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A framework of online-merge-offline (OMO) classroom for open education

A preliminary study

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Abstract

Purpose – The purpose of this paper is to propose a design of online-merge-offline (OMO) classroom for open education with design principles related to practical issues of teachers' teaching, students' learning and schools' management.

Design/methodology/approach – Three stages were covered: drafted an OMO classroom framework, built a sample classroom and explored end-users' experience. First, authors searched for and reviewed previous studies and related cases to draft an OMO framework. Second, a classroom, consisted of wireless devices, cloud-based services, Internet of Things terminals, ergonomics furniture, and comprehensive data management and analysis services, was built in Shanghai Open University. Third, invited 11 students', 18 teachers' and 9 school managers' perspectives were collected and analysed by surveys and interviews.

Findings – All student participants responded positively in terms of learning experience in the classroom. They not only engaged in classroom activities such, but also accessed needed learning materials and interacted with teachers and peers anytime anywhere via mobile devices. Similarly, most teachers (90 per cent) made positive responses because of flexibility of teaching strategies and learning activities and expressed willingness to use the classroom in the future (94.4 per cent). In addition, more than 78 per cent of managers positively commented on the design of classroom, interaction effects and effective management. Visualised data allowed them to timely monitor status of facilities, comprehensively understand users' behaviour and issues, make necessary decision with scientific evidence.

Research limitations/implications – The framework and classroom not only provide teachers, students, school managers and researcher with a better understanding of innovative open education, but also indicate the key role of objective-oriented and data-driven issues for further work.

Originality/value – To meet needs of teachers, students, managers and researchers in today's open education, an OMO classroom was built in Shanghai Open University based on the proposed Objective-Oriented Pedagogy-Space-Technology (OPST) framework. The framework provides readers (especially teachers and administrators of open-education institutes, staff of information centres and ed-tech researchers) with a better understanding of innovative instruction and effective management, and the originally designed classroom can be a practical and illuminating example.

Keywords Blended learning, Open education, Teaching innovation, Objective-oriented PST, Online-merge-offline, Smart classroom

Paper type Research paper

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Introduction

Since the late 1990s, many countries increased their investments in technologies for educational purposes, with the assumption that use of technology in schools could enhance teaching achievement and facilitate learners' outcomes (Huang *et al.*, 2010; Yang *et al.*, 2018). However, some researchers found that most applications of technologies remained "on the surface" that would not effectively support teaching and learning in most classrooms (Cuban, 2009; JISC, 2009). According to a report published by Organization for Economic Co-operation and Development (OECD, 2015), without appropriate instructional design, investing heavily in school computers and classroom technology, including hardware and software, could not effectively improve learners' performance.

More and more educators begin to perceive that the core business of schools is to provide students with a learning environment that is open, respectful, caring and safe (OECD, 2006, 2015). In open learning environment, learning activity is a context-dependent exercise that is invariably grounded in the situation, environment and culture. In this kind of culture, new knowledge is realised, acquired and used appropriately (Kasvio, 2011; Zhang *et al.*, 2016). The development of virtual (online) and physical (offline) learning environment has allowed learners at all levels of schooling to access to global communications and various resources. In this case, the combination of online and offline (OnO) features could be regarded as OnO modes.

However, that is not enough or supportable for open education in modern society – which is responding to the latest evolution of the internet, the so-called Web 2.0. A learning environment of open education in the context of Web 2.0 is not only an OnO platform that expands access to all sorts of resources from offline to online (and vice versa) but also an interactive environment blurring the boundary between producers (e.g. traditional teachers) and consumers (e.g. traditional students) of content (Seely and Adler, 2008). Therefore, the school environments should be more open, adaptable and flexible for teachers and students (Yang *et al.*, 2018; Zhang *et al.*, 2016; Zhu, 2016). Design of school and classroom is not just a concept of architect, it can and should also care about students' learning needs, teachers' practical necessities and expectations of communities (OECD, 2015). The key issues of constructing appropriate learning environment are not only tech-rich or tech-enabled classrooms, but also learners' OnO access to necessary digital resources, receive relative learning guidance and suggestions at the right time, and interact with teachers and peers anytime anywhere.

