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The effects of using Merrill's first principles of instruction on learning and satisfaction in MOOC

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ABSTRACT

This study investigates the effects of a developed MOOC based on Merrill's principles of instruction on participants' learning outcomes and satisfaction. A pre-test-post-test with a control group design was used in this study. In total, 335 participants were assigned into experimental (using Merrill's principles of instruction) and control group (using the conventional method). However, 291 subjects (143 participants from the experimental and 148 participants from the control group condition) remained in the course up to the last session, and only 200 participants (100 participants per each condition) filled in the surveys. The results were in favour of participants in the experimental condition both in terms of learning and satisfaction compared to the participants in the control group condition. By implementing Merrill's principles of instruction in designing MOOCs and actively engaging participants in a problem-centred learning process, their learning outcomes and satisfaction can be further improved.

KEYWORDS

MOOC; Merrill's principles of instruction; learning; online learning; satisfaction

Introduction

Over the last few years, the debate about online learning in higher education has intensified (Noroozi et al., 2016, 2018), particularly in response to the global Massive Open Online Courses (MOOCs) (O'Connor, 2014). MOOCs are the state-of-the-art form of ICT use in education that permits large numbers of learners to access online courses (Jung & Lee, 2018; Weinhardt & Sitzmann, 2019). MOOCs have increased in popularity in recent years (Foley et al., 2019) with the core purpose of providing opportunities for public instruction and free access to the academic training of all instruction-seeking applicants (Yuan & Powell, 2013). MOOCs create unlimited opportunities for innovation in education that not only allow institutions to configure and implement the core values of academic education but also can shift the focus from traditional lectures to inclusive-oriented learning (Yuan & Powell, 2013), where learners are provided with a higher level of autonomy over their learning activities (Ding & Shen, 2019; Jansen et al., 2020).

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Despite the widespread use of MOOCs and their benefits to provide free access to education seekers worldwide (Jung & Lee, 2018), MOOCs have received criticism regarding insufficient interaction between teachers and students (Leito et al., 2015), low course completion rates (Haggard et al., 2013), small impacts on learning (Daniel, 2012) and participants' satisfaction (Gamage et al., 2016). Such drawbacks might be due to issues related to the instructional design principles and learning theories behind MOOCs (Aldowah et al., 2019; Yuan & Powell, 2013).

Most MOOCs have only concentrated on making higher-quality visual learning content available rather than dealing with instructional design and learning experiences (Haggard et al., 2013; Watson et al., 2016). Literature suggests that the difficulty of course content, motivation, and social interactions are course design-related factors responsible for student dropout from online courses such as MOOCs (Aldowah et al., 2019). Thus, Suen (2014) emphasises that due to the enormous enrolment in MOOCs, course design should be done carefully by considering the principles of instructional design.

Margaryan et al. (2015) found that the majority of the MOOCs lacked even basic instructional design principles, which are the foundations for a quality learning experience. Most of the current MOOCs perform well in organising and delivering courses; nevertheless, due to the lack of attention to the instructional design principles, the students' learning experiences in these learning environments are scarce (Kop et al., 2011; Mackness et al., 2010; Milligan et al., 2013) especially when it comes to the students' active engagements and interactions (Yılmaz et al., 2017). In this regard, scholars identified and proposed different instructional designs in terms of key elements (Scagnoli, 2012), questions (Jasnani, 2013), steps (Siemens, 2012), models such as ADDIE (Kopp & Lackner, 2014), and principles of instruction (Alharbi & Jacobsen, 2014) for designing the MOOCs.

Merrill (2018) argues that while different instructional design theories and practices focus on various aspects of instruction using different vocabularies, they are all based on careful consideration of common principles underlying effective instruction known as the First Principles of Instruction. According to these principles, instructional activities should be centred on *real-world problems* (Merrill, 2002). Also, instruction should follow a four-phase cycle of instruction that *activates* students' prior-knowledge, *demonstrates* new knowledge to the students, makes students *apply* their new knowledge, and encourages them to *integrate* that knowledge into their lives (Merrill, 2006, 2013). Merrill's first principles of instruction serve as a solid framework for designing and developing learning environments facilitating students' active learning and engagement, which can enhance student performance (Gardner, 2011), content comprehension, critical thinking, and metacognitive skills (Nielsen Archibald, 2010), creativity (Jalilehvand, 2016), and learning the topic at hand (Zarei et al., 2014).

