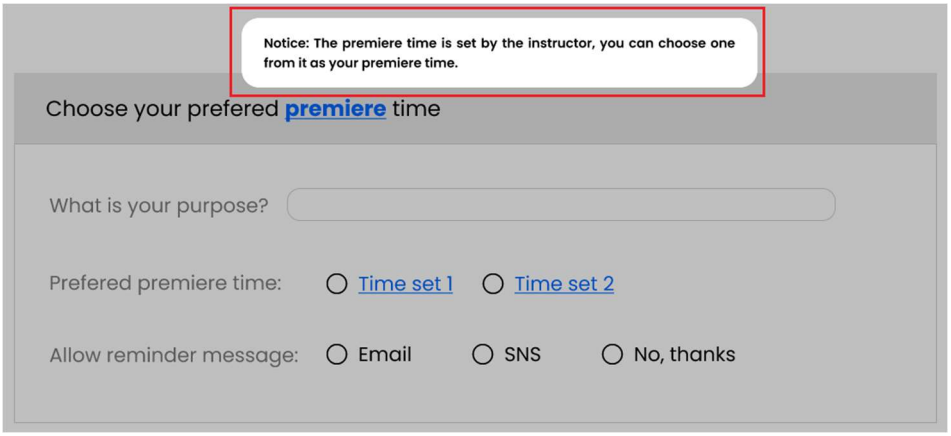

Figure 4.52 Add Introduction for Premiere Time

5) Adding Exam and Homework

Based on the improvement suggestions given by the learners, the entrance to exams and homework were added to the learning page. Instructors can choose to assign exams and homework to learners, and learners can choose to do or not like other learning activities provided in this platform.

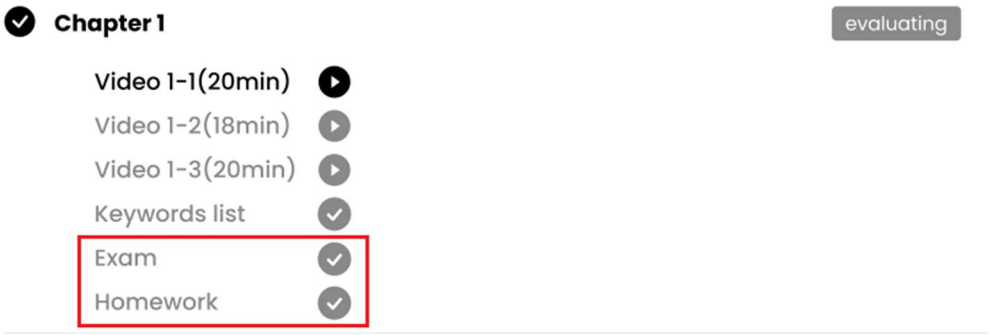

Figure 4.53 Add Exam and Homework

6) Categorizing the Course Information

Based on the improvement suggestions given by the learners, on the course introduction page, two kinds of course information were added. One is the difficulty level of the course, another is the course syllabus.

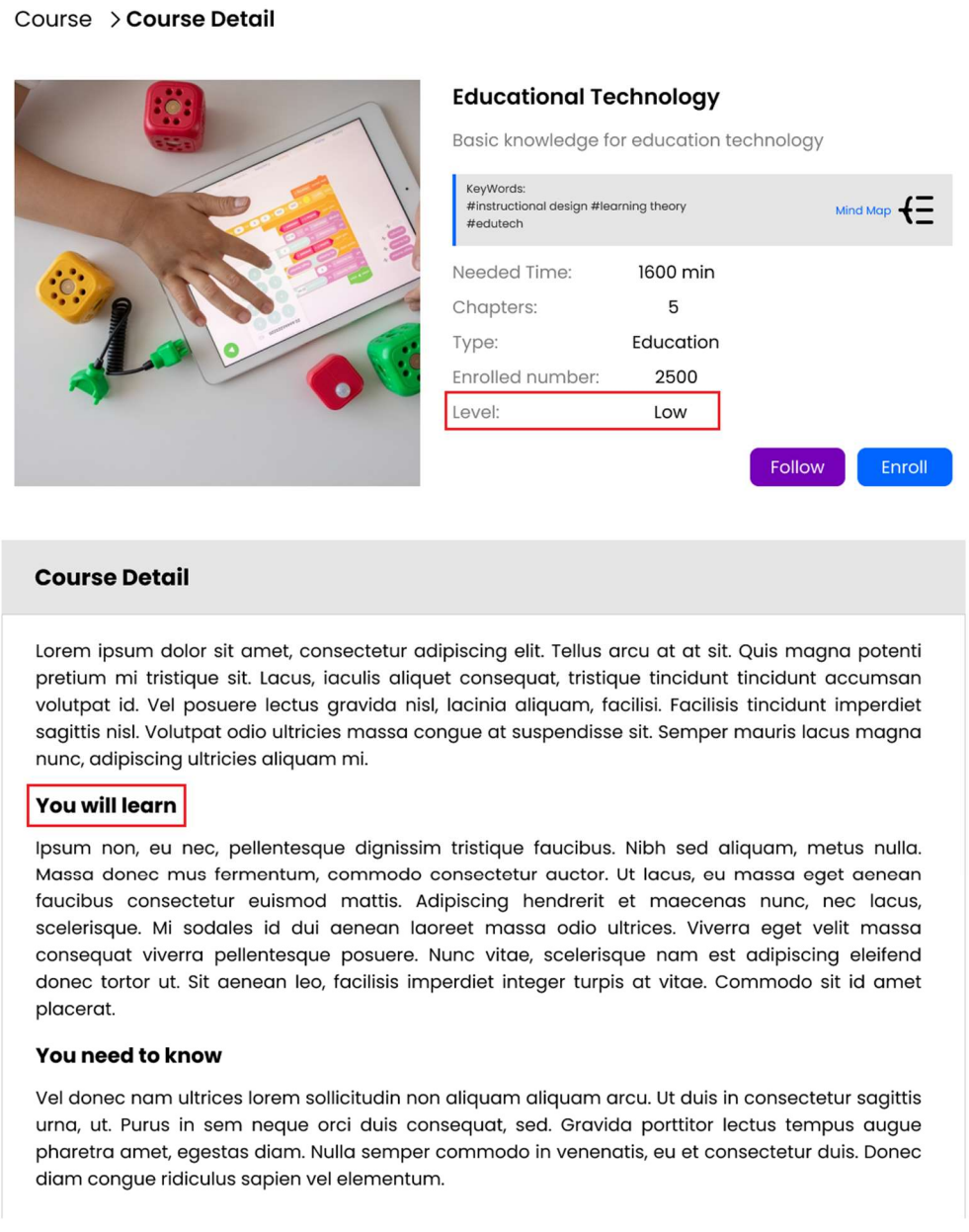

Figure 4.54 Add Course Difficulty and Course Introduction

7) Adding Wiki and Reminder

Based on the improvement suggestions given by the learners, two functions were added. One is the wiki function which allows group members to work on a note together. The other is a reminder message function that allows learners to get reminded by their email or SNS account.