For example, traditional classroom activities confine teaching to a fixed place and are implemented by teachers facing the same student groups in a classroom. In open education, with the emergence of smart classroom (e.g. live classroom and broad-casting), schools can use a live-broadcasting classroom for multi-campus teaching, urban and rural teaching, give full play to the role of outstanding teachers, enable the share of outstanding teaching resources and solve the problem of unbalanced resource distribution and unreasonable allocation (Xie, 2018; Zhang *et al.*, 2016).

However, Petraglia (1998) argued that instructional designers (or educational technologists) sometimes tended to overlook the original, fundamental, epistemological ideas of constructivism. This means that when the design of an online learning environment is ultimately separated from learners' real-life environments, it is inevitably challenging to make online learning authentic. The notion of online to offline (O2O) was proposed by Alex (2010) attracting attention of education, academia and industry. To take the advantages of O2O ideas, Zhu (2016) found that students' learning interest and informal learning behaviour could be encouraged by a mobile social network APP. However, considering practical situations in open-education courses, some scholars stated that it would be hard to ensure students' engagement in learning when just heavily relying on online activities (Lee, 2018; Yang *et al.*, 2018). That points to a gap between accepted theoretical ideas of effective online learning and actual pedagogical practices in most of higher-education institutions that are providing online/blended courses to the public (Lee, 2018; Zhang *et al.*, 2016).

In summary, in many classes of open education, teachers' teaching and students' learning mainly are conducted online. However, the interaction and activities in classrooms still play a role in people's learning process. In addition, how to develop a space that can fully support OnO teaching and learning activities for better experience in open education still lack successful cases. As to the design of classroom, although various innovative technology tools are embedded in many so-called smart classrooms or smart learning environments, few practical studies have been done on comprehensive issues such as teaching, learning and management experience. Therefore, the purpose of this study was to explore a new feasible framework of online-merge-offline (OMO) that indicated design principles to build a classroom to meet practical needs from open education.

Methods

For the purposes of this study, three-stage work were covered: drafted design principles for OMO classroom based on systematic literature review, built a sample classroom, and explored experience and perspectives of school end-users including students, teachers and managers.

Stage 1: propose a framework with design principles

In Stage 1, three steps were conducted: searched databases by keywords, filtered papers by terms and abstracted key concepts by reviewing. First, since initial searches had suggested that an extremely large number of papers would be found, the keyword searching conducted in this study adopted the databases used in the previous reviews by Connolly *et al.* (2012) and Boyle *et al.* (2016): Education Resources Information Center, Ingentaconnect and Institute of Electrical and Electronics Engineers Xplore, Science Direct and Google Scholar. Since technology advances at a quite rapid pace in educational applications, the review aimed to explore the most recent studies regarding smart classrooms and related instructional practices. The date range was restricted from January 2015 to April 2019, and keywords were used as listed below:

("smart classroom" OR "smart teaching" OR "smart learning" OR "smart management" OR "classroom") AND ("online and offline" OR "online to offline" OR "online merge offline" OR "OMO") AND ("open education" OR "open instruction").

Second, filtering papers by inclusion criteria. The search engines in databases were used to identify articles according to the search terms specified by the researchers, and a large number of papers were returned. However, many of them were irrelevant or did not explore elements and principles of smart classroom. Therefore, researchers filtered these papers by inclusion criteria: mentioned OnO activities, explored key components of smart classroom, and provided basic evaluation dimensions. Third, proposing preliminary design principles according to the review. After the filtering, papers were reviewed by three researchers to draft an OMO classroom design principles for open education (Table I).

Table I. Essential design principles of an OMO classroom

Dimension	Description
Resource	The convenience level of accessing online platform and digital resources in and outside of the classroom
Environment	The comfortability of the physical environment, such as colour design, spaces, light, sound, etc.
Equipment	The convenience level and comfortability of the classroom furniture such as collaborative student desks and ergonomics chairs
Engagement	The participation and involvement levels of teachers and students in classroom activities
Enhancement	The effects on teachers' teaching, and students' learning and managers' management