One may expect that Merrill's first principles of instruction would be implicitly incorporated in any educational setting also in the design of MOOC platforms. However, incorporating Merrill's first principles of instruction is sometimes neglected in designing MOOCs (Margaryan et al., 2015). Likewise, Hendriks et al. (2020) showed that the activation and demonstration principles are less emphasised, and the integration is the most neglected principle in designing MOOCs. Also, Badali et al. (2018) reported that Merrill's first principles of instruction are poorly incorporated in designing the MOOCs. Thus, given the importance of these principles, scholars suggest considering such design principles in developing MOOCs (Lee et al., 2020; Zhu et al., 2019).

Research purpose

Merrill's first principles of instruction constitute critical components for designing any learning environment, includes MOOCs, to facilitate students' active learning. However, minor attention has been paid to MOOC-pertinent studies in this regard. Besides, according to Hew and Cheung (2014), most of the MOOC studies have centred on the investigation of learners' experiences through surveys, without solid empirical research. Thus, there is not much empirical evidence to confirm MOOCs' effectiveness, especially when it comes to learning gains and participants' engagement (Lee et al., 2020; Margaryan et al., 2015).

This study aims to fill these gaps by using Merrill's first principles of instruction as an instructional design framework for implementing multiple active learning strategies in designing a MOOC. Besides, it aims to measure the impacts of the designed MOOC on participants' learning outcomes and their satisfaction in empirical research.

Materials and methods

Design and procedure

A pre-test-post-test control group design was used in this study to answer our research question. The participants in the experimental group condition (N = 100) followed the course in a MOOC platform (ATA platform) supporting by Merrill's first principles of instruction. The participants in the control group condition (N = 100) also studied the same learning materials but in another platform (Vakavesh platform) without reinforcing the first principles of instruction.

The participants were first given pre-test surveys on their demographic characteristics and their prior knowledge about the subject. Then, participants followed the MOOC course, which lasted four weeks. Afterwards, the post-test was administrated to measure participants' learning outcomes and their satisfaction.

Courses' instructional design

Both platforms had the same facilities suitable for MOOCs, such as discussion forums, synchronise chat rooms, broadcasting video clips, submitting the assignments, etc. Also, the course's main content was delivered to the participants in both platforms through the same video clips recorded with the same lecturer in four sessions, i.e. introduction, teachers, communication skills, teachers' management skills, teaching and learning approaches. Each session began with elaborating on the tasks which participants needed to accomplish the objectives. The participants could watch the videos on specific dates, and they needed to take multiple formative and summative assessments during and at the end of the sessions. Besides, they had the opportunity to discuss their questions with the teacher or other participants in the forum. However, despite all the similarities, in each session for the ATA platform, Merrill's first principles of instruction were implemented throughout the course in different phases. Table 1 demonstrates how the principles were implemented in session 3 of the course for the experimental condition.

In total, 335 official teachers at the Iranian ministry of education enrolled for the MOOC course 'Teaching Skills' through a convenience sampling method. The enrolment was voluntary upon an open call on different social media. After accepting the invitation to participate in the course, we asked the participants to join an online allocation platform

Table 1. The implementation of Merrill's first principles of instruction in session 3 of the ATA platform.

What	How	When
Problem-centred Principle	Participants were needed to watch a video showing real anarchy in a class where the teacher could not control the students.	Two weeks before starting the session and watching the main video.
Activation Principle	(1) The video of the real anarchy in a class was ended with some questions to probe the participant's prior knowledge and experiences in a similar situation. (2) Participants were needed to discuss and share their solutions in the forum.	2–3 days before starting the session and watching the main video.
Demonstration principle	Participants watched a video clip demonstrating how to implement the suggested strategies for managing anarchy in a real class.	After watching the main video of the session.
Application Principle	Participants were asked to apply the strategies in their own classes and to reflect on them.	At the end of the session.
Integration Principle	Participants were asked to argue about the applicability of the strategies in other contexts (e.g. at home, street) and to share their experiences in this regard.	At the end of the session.

(different from the designed MOOCs) to randomly assign them to one of the control or experimental group conditions. After the automatic assignment, the allocation platform provided participants in each group with a link leading them to one of the designed MOOCs (i.e. ATA or Vakavesh platform) based on their group condition. At the beginning of the MOOC, 44 participants dropped out. Thus, in total, 291 subjects remained in the course up to the last session – however, only 200 participants (100 participants per each condition) filled in the surveys, both in pre- and post-test. It is to be noted that in the end, the findings of the study were based on the comparison of these 200 participants' performance in pre- and post-tests (see Table 2).