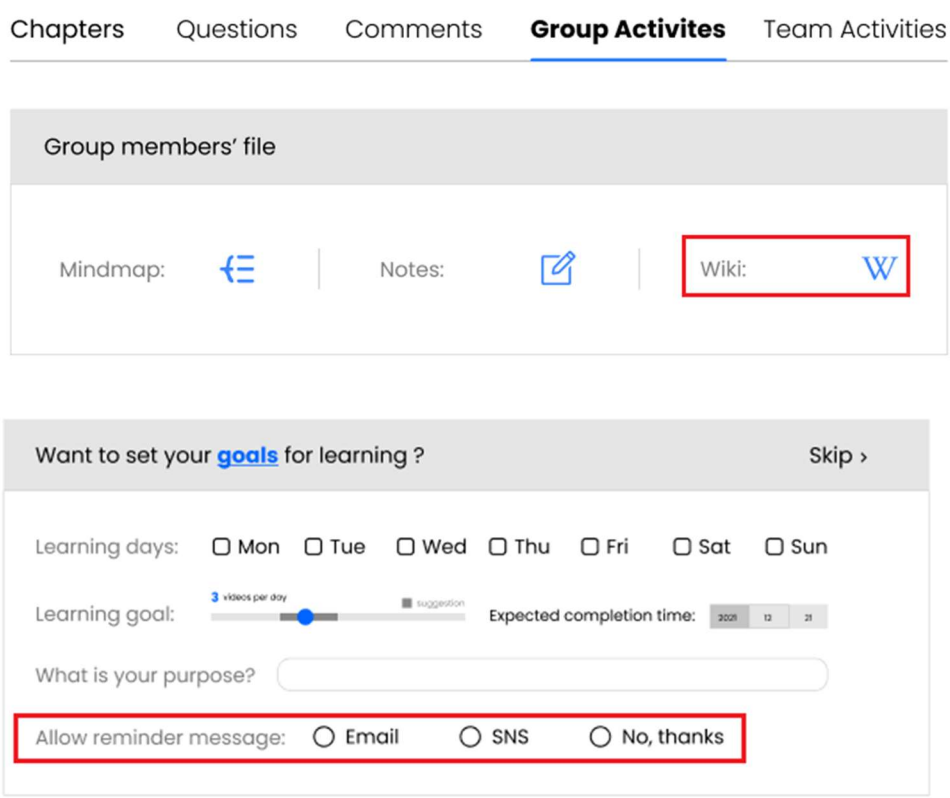

Figure 4.55 Add Wiki and Reminder Function

8) Visualizing the Premiere Time Selector

Based on the improvement suggestions given by the learners, visualized timetables for premiere mode were designed as a replacement for simple text descriptions.

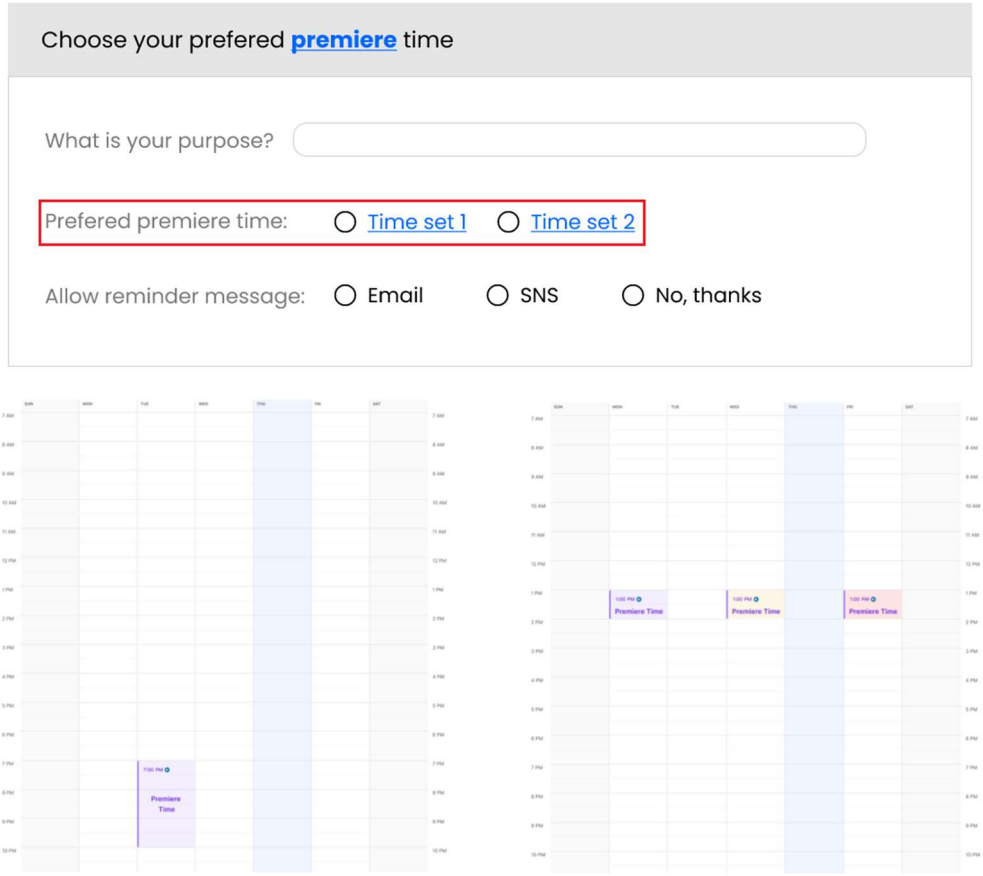

Figure 4.56 Add Visualized Timetable

4.3.2. Learners' Responses to the Revised Interface (Second Usability Test)

At the end, the learners who participated in the learners' response test were invited to evaluate the revised interface to make sure the prototype was properly revised. To achieve this, the "Learner Response Evaluation Sheet (2nd)" (see APPENDIX 6) that contains 12 questionnaire questions and 2 interview questions was given to the learners along with the revised interface. The learners were asked to rate each item from a score of 1 to 5, and share their thoughts about the revised interface.

The result of the questionnaire (see Table 4.15) shows that the mean value of each question ranged from 4.4 to 5.0, which shows all of the learners are satisfied with the revision, and this positive attitude was confirmed during the interview.

Based on the result of learners' responses and the revision of the interface, the design guidelines were revised for the second time. The main changes are: 1) add guideline 1.2.3 "Allow learners to set up goal achievement reminders by Email and SNS". 2) add guideline 1.1.4 "Allow premiere mode learners to choose their preferred premiere time by offering them a visualized time selector". 3) change guideline 1.1.2 by adding "random group type". 4) change guideline 1.4.2 by adding "wiki, exams, and homework". 5) delete guideline 2.4.2, which is similar to guideline 2.4.1. And 6) Add a column to show the functions designed into the interface.

Table 4.15 Result of Learners' Responses (2nd)

Questions	M	SD
1. The problems related to consistency (choice of words, icons) have been properly fixed.	5.0	.00
2. The group chatting window now can be easily accessed.	5.0	.00
3. The information of the teacher now is properly positioned.	5.0	.00
4. The team activity window now is properly redesigned.	4.4	.54
5. I can easily find the note-taking function.	4.8	.44
6. The interaction problem with the learning route recommendation page now is properly fixed.	4.4	.54
7. The explanations for the novel functions (learning mode, goal, group, team, and premiere time) are clear.	5.0	.00
8. Exams and homework have been added to a proper place.	4.8	.44
9. The course information page now is properly designed.	5.0	.00
10. Wiki function is a good way for group members' interaction.	4.8	.44
11. The external reminder (Email, SNS) functions are added properly.	4.8	.44
12. The newly designed premiere time selector (visualized timetable) is better in terms of user experience compared with the old one.	4.8	.44

Chapter 5. Discussion and Conclusion

This research is aimed to propose a MOOCs platform that can boost learners' motivation. As a type of distance education, learning using MOOCs demands learners to have strong self-regulated learning and self-directed learning skills, which can be influenced deeply by the level of learners' intrinsic motivation. Thus, in this research, based on the self-determination theory proposed by Ryan & Deci (1985), literature review was conducted to conclude MOOCs interface design guidelines that can support learners' autonomy, competence, and relatedness. After that, the design guidelines went through two rounds of validation tests by 4 experts, and then a MOOCs interface prototype was developed based on those design guidelines and was tested by 5 MOOCs experienced learners. Finally, based on the result of the learner test, both the MOOCs interface prototype and design guidelines were revised. In this part, the significance of the research will be discussed. Also, the summary and the limitation of the research will be present along with suggestions for follow-up research.

5.1. Discussion

The MOOCs interface developed in this research is highly intrinsic motivation oriented. By offering learners autonomy support, competence support, and relatedness support, this MOOCs interface can help learners foster their learning motivation, thus sustaining learning. The significance of this research can be summarized as follows.