To date, some principles for design or evaluation have developed. For example, Li *et al.* (2015) created an inventory for smart classroom, and it consists of ten factors: physical design, flexibility, technology use, learning data, differentiation, investigation, cooperation, students' cohesiveness, equity and learning experience. Yang and Huang (2015) developed a classroom environment evaluation scale to evaluate both physical classroom environments and virtual environments covering ten aspects: showing, manageable, accessible, tracking, enhancement, teacher support, involvement, investigation, task orientation and cooperation. Last year, MacLeod *et al.* (2018) developed an instrument for understanding students' preferences toward smart classroom. It comprises eight dimensions covering student negotiation, inquiry learning, reflective design, connectedness, ease of use, perceived usefulness and multiple sources. By adapting and organising existing instruments, Yang *et al.* (2018) proposed a five-dimension framework for smart classroom evaluation. They invited 13,495 students from 135 primary and middle schools to respond to a questionnaire. The results showed that most students did not perceive much smart-learning experience in classrooms, especially in resource and enhancement aspects. This indicates that although the internet and digital devices were regarded as the basis for equipping smart classroom, how to engage students in learning activities to improve learning experience and facilitate their learning performance should be also carefully considered. Therefore, after referring to previous framework and inventories, and considering teachers' and students' needs in open education, this study drafted five key design principles of an OMO classroom, as shown in Table I.

The five-dimension principles provided an overview of design ideas, but we still lack a structured framework that can be used to build a practical classroom. To know more about the next generation learning spaces, Radcliffe *et al.* (2008) explored the interdependence of pedagogy, space and technology and proposed Pedagogy-Space-Technology (PST) framework that provided educational institutions with comprehensive principles to develop teaching and learning spaces. The framework consists of "pedagogy", "space" and "technology". In the framework, the pedagogy plays a role in purpose setting and instructional design, the space provides us with practical environment, and technology covers hardware, software and network. Simply put, they connect to and promote each other.

Based on PST framework, Liu and Liu (2014) designed and built a future learning centre that was regarded as an intelligent learning environment in Open University. Similarly, Ng (2015) developed an online moot court implemented in Charles Darwin University to support in-campus and off-campus students to practice more effectively. Hua *et al.* (2017) highlighted the importance of educational purposes and attempted to redesign learning spaces by meeting requirement from PST, respectively to provide students with better learning experience.

Above-mentioned studies indicated that more and more schools have attempted to enhance learning spaces based on PST conception. However, issues regarding teaching or learning objectives seem to be somehow ignored or lack of exploration. This study, therefore, further tried to integrate objective aspect with the design principles mentioned above to draft an OMO classroom framework. In the drafted framework, all development dimensions need to meet instructional objectives. In other words, objective-oriented design has an impact on connection in smart-classroom development between pedagogy, space and technology (Figure 1).

Objective-oriented OMO classroom. OMO classroom aims to integrate OnO teaching and allows students to learn anytime anywhere. It is to provide seamless connection between formal and informal learning for learners and make the most use of educational data to help teachers know students' learning progress, thereby meeting instructional objectives set in the very beginning. To be specific, in OMO classroom framework, objectives bridges gaps between pedagogy, space and technology and data play an essential role in the implementation of framework. This is because data are collected from all users

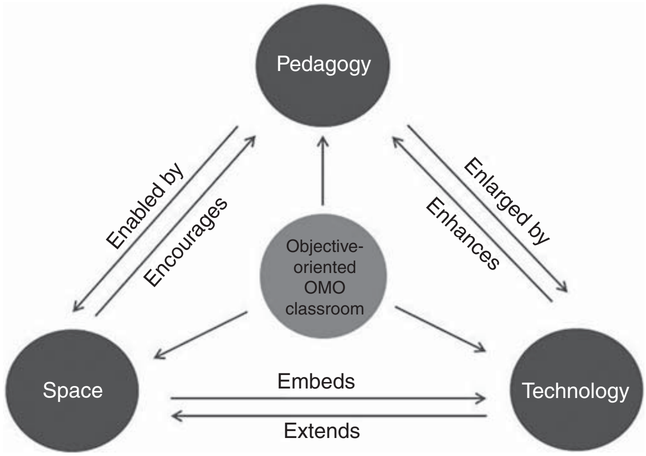

Figure 1.
Online-merge-offline classroom framework based on PST

(i.e. teachers and students) via all facilities/tools expectedly equipped in classroom, and they can be organised and analysed for further instructional applications such as learning analytics and teacher evaluation.