Firstly, this research proposed an intrinsic motivation oriented MOOCs interface. Thanks to the open nature of MOOCs, learners can easily get access to learning resources from MOOCs. But on the other hand, because there is little coercion for MOOCs learning, intrinsic motivation plays a vital role during the learning process. Thus, if a MOOCs learner loses his/her intrinsic motivation on a MOOCs course, it is very likely that he/she couldn't sustain in learning. Unlike other attempts that motivate MOOCs learners by using extrinsic motivators such as gamification elements, in this research, the three factors autonomy, competence, and relatedness that can Influence learners' intrinsic motivation proposed by Deci & Ryan (1985) were adopted as the design principles to guide the development of the MOOCs interface. By supporting the three factors, MOOCs learners are more likely to keep on learning out of their interest, not extrinsic awards.

Secondly, this research introduced three learning modes to the MOOC learning environment. Some of the existing MOOCs platforms are offering two learning modes to MOOCs learners, one is self-paced learning, another is instructor-paced learning. According to

edx's learner help center, the self-paced mode is a way that everything is available as soon as the course starts, and the instructor-paced mode is a way that content may be published periodically. After an analysis of the 5 main existing platforms of the U.S. and China, the difference of those platforms was found in terms of learning mode support. For example, both of the two Chinese platforms xuetangX, icourse163, and one of the American platforms edx are offering both two learning modes to learners, while Udacity and Coursera only offer learners self-paced mode for learning. And the way xuetangX, icourse163, and edx offer learning modes are different. Learners can choose learning mode when enrolling in a course from xuetangX and icourse163. While learning mode is determined by the instructor, learners don't have a choice when enrolling in a course from edx. It seems like the two Chinese MOOCs platforms are the best in terms of learning mode support, however the way they achieve this needs to be considered. Both of them are offering self-paced mode by reusing courses' past sessions, which means only the instructor-paced mode learners can get access to the newest version of the course. Besides, for the instructor-paced mode, because the instructor controls the opening of learning resources, learners who enrolled in a course in the middle of the session have to face the fact that the due set by the instructor has passed already. In this research, the self-paced mode of edx was adopted, and two new learning modes, namely scheduled and premiere, were proposed when designing the MOOCs interface. The scheduled mode is a way that content is published weekly by the

system based on learners' enrollment week. The premiere mode is a way that instructors set the premiere time, and learners join the premiere with other learners, instructors, and course assistants to learn together. By applying those three learning modes to the MOOCs interface, learners can choose their favorite learning mode when enrolling in any course, which is one of the autonomy support features of the MOOCs interface designed in this research.

Thirdly, this research introduced the learning group and learning team to the MOOCs environment to facilitate learners' interaction. According to the mode of interaction (Anderson, 2003), interactions between student-student, student-teacher, and student-content are critical for deep and meaningful learning in the context of distance education. Also, from the perspective of the community of inquiry (CoI) framework developed by Garrison et al. (1999), social presence is one of the three elements that should be taken seriously for learning, which refers to the ability of learners to perceive society and emotions like "real people" through communication. And a lot of research has proved that there is a strong relationship between social presence and learning outcomes (Garrison, Arbaugh, 2007). However, as a way of distance learning, MOOCs have to face the fact that learners are isolated during the learning process, the interaction and the social presence generated from communication are relatively low compared with face-to-face learning. In this research, functions for creating groups and teams were designed to create a foundation for learners to build relations with others, thus supporting learners' relatedness.

Fourthly, this research provided an example of the dashboard for the context of MOOCs. With the development of artificial intelligence and big data technologies, dashboards for instructors and learners are receiving more and more attention from educational researchers. Many dashboards have been developed to support the teaching and learning process. However, according to Schwendimann (2016), compared with dashboards used in traditional face-to-face teaching, course management systems, intelligent tutoring systems, and blended learning settings, very few dashboards were developed for MOOC environments and most of those dashboards focus on supporting teachers. Considering so many learners are learning in the MOOCs environment nowadays, and the key role of learning dashboards for supporting self-regulated learning (SRL), the problem that the lack of learning dashboards on existing MOOCs platforms is critical to fix (Jivet, 2016). In this research, dashboards were designed separately for each learning mode, with the "all course" and "weekly", "monthly", "yearly" being considered, 12 learner dashboards were designed for the MOOCs learners. Because along with the learner dashboard, informative feedback must be provided tailored to the learner (Jin, 2019), in this research, learning information related to learning goal achieving, career goal achieving, and learning activities are provided to the learners along with some extra learning material as informative feedback to support their competence.

Last but not least, this research provides insight into how to help learners achieve personalized learning in the MOOCs environment.

The interface developed in this research contains a lot of features that support learners' autonomy, so the learners are able to make a lot of choices during the whole learning process. For example, learners can choose not only their preferred learning mode, but they can also choose to participate in many learning activities which include personal, group, and team activities. By offering diverse learning styles to the learners, hopefully, they can find their most suitable way of learning. Another feature of this interface that can help learners to achieve personalized learning is that learning paths are provided for the learners based on their skill and career goal.

5.2. Conclusion

There are some limitations of this research that need to be pointed out. In this section, the limitations of this research will be introduced along with suggestions for future research.

Firstly, in this research, a prototype of the MOOCs interface was designed with Figma following the MOOCs interface design guidelines, and the prototype was provided to 5 learners to test their response to it. Although the prototype is a high-fidelity one that can show the learners how the product works by stimulating, there is an inevitable limitation for testing learners' responses. Future researchers can cooperate with front-end and back-end developers to turn the prototype into a real web application and cooperate with instructors and instructional designers to design a real course for the MOOCs platform, then test learners' response to it.

Another limitation caused by the prototype is not able to access learning data to test the learners' motivation level objectively. Instead, in this research, learners' perceived autonomy support, perceived competence support, and perceived relatedness support were tested to judge the effectiveness of the interface on learners' intrinsic motivation. With a real functional MOOCs platform, it is possible to test learners' long-term usage, thus having a more objective clue on the impact of the platform in terms of learners' motivation.

Secondly, in this research, the participating learners are college students or graduate students who major in Education, Business, and

Chemistry. Because online education requires learners to have a high level of self-regulated learning, and this skill can be different among students at different ages, learning stages, etc, the research is limited in terms of generalizing the findings. Therefore, there is a need to test the effectiveness of the interface through future studies by inviting more learners of different ages and disciplines to examine how the interface affects their motivation.

Thirdly, in this research, to support learners' relatedness, a lot of space was designed for them to communicate with each other. For example, chatting windows, comment windows, question windows, group windows, and team windows. Those technologies are not new, which can be easily found in other applications. Recently, with the rise of metaverse and VR technology, a more immersive way for interaction is becoming possible. Future research can apply the VR learning environment into the MOOCs platform, and test its effect on learners' perceived relatedness and motivation.

Fourthly, in this research, three learning modes were offered to the learners, and the difference in learners' preferences for learning modes was found during the interview. Future research can separate learners into three groups based on their preferences and test their difference in terms of learning motivation. And based on the result, offering specialized motivational support to the learners from different groups.

Last but not least, to support learners' intrinsic motivation, extrinsic motivational factors are deleted during the revising of the design guidelines because there is a risk of influencing intrinsic motivation.

However, some of the participating learners claimed that they prefer to have extrinsic motivators designed into the MOOCs interface such as gamification elements. How to balance the effect of the intrinsic motivator and extrinsic motivator is a topic that has always been discussed in traditional learning environments. Future research needs to be done to propose effective strategies to balance intrinsic motivation with extrinsic motivation in the MOOC learning environment, thus meeting the needs of diverse learners.

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APPENDIX 1

Expert Validation Form

We would be grateful if you verify the validity of the design principles and design guidelines for the research 'Development of MOOCs interface for Supporting Motivation', and give us your opinion for improvement. The basic information and response contents prepared in this survey will never be used for any purpose other than for research purposes and are strictly confidential. If you agree to the use of the basic personal information and responses created in this survey, please check the 'Agree'. Thank you very much for participating.

☐ Agree

XIE SHIHAO (xieshihao@snu.ac.kr, 010-4351-1024)
Seoul National University, Educational Technology

– Expert Profile –

1. Name (Gender) :
2. Research Field :
3. Academic Background (Major) :
4. Affiliation/Title :
5. Research Experience (Time) :

A. Design Principles and Design Guidelines

Motivation Factors	Design Principles	Description	MOOC Design
Autonomy: the need to feel ownership of one's behavior	power (McClelland, 1961; KHURANA, JOSHI, 2017)	allow learners to control their own work	offer multiple ways of learning control to MOOCs learners, e.g. self-paced learning, scheduled learning, and premieres
	goal (Locke, 1990; Shi & Cristea, 2016; Gagn , 2018)	allow learners to establish their goals	let learners set their goals for enrolled courses. e.g. 40 minutes a day
			help learners to track goal achieving progress through a dashboard
	purpose (Keller, 1984; Marczewski, 2013; Muñoz-Restrepo, Ramirez & Gaviria, 2020)	allow learners to write down their purpose for each course and remind them	let learners set their purpose for each course, and show them on the course pages
	interest (Renninger & Hidi, 2019)	invite students to pursue their personal interests	recommend courses based on interest
	choice (Katz & Assor, 2007; Patall, 2013;	allows students to decide for themselves	

	Gagn & Deci, 2005; Muñoz-Restrepo, Ramirez & Gaviria, 2020)		allow learners to choose their ways of learning
	invitational language(Reeve, Cheon, 2021)	encourage student initiative and behavior change by relying on volition-rich language (i.e., "You might want to …," "You might consider … ")	use invitational language in the MOOCs system
	explanatory rationales (Vansteenkiste et al., 2018)	reveals the "hidden value" and "personal relevance" within the request	reveal learners the value of each learning activity
Competence: the need to produce desired outcomes and to experience mastery	self-actualization (Maslow, 1943; Herzberg, 1959; Alderfer, 1969; McLeod, 2018) scaffolding (Muñoz-Restrepo, Ramirez & Gaviria, 2020)	help learners to grow and develop to their fullest potential	let learners set their goals of development when registering an account
			give learners appropriate learning route recommendation

			provide learners additional learning material based on their learning activities
	achievement (Herzberg, 1959; McClelland, 1965)	help learners to accomplish and demonstrate their achievement	show learners their achievements through a dashboard
			restrict and remind learners when enrolling in improper courses based on their profile and give them course recommendation
			show learners keywords checklist at the end of each chapter
	mastery (Marczewski, 2013)	allow learners to feel their skill is increasing in direct proportion to the level of challenge	show learners their advancement through a dashboard
	positive feedback(Gagn & Deci, 2005)	offer positive feedback to make learners feel responsible for their successful performance	use positive feedback and avoid negative feedback in the MOOCs system

Relatedness: the need to feel connected to others	love and belongingness (Maslow, 1943; Herzberg, 1959; McClelland, 1961; Alderfer, 1969)	allow learners to be part of a group	organize various types of online communities. e.g. group based on course registration time, location, career goal, etc
	social environment (Bandura, 1999; Gopalan et al., 2017; Shi & Cristea, 2016)	allow learners to learn and construct knowledge from communication among the community	promote communication between learners by using bullet chatting, comments section, forum page, search function, etc
			provide space for learners to facilitate their communication with the teachers. e.g. let the learners evaluate the courses after each chapter and show both the learners and the teachers the result
	task-oriented environment (Mayo, 2005)	facilitate cooperation between students by creating a task-oriented environment	provide a task-oriented space for learners to cooperate
Satisfaction: learners should be satisfied with what they achieved during the learning	esteem (Maslow, 1943; McLeod, 2018)	facilitate learners to feel respected by others	let learners share their achievements by publishing their profile
	recognition (Herzberg, 1959)	allow learners to be praised and recognized by superiors and peers	offer chances for learners to praise each other by using like button, comments section, etc

process	reinforcements (Skinner, 1938; Gordan, Amutan, 2014)	allow learners to be motivated by incentives and reinforcement	give learners rewards (e. g. badges) after completing each chapter by using pop up window
	expectancy (Vroom, 1964)	make learners believe that more effort will result in success	show learners successful learning cases of other learners
	instrumentality (Vroom, 1964)	make learners believe that there is a connection between activity and goal	after each learning activity, show learners the progress change by using a pop-up window
	physical environment (Herzberg, 1959; Bandura, 1999; Gopalan et al., 2017)	make learners feel comfortable when using the interface	use colors that can make learners feel comfortable
			allow learners to select and use their favorite theme

B. Validation of design principles and design guidelines

The following questions ask the validity of each item of design principles and design guidelines for supporting motivation in the MOOCs environment. After reviewing each design principle and guideline, please give a validation score of 1−4.

Motivation Factors	Design Principles	MOOC Design	Rating (Not at all true → Very true)			
			1	2	3	4
Autonomy: the need to feel ownership of one's behavior	power (McClelland, 1961; KHURANA, JOSHI, 2017)	offer multiple ways of learning control to MOOCs learners, e.g. self−paced learning, scheduled learning, and premieres				
	goal (Locke, 1990; Shi & Cristea, 2016; Gagn□, 2018)	let learners set their goals for enrolled courses, e.g. 40 minutes a day				

		help learners to track goal achieving progress by using a dashboard				
	purpose (Keller, 1984; Marczewski, 2013; Muñoz-Restrepo, Ramirez & Gaviria, 2020)	let learners set their purpose for each course, and show them on the course pages				
	interest (Renninger & Hidi, 2019)	recommend courses based on interest				
	choice (Katz & Assor, 2007; Patall, 2013; Gagn & Deci, 2005; Muñoz-Restrepo, Ramirez & Gaviria, 2020)	allow learners to choose their ways of learning				
	invitational language (Reeve, Cheon, 2021)	use invitational language in the MOOCs system				

	explanatory rationales (Vansteenkiste et al., 2018)	inform learners of the value of each learning activity				

[For items rated less than four (e.g. 1, 2, 3), please write down the reason and your suggestion]

Competence: the need to produce desired outcomes and to experience mastery	self-actualization (Maslow, 1943; Herzberg, 1959; Alderfer, 1969; McLeod, 2018) scaffolding (Muñoz-Restrepo, Ramirez & Gaviria, 2020)	let learners set their goals of development when registering an account				
		give learners appropriate learning route recommendation				

		provide learners additional learning material based on the learning activities				
	achievement (Herzberg, 1959; McClelland, 1965)	show learners their achievements through a dashboard				
		restrict and remind learners when enrolling improper courses based on their profile and give them course recommendation				
		show learners keywords checklist at the end of each chapter				
	mastery (Marczewski, 2013)	show learners their advancement through a dashboard				

	positive feedback(Gagn & Deci, 2005)	use positive feedback and avoid negative feedback in the MOOCs system				

[For items rated less than four (e.g. 1, 2, 3), please write down the reason and your suggestion]

Relatedness : the need to feel connected to others	love and belongingness (Maslow, 1943; Herzberg, 1959; McClelland, 1961; Alderfer, 1969)	organize various types of online communities. e.g. group based on course registration time, location, career goal, etc				
	social environment (Bandura, 1999; Gopalan et al., 2017; Shi & Cristea, 2016)	promote communication between learners by using bullet chatting, comments section, forum page, search function, etc				

		provide space for learners to facilitate their communication with the teachers. e.g. let the learners evaluate the courses after each chapter and show both the learners and the teachers the result				
	task−oriented environment (Mayo, 2005)	provide a task−oriented space for learners to cooperate				

[For items rated less than four (e.g. 1, 2, 3), please write down the reason and your suggestion]