Pedagogy design. No matter in which schooling system (e.g. higher education, open education, K-12 education and vocational education), pedagogy is usually regarded as the key to effective instruction. With the fast development of information technology, innovative instructional strategies, such as online teaching and blended learning, have attracted teachers', students' and even parents' attention. Not just teachers' teaching design, the issues regarding learning spaces and technology applications may have a big impact on the implementation of the pedagogical strategies. That means these three dimensions are intimately linked.

Space design. The main goal of space design is to meet the needs of teachers and students in classroom activities. The scope should cover the entire environment, facilities, furniture and space layouts. Space design has an influence on teachers teaching and students' learning experience. For example, when a teacher groups and asks students to do some topic discussion, every group would need a specific classroom space. In this case, collaborative student desks and ergonomics chairs can help with that. Furthermore, in open education, classroom activities can be conducted OnO simultaneously. Thus, how to design an appropriate space and what kinds of equipment should be provided may reply on the instructional objectives, pedagogical strategies and technological support.

Technology applications. In the era of information and computer technology, OMO classroom can be expected to cover most necessary equipment and facilities, software, learning analysis, and teaching evaluation services, OnO platforms and data integration mechanism. Therefore, what kinds of technology tools should be embedded in the classroom and how teachers and learners can apply them to facilitate effective teaching and learning would be key issues when considering developing and examining effects of smart classrooms. Additionally, to some extent, technology use can also affect the space design because aspects of hardware, software and network connection are hardly separated from each other in OMO classrooms.

Stage 2: build a sample classroom

In Stage 2, to practically satisfy the needs of teacher and students for innovative teaching, blended learning and effective management in open education, a sample classroom was built based on the OMO framework in Shanghai Open University. It consists of video–audio interaction based on wireless devices (e.g. projection), cloud-based services (e.g. auto-lecture-recording), Internet of Things (IoT) and recognition technology (e.g. automated access control), ergonomics classroom furniture (e.g. collaborative student desks and ergonomics chairs), and mechanism for comprehensive data management and analysis (e.g. learning analytics and teaching evaluation).

As to pedagogy, blended learning (e.g. flipped classroom activities, synchronous online teaching, exploratory learning, personalised learning and experiential teaching) can be greatly supported in the classroom and in which teachers can choose different teaching modes according to their course features and objectives set for students. In teachers' course design, teachers not only focus on the learning materials provided for students, but also care about the interaction between teachers, students and student peers. In OMO classroom, teachers would be able to search for, access to, and share learning content with students via an online teaching platform and its app-based services. As to classroom interaction, students would be able to easily participate in various interactive activities such as quick survey, quiz, voting and fast answer race games with their mobile devices or facilities in classroom. Additionally, teacher and student behaviour would be recorded and analysed for future enhancement of teaching and learning. For example, learning analytics services provide teachers with a better understanding of students' learning progress and possible learning difficulty, thereby giving them necessary assistance and supplementary materials. Another application can be scientific decision making. School managers can gain timely feedback from end-users (i.e. teachers and students) and provide necessary support or establish related regulations according to evidence-based reports.

As for space design, acoustic insulation materials and optimised speakers were used to make sound produced in the classroom clearer. First, light in the classroom can be adjusted according to indoor and outdoor situations automatically or manually. Second, IoT technology was employed in the classroom. It can automatically detect current temperature and remotely operate central control system to maintain appropriate temperature. Third, auto-air-control systems were adopted to better air quality and to alleviate negative impacts of environment on teachers' and students' experience in class. Fourth, the walls were mainly painted in pale blue, consistent with other furniture. Not just sound, light, temperature, walls, the furniture including tables and chairs in the OMO classroom were also carefully considered. Student desks and chairs are in ergonomic design, meaning they can be easily adjusted height and tilt level of backrest to be more comfortable for users. The provided desks and chairs are movable that make it easier for students to do grouping tasks.

As for dimension of technology, four types of facilities and equipment were embedded in the classroom: a space management system, multimedia techniques, instructional platforms and a recording/broadcasting system. First, the classroom equipped an intelligent space management terminal with an online backend control panel. This system provides access control management, attendance management, space usage analysis, room status monitoring, room booking and announcement management. Second, multimedia techniques include interactive white boards, intelligent tutoring robots, desktop computers, tablet computers and smart phones. These wireless devices enable teachers and students to browse websites, search for certain information, share learning content or interact with peers without complicated settings.