Satisfaction: learners should be	esteem (Maslow, 1943; McLeod, 2018)	let learners share their achievement by publishing their profile				

satisfied with what they achieved during the learning process	recognition (Herzberg, 1959)	offer chances for learners to praise each other by using like button, comments section, etc				
	reinforcements (Skinner, 1938; Gordan, Amutan, 2014)	give learners rewards (e. g. badges) after completing each chapter by using pop up window				
	expectancy (Vroom, 1964)	show learners successful learning cases of other learners				
	instrumentality (Vroom, 1964)	after each learning activity, show learners the progress change by using a pop-up window				

	physical environment (Herzberg, 1959; Bandura, 1999; Gopalan et al., 2017)	use colors that can make learners feel comfortable				
		allow learners to select and use their favorite theme				

[For items rated less than four (e.g. 1, 2, 3), please write down the reason and your suggestion]

[Other opinions on design principles and design guidelines]

APPENDIX 2

Expert Validation Form (2nd)

We would be grateful if you verify the validity of the design principles and design guidelines for the research 'Development of MOOCs interface for Supporting Motivation', and give us your opinion for improvement. The basic information and response contents prepared in this survey will never be used for any purpose other than for research purposes and are strictly confidential. If you agree to the use of the basic personal information and responses created in this survey, please check the 'Agree'. Thank you very much for participating.

☐ Agree

XIE SHIHAO (xieshihao@snu.ac.kr, 010-4351-1024)
Seoul National University, Educational Technology

– Expert Profile –

1. Name (Gender) :
2. Research Field :
3. Academic Background (Major) :
4. Affiliation/Title :
5. Research Experience (Time) :

A. Validation of design principles and design guidelines

The following questions ask the validity of each item of design principles and design guidelines for supporting motivation in the MOOCs environment. After reviewing each design principle and guideline, please give a validation score of 1−4.

Motivational Design Principles	Motivational Design Guidelines	Design guidelines for MOOCs interface	Not at all true Rating Very true			
			1	2	3	4
1. Autonomy: the need to feel ownership of one's behavior	1.1 choice (Katz & Assor, 2007; Patall, 2013; Gagn□ & Deci, 2005; Muñoz−Restrepo, Ramirez & Gaviria, 2020) Allow learners to make their choice for learning	**Allow learners to make choices** for their learning mode: self−paced learning, scheduled learning, and premieres (Premieres lets viewers watch and experience a new video together in real−time, which has been used in entertainment platforms such as YouTube, yet has not been adopted by main MOOCs platforms)				
		Allow learners to choose if they want to join a learning group, and what kind of group (local−based, career−based) they want to join				

		Offer a variety of learning activities such as individual activities, team activities for learners to choose				
	1.2 **goal** (Locke, 1990; Shi & Cristea, 2016; Gagn□, 2018) Design so that learners can set their own learning goals and check their achievement	**Give learners the choice** to set their goals so that the image of learning is formed intrinsically rather than extrinsically				
		Provide assistance to enable learners to set appropriate goals				
		Provide goal achievement information in pages such as dashboards and learning contents, so that learners **who set goals** can check their goal achievement				
	1.3 **purpose** (Marczewski, 2013; Muñoz-Restrepo, Ramirez & Gaviria, 2020)	**Give learners the option** to write down their motivation for course enrollment, so that the image of learning can be formed intrinsically rather than extrinsically				

	Make learners think they learn because there was a reason	Present learners their recorded motivation for course enrollment in the learning pages so that learners do not forget their initial motivation				
	1.4 **interest** (Renninger & Hidi, 2019) Design so that learners can engage in learning activities that fit their hobbies	Offer course recommendations based on the courses that the learner likes				
		Offer chances for learners to participate in learning activities that fit their hobbies by providing a variety of individual and team activities such as mind maps making, note-taking				
	1.5 **invitational language** (Reeve, Cheon, 2021) Encourage learners' initiative and behavior change by relying on volition-rich language(e.g., "You might want to …," "You might consider … ")	When **recommending learning content or learning activities** to learners, avoid using strong language, and use invitational language instead				
		Use invitational language as much as possible when **providing feedback**				
	1.6 **explanatory rationales** (Vansteenkiste et al., 2018) Reveals learners the "hidden	When **recommending learning content or learning activities** to learners, make sure to provide their values and personal relevance				

	value" and "personal relevance" within requests	When providing **feedback**, make sure to provide the reasons for it				
2. Competence: the need to produce desired outcomes and to experience mastery	2.1 **self-actualization** (Maslow, 1943; Herzberg, 1959; Alderfer, 1969; McLeod, 2018) / **scaffolding** (Muñoz-Restrepo, Ramirez & Gaviria, 2020) Help learners to grow and develop to their fullest potential	**To provide more precise support**, allow learners to set up their careers when registering for an account				
		Inform learners when enrolling in improper courses based on their profile **by offering explanatory rationales**				
		Offer learning paths for learners **based on their career goals**				
		Offer support for social regulated learning (planning, monitoring, evaluating) to promote collaborative learning of online communities				

		Provide learners with additional learning material based on their ability and learning activities				
	2.2 **achievement** (Herzberg, 1959; McClelland, 1965) Allow learners to feel and demonstrate their achievements	Offer learners **statistics results of learning activities (weekly, monthly, and yearly)** through the dashboard				
		Offer choices for learners to share their achievements with others within the MOOC platform and through SNS				
		Show progress change by using a pop-up window after each learning activity				
	2.3 **mastery** (Marczewski, 2013) Make learners feel that their abilities are increasing through learning activities	Offer learners a keywords checklist at the end of each chapter, **by which the learners can have an intuitive idea of what they have learned**				
		Inform learners of their changes **in terms of ability (e.g. numbers of keywords) and learning activity attendance** through the dashboard				

	2.4 **positive feedback** (Gagn & Deci, 2005) Provide positive feedback to help learners feel responsible for their successful performance	Provide positive feedback as much as possible, **while when negative feedback is inevitable, provide it in an informative way**				
		Provide **informational rewards** for learners after completing each chapter by using a pop-up window				
3. Relatedness: the need to feel connected to others	3.1 **love and belongingness** (Maslow, 1943; Herzberg, 1959; McClelland, 1961; Alderfer, 1969) Allow learners to join a group and feel a sense of belonging	Organize various types of online communities (e.g. group based on location, career goal), and **make it can be accessed easily**				
		Show learners successful learning cases of other learners in the same group				
		Provide like-button and emoticons to help learners share their emotions with each other, thus feeling a sense of belonging				

	3.2 **social environment** (Bandura, 1999; Gopalan et al., 2017; Shi & Cristea, 2016) Allow learners to learn and construct knowledge through communication in a community	Offer various communication spaces (e.g. comment space, question space, note space, group activity space) with search functions to promote learners' communication				
		Foster interaction between learner and instructor. e.g. Allow the learners to evaluate the courses after each chapter and show the result to both the learners and the instructor				
	3.3 **task-oriented environment** (Mayo, 2005) Facilitate cooperation between students by creating a task-oriented environment	**Offer options** for learners to take group assignments				
		Provide options for creating and sharing mind maps, notes with group members				

[Other opinions on design principles and design guidelines]

APPENDIX 3

User Tasks

1. Create an account and choose your career goal
2. Take an assessment and check your course recommendations
3. Checking the detail of the course "Learning Analytics"
   - check the mindmaps other learners create
   - try to enroll in the course, check the learning advice that we gave
4. Enroll in the course 'Educational Technology' and choose the option 'Self-paced'
   - set learning days to Tuesday, Wednesday, learning goals '3 videos per day'
   - write down why you learn this course
   - join a location-based group named group1
   - watch the video 1-1, take a note, create a mindmap, and leave a question about it
   - chat with your group members
   - go to the group activities section to see what your group members posted
   - finish the keywords checklist and check your learning result
   - evaluate the chapter you learned
   - join a team to finish the team project
5. Enroll in the course 'Educational Technology' and choose the option 'Scheduled'
   - set learning days to Monday, Tuesday
   - write down why you learn this course
   - create a location-based group named group1
   - check your todays' learning goal
6. Enroll in the course 'Educational Technology' and choose the option 'Premiere'
   - write down why you learn this course
   - set premiere time to Monday
   - create a location-based group named group1

- go to join the premiere
- check the learner numbers who is participating
- switch the chatting room to my group
- send emoticon

7. Find your info page, courses that you enrolled in, courses that your favorite

8. Find your dashboard
   - switch to educational technology
   - check your learning status, describe how much you have achieved your learning goal
   - check your learning advice
   - download the extra resource from the course Educational Technology
   - check how many questions you have asked and answered
   - set your dashboard info to public or private
   - check the model learners' learning activities in your group

Learner Response Evaluation Sheet

First of all, I would like to thank you for taking your precious time to participate in this research. This questionnaire was prepared to find out the thoughts and feelings related to learning that occurred while you use the MOOCs interface developed in this research. Please answer each question based on your honest thoughts and experiences. We promise that the content of your responses will be kept strictly confidential and will not be used for any purpose other than research purposes. If you agree to the use of the basic personal information and responses created in this survey, please check the 'Agree'.

☐ Agree

XIE SHIHAO (xieshihao@snu.ac.kr, 010-4351-1024)
Seoul National University, Educational Technology

– Personal information –

1. Name (Gender) :
2. Age :
3. Educational Background :
4. Major :
5. MOOCs learning time per week:
   ① less than 1 hour ② 1 hour~3 hours ③ 3 hours~7 hours ④ more than 7 hours
6. MOOCs platforms you use mainly (multiple responses possible):

<Survey>

Question		Not at all true Rating Very true				
		1	2	3	4	5
1. This interface is more effective for learning compared to platforms such as Coursera, edX, Udacity, xuetangX, icourse163						
2. This interface can help to motivate and maintain learning compared to platforms such as Coursera, edX, and Udacity.						
3. By using this interface, learning is more interesting.						
4. I want to learn by using this interface more practically.						
5. I want to recommend this interface to my friends.						
6.	6-1. Choosing a learning mode helps me to have a sense of ownership in learning (compared to without a choice).					
	6-2. Choosing to join a group or not helps me to have a sense of ownership in learning.					
	6-3. Choosing learning activities helps me to have a sense of ownership in learning.					
	6-4. Setting my own goal helps me to have a sense of ownership in learning.					

	6-5. When I set my goal, the assistance provided is useful.					
	6-6. Goal achieving information helps me to have a sense of ownership in learning.					
	6-7. Writing down my learning purpose and reminding me of it help me to have a sense of ownership in learning.					
	6-8. Choosing learning activities that I like helps me to engage in learning.					
	6-9. Invitational language (e.g. "You might") doesn't make me feel forced to do something.					
	6-10. Getting informed of the value of learning and its' relevance helps me to have a sense of ownership in learning.					
7.	7-1. Learning path recommendation based on my career goal is helpful for developing to my fullest potential.					
	7-2. Learning support when collaborating with group members is helpful for developing to my fullest potential.					
	7-3. Additional learning material is helpful for developing to my fullest potential.					
	7-4. The statistic result of learning activities (weekly, monthly, yearly) shown on the dashboard makes me feel a sense of achievement.					
	7-5. Sharing my learning record within the platform or through SNS is helpful for demonstrating my achievements.					

	7-6. The pop-up window that shows the progress change after each learning activity makes me feel a sense of achievement.					
	7-7. Keywords checklist makes me feel my ability is increasing because of learning activity.					
	7-8. The dashboard that shows concepts I have learned and the changes of my learning activity over time makes me feel my ability is increasing.					
	7-9. Positive informative feedback makes me feel responsible for my success.					
8.	8-1. Joining online communities makes me feel a sense of belonging.					
	8-2. Showing successful learning cases in a group makes me feel a sense of belonging.					
	8-3. Using like-button, and emoticons to express emotions to group members helps me feel a sense of belonging.					
	8-4. Diverse communication spaces with search functions help me communicate with others.					
	8-5. Evaluating courses after each chapter is a good way to communicate with the instructor.					
	8-6. Taking a team assignment makes me feel connected with others.					
	8-7. Sharing mind maps, notes with group members makes me feel connected with others.					

<In-depth interview>

1. What MOOCs platforms do you use mainly? Do you think those platforms can help you to sustain your learning, and why?

2. What are the strengths and weaknesses of this interface compared to those MOOCs platforms that you mainly use?

3. Do you think this interface can motivate you to study? And why do you think so?

4. What other interface-related factors motivate you to study online? And why do you think so?

5. What is the biggest problem with this designed MOOCs interface?

6. Do you think this designed MOOCs interface can be improved?

   If so, what part of it can be improved?

APPENDIX 4

The Initial Version of The MOOCs Interface Design Guidelines

Motivation Factors	Design Principles	Description	MOOC Design
Autonomy: the need to feel ownership of one's behavior	power(McClelland, 1961; KHURANA, JOSHI, 2017)	allow learners to control their own work	1.1 offer multiple ways of learning control to MOOCs learners, e.g. self-paced learning, scheduled learning, and premieres
	goal(Locke, 1990; Shi & Cristea, 2016; Gagn□, 2018)	allow learners to establish their goals	1.2 let learners set their goals for enrolled courses. e.g. 40 minutes a day
			1.3 help learners to track goal achieving progress through a dashboard

	purpose (Marczewski, 2013; Muñoz-Restrepo, Ramirez & Gaviria, 2020)	allow learners to write down their purpose for each course and remind them	1.4 let learners set their purpose for each course, and show them on the course pages
	interest(Renninger & Hidi, 2019)	invite students to pursue their personal interests	1.5 recommend courses based on interest
	choice(Katz & Assor, 2007; Patall, 2013; Gagn & Deci, 2005; Muñoz-Restrepo, Ramirez & Gaviria, 2020)	allows students to decide for themselves	1.6 allow learners to choose their ways of learning

	invitational language(Reeve, Cheon, 2021)	encourage student initiative and behavior change by relying on volition-rich language (i.e., "You might want to …," "You might consider … ")	1.7 use invitational language in the MOOCs system
	explanatory rationales (Vansteenkiste et al., 2018)	reveals the "hidden value" and "personal relevance" within the request	1.8 reveal to learners the value of each learning activity
Competence: the need to produce desired outcomes and to experience mastery	self-actualization (Maslow, 1943; Herzberg, 1959; Alderfer, 1969; McLeod, 2018) scaffolding (Muñoz-Restrepo, Ramirez & Gaviria, 2020)	help learners to grow and develop to their fullest potential	2.1 let learners set their goals of development when registering an account
			2.2 give learners appropriate learning route recommendation

			2.3 provide learners additional learning material based on their learning activities
	achievement (Herzberg, 1959; McClelland, 1965)	help learners to accomplish and demonstrate their achievement	2.4 show learners their achievements through a dashboard
			2.5 restrict and remind learners when enrolling in improper courses based on their profile and give them course recommendation
			2.6 show learners keywords checklist at the end of each chapter

	mastery (Marcz ewski, 2013)	allow learners to feel their skill is increasing in direct proportion to the level of challenge	2.7 show learners their advancement through a dashboard
	positive feedback (Gagn & Deci, 2005)	offer positive feedback to make learners feel responsible for their successful performance	2.8 use positive feedback and avoid negative feedback in the MOOCs system
Relatedness: the need to feel connected to others	love and belongingness (Maslow, 1943; Herzberg, 1959; McClelland, 1961; Alderfer, 1969)	allow learners to be part of a group	3.1 organize various types of online communities. e.g. group based on course registration time, location, career goal, etc
	social environment (Bandura, 1999; Gopalan et al., 2017; Shi & Cristea, 2016)	allow learners to learn and construct knowledge from communication among the community	3.2 promote communication between learners by using bullet chatting, comments section, forum page, search function, etc