Third, instructional platforms are the key part of OMO classroom. They provide teachers with opportunities to attempt various teaching design and classroom activities. For example, fast answer race, randomly select students, quick grouping, voting for certain topic and sharing screen can be applied to help teachers enrich teaching strategies and improve students' experience. In addition, learning analytics is also a main feature. Its services are mainly for learner analysis and teaching evaluation, including behavioural data collection, visualisation and review reports. During classroom activities, students' involvement, reaction, attendance and completeness of learning tasks would be recorded and visualised. With these platforms, teachers can know how their teaching materials are used/watched by students. That is, whether the content is viewed/downloaded, which parts attracted students' attention most, screen recordings, annotation, comments on courses and so forth.

The data collected mentioned above can form comprehensive evaluations via visualisation tools for teachers, students and school managers. These visualised data are not only for reviews of instruction and facility usage (e.g. space utilisation rate), but also for teacher and learner persona shaping. That would bring teachers and school managers deeper understanding of features of teachers/leaners, patterns of teaching/learning and changes of teaching/learning behaviour. The raw data can be conditional open for certain research purposes and the visualised overviews would make it easy for school managers to monitor instruction-related affairs and make necessary decision with evidence.

Last, the recording and broadcasting system allows teachers teach in class and online at the same time and provides in-campus and off-campus students with opportunities to participate in classroom activities together. Entire teaching process would be automatically recorded, and these recordings are editable for further usage such as teachers' course preparation and students' review after class. Apart from live/on-demand broadcasting and lecture recording, teachers would be able to produce micro-lessons via the system and teaching collaboratively with other teachers.

In summary, in the OMO classroom, teachers and students could conduct OnO at the same time without too many settings. To be specific, teachers and students could show any files (e.g. teaching materials prepared before lectures, idea reports drafted in class and group assignments after discussion) from their own mobile devices (e.g. phones, laptops and tablets) on walls by projectors. That provides teachers with an opportunity to get closer to their students when lecturing instead of always standing at the front of classroom. Students could also share their work or learning materials with peers immediately. When teachers need to highlight key points or demonstrate concepts for students, they could present slides and directly draw or write anything on walls. That design provides teachers and students with experience of combining online materials and offline actions in class. At the same time, the lecture would be automatically recorded and saved on cloud servers for further usage such as teachers' course preparation for following courses and students' self-studying after the lecture (Plates 1 and 2). For students who may not always be physically present at a school, they can attend the lecture and interact with teachers and peers via their mobile devices anywhere (Figure 2). The classroom also provides some physical spaces with big screens, collaborative student desks and ergonomics chairs for various classroom activities (Plate 3). All above-mentioned design and equipment are to support OnO activities at the same time without complicated settings. In other words, merging OnO activities for effective open teaching and learning.

Stage 3: explore end-user experience

In Stage 3, 11 students, 18 teachers and 9 school managers from Shanghai Open University were invited to experience OnO instructional activities in the sample OMO classroom for one week. Questionnaire surveys were employed to explore feedback of students and teachers, respectively. The questionnaire consisted of five dimensions: general environment design, equipment design, space management and support, teaching/learning activities and willingness to use.

Interviews were conducted in semi-structured design to know users' opinions further, and the guides contained eight basic questions covering ideas of smart classrooms, expected features, feasibility of the OMO classroom, comparison with conventional classrooms, satisfaction of teaching/learning/management and overall experience.

Plate 1.
Presenting, highlighting and live broadcasting at the same time

Plate 2.
Lecturing, auto-lecture-recording and live broadcasting at the same time

Figure 2.
A screenshot of attending a lecture and interact with teachers and peers via students' mobile devices

Plate 3.
Physical spaces for collaborative teaching and learning activities

Findings and discussion

Students' learning

In general, the student participants gave positive responses to the design of classroom, including tables, chairs, screens, walls and the spaces provided when learning in class. They mentioned that learners could not only engage in classroom activities such as discussion and presentation, but also easily get access to needed learning materials and interact with teachers and peers anytime anywhere via mobile devices, even if they were outside of class. In the week of experience, some students attended the lecture at home, in an office or in the street. With personal mobile devices, such as smart phones or tablets, they could ask questions and share collected learning materials with their peers who were sitting in the classroom. Overall, the combination of OnO accesses provides learners with more opportunities to join classroom activities and interact with each other. That would make open education more accessible and supportable.