			3.3 provide space for learners to facilitate their communication with the teachers. e.g. let the learners evaluate the courses after each chapter and show both the learners and the teachers the result
	task-oriented environment(Mayo, 2005)	facilitate cooperation between students by creating a task-oriented environment	3.4 provide a task-oriented space for learners to cooperate
Satisfaction: learners should be satisfied with what they achieved during the learning process	esteem(Maslow, 1943; McLeod, 2018)	facilitate learners to feel respected by others	4.1 let learners share their achievement by publishing their profile
	recognition (Herzberg, 1959)	allow learners to be praised and recognized by superiors and peers	4.2 offer chances for learners to praise each other by using like button, comments section, etc

	reinforcements (Skinner, 1938; Gordan, Amutan, 2014)	allow learners to be motivated by incentives and reinforcement	4.3 give learners rewards (e. g. badges) after completing each chapter by using pop up window
	expectancy(Vroom, 1964)	make learners believe that more effort will result in success	4.4 show learners successful learning cases of other learners
	instrumentality (Vroom, 1964)	make learners believe that there is a connection between activity and goal	4.5 after each learning activity, show learners the progress change by using a pop-up window
	physical environment (Herzberg, 1959; Bandura, 1999; Gopalan et al., 2017)	make learners feel comfortable when using the interface	4.6 use colors that can make learners feel comfortable
			4.7 allow learners to select and use their favorite theme

APPENDIX 5

Revised Design Guidelines

Motivational Design Principles	Motivational Design Guidelines	Design guidelines for MOOCs interface
1. Autonomy: the need to feel ownership of one's behavior	1.1 choice(Katz & Assor, 2007; Patall, 2013; Gagn & Deci, 2005; Muñoz-Restrepo, Ramirez & Gaviria, 2020) Allow learners to make their choice for learning	1.1.1 **Allow learners to make choices** for their learning mode: self-paced learning, scheduled learning, and premieres (Premieres lets viewers watch and experience a new video together in real-time, which has been used in entertainment platforms such as YouTube, yet has not been adopted by main MOOCs platforms)
		1.1.2 **Allow learners to choose** if they want to join a learning group, and what kind of group (local-based, career-based) they want to join
		1.1.3 **Offer a variety of learning activities such as individual activities, group activities for learners to choose**

	1.2 goal(Locke, 1990; Shi & Cristea, 2016; Gagn□, 2018) Design so that learners can set their own learning goals thus achieving it.	**1.2.1 Give learners the choice** to set their goals so that the image of learning is formed intrinsically rather than extrinsically.
		1.2.2 Provide assistance to enable learners to set appropriate goals
		1.2.3 Provide goal achievement information in pages such as dashboards and learning contents so that learners **who set goals** can check their goal achievement
	1.3 purpose (Marczewski, 2013; Muñoz-Restrepo, Ramirez & Gaviria, 2020) Make learners think they learn because there was a reason	**1.3.1 Give learners the option** to write down their motivation for course enrollment so that the image of learning can be formed intrinsically rather than extrinsically
		1.3.2 Present learners their recorded motivation for course enrollment in the learning pages so that learners do not forget their initial motivation

	1.4 interest (Renninger & Hidi, 2019) Design so that learners can engage in learning activities that fit their hobbies	1.4.1 Offer course recommendations based on the courses that the learner likes
		1.4.2 Offer chances for learners to participate in learning activities that fit their hobbies by providing a variety of individual and team activities such as mind maps making, note-taking
	1.5 invitational language (Reeve, Cheon, 2021) Encourage learners' initiative and behavior change by relying on volition-rich language(e.g., "You might want to … ," "You might consider … ")	1.5.1 When **recommending learning content or learning activities** to learners, avoid using strong language, and use invitational language instead
		1.5.2 Use invitational language as much as possible when **providing feedback**
	1.6 explanatory rationales (Vansteenkiste et al., 2018) Reveals learners the "hidden value" and "personal relevance" within requests	1.6.1 When **recommending learning content or learning activities** to learners, make sure to provide their values and personal relevance
		1.6.2 When providing **feedback**, make sure to provide the reasons for it

2. Competence: the need to produce desired outcomes and to experience mastery	2.1 self-actualization (Maslow, 1943; Herzberg, 1959; Alderfer, 1969; McLeod, 2018) / scaffolding (Muñoz-Restrepo, Ramirez & Gaviria, 2020) Help learners to grow and develop to their fullest potential	2.1.1 **To provide more precise support**, allow learners to set up their careers when registering for an account
		2.1.2 **Inform** learners when enrolling in improper courses based on their profile **by offering explanatory rationales**
		2.1.3 Offer learning paths for learners **based on their career goals**
		2.1.4 **Offer support for social regulated learning (planning, monitoring, evaluating)** to promote collaborative learning of online communities
		2.1.5 Provide learners with additional learning material based on their ability and learning activities

	2.2 achievement (Herzberg, 1959; McClelland, 1965) Allow learners to feel and demonstrate their achievements	2.2.1 Offer learners **statistics results of learning activities (weekly, monthly, and yearly)** through dashboard
		2.2.2 Offer choices for learners to share their achievements with others within the MOOC platform and through SNS
		2.2.3 Show progress change by using a pop-up window after each learning activity
	2.3 mastery (Marczewski, 2013) Make learners feel that their abilities are increasing through learning activities	2.3.1 Offer learners a keywords checklist at the end of each chapter, **by which the learners can have an intuitive idea of what they have learned**
		2.3.2 Inform learners of their changes **in terms of ability (e.g. numbers of keywords) and learning activity attendance** through dashboard

	2.4 positive feedback (Gagn□ & Deci, 2005) Provide positive feedback to help learners feel responsible for their successful performance	2.4.1 Provide positive feedback as much as possible, **while when negative feedback is inevitable, provide it in an informative way**
		2.4.2 Provide **informational rewards** for learners after completing each chapter by using a pop-up window
3. Relatedness: the need to feel connected to others	3.1 love and belongingness (Maslow, 1943; Herzberg, 1959; McClelland, 1961; Alderfer, 1969) Allow learners to join a group and feel a sense of belonging	3.1.1 Organize various types of online communities (e.g. group based on location, career goal), and **make it can be accessed easily**
		3.1.2 Show learners successful learning cases of other learners in the same group
		3.1.3 Provide like-button and emoticons to help learners share their emotions with each other, thus feeling a sense of belonging

	3.2 social environment (Bandura, 1999; Gopalan et al., 2017; Shi & Cristea, 2016) Allow learners to learn and construct knowledge through communication in a community	3.2.1 Offer various communication spaces (e.g. comment space, question space, note space, group activity space) with search functions to promote learners' communication
		3.2.2 Foster interaction between learner and instructor. e.g. Allow the learners to evaluate the courses after each chapter and show the result to both the learners and the instructor
	3.3 task-oriented environment (Mayo, 2005) Facilitate cooperation between students by creating a task-oriented environment	**3.3.1 Offer options** for learners to take group assignments
		3.3.2 Provide options for creating and sharing mind maps, notes with group members

APPENDIX 6

Learner Response Evaluation Sheet (2nd)

First of all, I would like to thank you for taking your precious time to participate in this research. This questionnaire was prepared to find out the thoughts and feelings related to the revised MOOCs interface. Please answer each question based on your honest thoughts and experiences. We promise that the content of your responses will be kept strictly confidential and will not be used for any purpose other than research purposes. If you agree to the use of the basic personal information and responses created in this survey, please check the 'Agree'.