Teachers' teaching

After teaching in the classroom for a week, teachers were generally satisfied with the entire design of the classroom, including the light, sound and ergonomics. Only 16.67 per cent of teachers concerned that if sounds of students and content (e.g. videos and animations) cannot be controlled and recorded appropriately, the quality of lectures *per se* and lecture recordings may be affected.

As to the equipment design and space management, 72.2 per cent of teacher participants were impressed with the combination of physical walls and content projection. This implies that presenting resources (e.g. files, notes or videos), highlighting, or taking notes by directly draw on the walls might bring teachers much more students' attention and that could be partly helpful for teachers to implement following learning activities. In addition, 66.7 per cent of teachers gave positive responses to displaying of course information and booking spaces on an IoT terminal device equipped outside the classroom. That was clear sign to all visitors, and it made it easy for teachers and students to book a room for certain purposes.

When it comes to instructional activities, in comparison with conventional classrooms, more than 90 per cent of invited teachers responded positively because of their various teaching design and students' learning activities were greatly supported by the OMO classroom. They mentioned that the classroom attracted students' attention, increased their interest of attending classroom activities with peers, and helped them interacted with teachers. Therefore, in the last dimension of teacher survey, 94.4 per cent of teachers expressed their willingness to use the classroom in the future.

In addition to the survey, three of teacher participants from different departments were interviewed to know teaching experience further. All of them mentioned that smart classroom should not only support various teaching and learning material formats (e.g. texts, slides, videos or animations), but also automatically record entire process of teaching and learning for further usage. Three key features of an OMO smart classroom were commonly stated: various materials, flexible interaction and lecture re-use.

First, in the past, most learning content students received were usually from teachers, but with development of the internet and mobile technology, an OMO environment can be expected to automatically search for, collect and present supplementary materials from different sources when teachers and students need. This demand was not satisfied greatly in the sample classroom and needed to be enhanced. Second, comfortable spaces and ergonomics classroom furniture (e.g. collaborative student desks and ergonomics chairs) are the must for teachers and students, and various interactive activities should be fully supported as well. For example, in open education, students usually study learning content and attend a lecture online, but the lack of real-time and face-to-face interaction with teachers and peers may have a negative effect on their learning. Thus, they complimented the OMO classroom on providing learners with more choices to participate in classroom activities. When students' needs were satisfied, positive feedback would also come back to teachers. Third, many teachers of open universities tend to record their lectures for course preparation in the future, and students would like to review and study these important videos by themselves. This implies the importance of auto-recording functions or tools that are provided in the OMO classroom already.

Managers' opinions

As for management issues, nine school managers were invited to visit and briefly experience interactive activities in the classroom. More than 78 per cent of them made positive comments on the design of classroom, interaction effects in the classroom and effective management of the courses and activities. They stated that data collected from online platforms and physical environment allowed them to timely monitor status of facilities, comprehensively understand users' behaviour and issues and develop solution plans based on scientific evidence. Some issues were also pointed out and needed to be improved: quality of speakers and microphones, types of tables and chairs and protection methods of equipment.

Implications and future work

In the era of information technology, students' learning needs pose a challenge to teachers' teaching and schools' environment (especially open universities and similar training institutions). This study provided a sample case of OMO classroom that supports online and physical instructional activities for open education. It is not about how much fancy hardware equipped or software installed, it is about how teachers' teaching and students' learning can be appropriately supported during the entire process. For instance, students who cannot attend a lecture in person would be able to receive high-quality learning materials, interact with each other immediately, and review lecture recordings anytime anywhere, just by their own mobile devices.

This study is a part of a big project regarding developing paradigm of smart open education based on OMO instructional environment for future learners. The OMO framework proposed in this paper can be referred to design a feasible interactive learning environment. Overall, although teachers, students, school managers responded positively on the classroom built in Shanghai Open University and OMO activities, the suggestions such as quality of sounds and equipment protection need to be considerably improved. In addition, the ways of various resources applications, effects of innovative teaching strategies and data-driven evaluations still need further exploration. These issues point to new possibilities of open education and needs of instructional experiment in future research.

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