☐ Agree

XIE SHIHAO (xieshihao@snu.ac.kr, 010-4351-1024)
Seoul National University, Educational Technology

– Personal information –

1. Name (Gender) :
2. Age :
3. Educational Background :
4. Major :
5. MOOCs learning time per week:
   ① less than 1 hour ② 1 hour~3 hours ③ 3 hours~7 hours ④ more than 7 hours
6. MOOCs platforms you use mainly (multiple responses possible):

<Survey>

Question	Not at all true Rating Very true				
	1	2	3	4	5
1. The problems related to consistency (choice of words, icons) have been properly fixed.					
2. The group chatting window now can be easily accessed.					
3. The information of the teacher now is properly positioned.					
4. The team activity window now is properly redesigned.					
5. I can easily find the note-taking function.					
6. The interaction problem with the learning route recommendation page now is properly fixed.					
7. The explanations for the novel functions (learning mode, goal, group, team, and premiere time) are clear.					
8. Exams and homework have been added to a proper place.					
9. The course information page now is properly designed.					
10. Wiki function is a good way for group members' interaction.					
11. The external reminder (Email, SNS) functions are added properly.					
12. The newly designed premiere time selector (visualized timetable) is better in terms of user experience compared with the old one.					

<In-depth Interview>

1. Do you think the interface has been properly revised, please feel free to share your opinions.

2. Some of the suggestions provided by participants have not been taken, the table below shows the reasons. Do you think it is reasonable?

Table Suggestions Not Been Taken

Categories	Details
interface–unrelated	Lesson length needs to be less than 30 minutes.
	It is better to provide more time options for premiere mode learners.
limitation of prototype	Subtitle function should be provided.
	Playback speed adjustment function is helpful for my learning.
not necessary	The group create function can be deleted. instead, let the system create groups for learners automatically.
	Using a survey for learning route recommendation is an easier approach.
research–unrelated	Extrinsic rewards such as certifications, achievement medals can improve learners' motivation.

국문초록

정보통신기술(ICT)의 발달로 오늘날 많은 사람이 전통적인 교실에서뿐만 아니라 온라인으로도 교육을 받고 있다. 온라인 교육의 한 방법으로 MOOC(Massive Open Online Courses)의 시장은 2012 년 첫 플랫폼이 공개된 이후 지속적으로 성장하고 있으며, 교육학자에게 많은 관심을 받고 있다. 특히 MOOC 는 고등교육, 평생교육, 기업교육 등에서 대체할 수 없는 역할을 한다는 연구 결과가 속속히 나오고 있다.

교육 분야에서 MOOC 가 점점 더 중요해질 것이라고 예상되지만, 지난 10 년 동안 MOOC 의 급속한 성장과 함께 MOOC 의 문제점들이 일부 발견되었다. 그중 하나는 낮은 이수율로서, 기존 교육에 비해 MOOC 학습자는 평균 이수율이 약 10%에 머무를 정도로 중도 탈락할 가능성이 높은 것으로 보고되었다. 선행 연구에 따르면 이러한 현상을 일으키는 원인 중 하나는 부족한 동기부여 때문이다.

사용자 인터페이스는 애플리케이션에서 사용자와 직접 상호 작용하는 부분으로서 어포던스를 제공하고, 사용자가 애플리케이션을 사용하는 방식을 결정하기 때문에 매우 중요하다고 말할 수 있다. 특히, E-learning 상황에서는 인터페이스가 더욱 중요한데, 이는 동기 부여에 영향을 미칠 수 있는 동기 요소들이 사용자 인터페이스에 설계될 수 있기 때문이다.

그러나 선행 연구에 따르면 현재의 MOOC 인터페이스 디자인은 동기 요소가 부족하고 MOOC 학습자 간의 상호 작용을 촉진하지 못하고 있다. 이에 따라서 본 연구에서는 학습자의 동기부여에 초점을 맞추어 MOOC 인터페이스를 설계하였고, 이를 위해 다음의 연구 문제들을 고려하였다. 1) MOOC 학습자가 학습을 지속하도록 동기를 부여하는 인터페이스 디자인

가이드라인은 무엇인가? 2) 인터페이스 디자인 가이드라인에 따른 예시적인 인터페이스는 무엇인가? 3) 인터페이스에 대한 학습자의 반응은 무엇인가?

연구 질문에 답하기 위해 Richey 와 Klein 이 제안한 설계・개발 방법론 중 유형 1 을 따랐다. 먼저 문헌검토를 통해 MOOC 인터페이스 디자인 가이드라인을 도출하고, 내적 타당성을 확보하기 위해 4 명의 전문가가 2 차례에 걸쳐 전문가검토를 실시하였다. 다음으로, 프로토타이핑 도구인 Figma 를 사용하여 가이드라인에 따라 MOOC 인터페이스의 프로토타입을 개발했다. 마지막으로, 디자인 가이드라인의 외적 타당성을 확보하기 위해 2 차례에 걸쳐 사용성 평가를 하고 학습자의 반응을 측정했다. 일련의 과제와 함께 프로토타입을 5 명의 학습자에게 제공하고, 그 결과를 바탕으로 프로토타입과 가이드라인을 모두 수정했다.

MOOC 인터페이스 디자인 가이드라인의 최종 버전은 3 가지 동기 부여 디자인 원리 (자율성, 유능성 및 관계성), 12 가지 동기 부여 디자인 가이드라인 (5 개 자율성 지원, 4 개 유능성 지원, 3 개 관계성 지원)과 34 개의 MOOC 인터페이스 디자인 가이드라인으로 구성되었다. 본 연구에서 개발한 MOOC 인터페이스는 이러한 MOOC 인터페이스 디자인 가이드라인에 따른 기능을 포함하고 있다. 자율성 지원 가이드라인을 반영하는 기능으로 학습 모드 선택 (self-paced, scheduled, premiere), 학습 그룹, 학습활동 선택, 학습목표 설정, 대시보드, 리마인더, 추천, 피드백 등 기능이 있었고, 유능성 지원 가이드라인을 반영하는 기능으로 레지스터, 수업 등록, 학습 경로, 팀 활동 지원, 대시보드, 학습목표 설정 등 기능이 있었으며, 관계성 지원 가이드라인을 반영하는 기능으로 대시보드, 피드백, 키워드 체크리스트, 학습 그룹, 채팅창, 그룹/팀 활동, 수업 평가, 팀 과제, 마인드맵, 노트 등 기능이 있었다. 사용성 평가에 참여한 학습자들은 개발한 MOOCs 인터페이스에 만족했으며, 5 점 척도 구성한 설문 문항으로 조사한 결과, 인터페이스 전반에 대한 인식 4.44 점, 자율성에 대한 인식 4.40 점,

유능성에 대한 인식 4.52 점, 관계성에 대한 인식 4.66 점이었다. 그리고 심층 인터뷰에서 취득한 질적 데이터를 오픈 코딩을 통해서 정리한 결과, 개발한 MOOCs 인터페이스의 장점, 문제점, 개선점을 도출했다. 장점으로 자율성 지원을 위한 선택 제공, 유능성 지원을 위한 스캐폴딩과 적응형 학습, 관계성 지원을 위해서 제공하는 상호작용, 그리고 기존 플랫폼과의 의미있는 차이점 등이 있었다. 문제점으로 기존 플랫폼들이 제공하지 않은 새로운 기능에 대한 가이드가 필요하다는 점, 불일치한 아이콘과 용어, 부적절한 포지셔닝과 인터랙션 등이 있었다. 개선점으로 위키 기능, 알림 메시지 기능을 추가하고 시간표를 시각화 등이 있었다.

본 연구의 의의는 다음과 같이 요약될 수 있다. 1) 내재적 동기부여 지향한 MOOC 인터페이스를 제안하였다. 2) MOOC 학습 환경에 3 가지 학습 모드를 도입했다. 3) 학습자의 상호 작용을 촉진하기 위해 학습 그룹과 학습 팀을 MOOC 학습 환경에 도입했다. 4) MOOC 상황에 대시보드의 예시를 제공했다. 그리고 5) 학습자가 MOOC 환경에서 맞춤형 학습을 달성하도록 돕는 방법에 대한 인사이트를 제공했다.

주요어: MOOCs 인터페이스, 동기부여, 자율성 지원, 유능성 지원, 관련성 지원

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