Materials

Learning outcomes survey

A survey consists of 20 multiple-choice questions was developed to assess participants' learning outcomes. A panel consists of four education experts, and two teacher training experts brainstormed to generate questions related to the learning outcomes. The brainstorming session resulted in 23 questions. To detect any possible overlap, two other experts in the field of education were asked to review the questions. As a result, three questions were identified as redundant and consequently discarded. Examples of the questions are shown in Table 3.

For assessing the content validity, the method of Content Validity Ratio (CVR) was used. Twelve experts were asked to rate each question. After expert comments were collected,

Table 2. Participants demographic information.

		Age		Experiences*		Gender	
Group	N	M	SD	M	SD	Male	Female
Control	100	34.13	7.68	10.53	4.89	41	59
Experimental	100	36.26	7.28	8.49	4.94	47	53

*Teaching experiences (in Year).
N = Number. M = Mean. SD = Standard Deviation.

Table 3. Sample questions of learning outcomes test.

Q10. What is the best distance between a teacher and a student in the classroom?
a) Close distance
b) Personal distance
c) Social distance
d) Public distance
Q15. Which of the following is correct about having a teacher lesson plan?
a) It organises the content
b) It boosts learners' confidence
c) It is a non-verbal communication
d) The lesson plan is one of the criteria for choosing a teaching method

as suggested by Lawshe (1975), the questions that had a CVR higher than.56 were maintained, and the remaining questions were left out. All questions had a CVR higher than .56 with an average of .82. Furthermore, the content validity of the final survey was evaluated based on the magnitude of the Content Validity Index (CVI) values as it related to the degree of agreement among the panellists (Lynn, 1986). A CVI index of greater than 0.80 is a high value which denotes a high level of agreement (Yusoff, 2019). The result of the CVI evaluation showed a high level of agreement among the nine experts (CVI = .89).

Finally, inter-raters' reliability was employed. For this, 20 learners were randomly assigned to answer the survey. Cronbach's alpha was equal to .84, which indicates the high reliability of this test.

Participants' satisfaction survey

A self-made satisfaction with MOOC survey was developed based on Gameel's (2017) study. The survey consisted of 17 items rated on five-point Likert scale (1 = strongly agree; 5 = strongly disagree) in three different categories, namely the learners' perceived usefulness (5 items), teaching and learning aspects of the MOOC (6 items), and learner-content interaction (6 items) (see Table 4).

A panel consisted of nine educational experts in the field reviewed the items in terms of their relevance, transparency, and understandability. Also, they were asked to rate each item considering the essentiality statements, which resulted in (CVI = .84) and (CVR = .78). Furthermore, the overall reliability of the survey with 20 learners was sufficient (Cronbach's α = .87).

Results

A one-way ANCOVA was conducted to determine statistically significant differences between participants' learning outcomes in two conditions, controlling for their prior-knowledge. Assumption evaluations indicated that the homogeneity of regression slopes and variance assumptions were all satisfactory. Specifically, the interaction effect of the variable and the covariate was not significant for the experimental (p = .25) and

Table 4. Example of the items for participants' satisfaction survey.

Q1. I would recommend this course to friends/colleagues (learners' perceived usefulness)
Q8. The interactive content of this course contributed to learning (Teaching and learning aspects of the MOOC)
Q14. This course effectively challenged me to think (Learner-content interaction)

the control (p = .31) conditions. Also, the results of Levene's test confirmed the homogeneity of the variances for both experimental (p = .87) and control (p = .59) conditions. The ANCOVA analysis showed that the mean scores of all participants in the learning outcome test improved significantly (p < .005) from pre-test to post-test. Also, the mean score of the experimental group condition (M = 17.45, SD = 6.09) was significantly higher (p < .001) than the control group condition (M = 15.74, SD = 5.87) in the post-test (see Table 5).

Regarding the participants' satisfaction, the ANOVA analysis showed that participants' satisfaction with learning in the experimental group condition (M = 71.80, SD = 16.72) was significantly higher (F(1,119) = 4.50, p < .05, η^2 = .12) than participants' satisfaction in the control group condition (M = 67.35, SD = 14.89).

Discussion

This study shows that incorporating Merrill's first principles of instruction in designing the MOOC affects participants' learning and satisfaction. These findings substantiate previous findings in the literature. For example, scholars found that using Merrill's first principles of instruction in teaching improves students' meaningful learning (Zarei et al., 2014), their content comprehension and metacognitive skills (Nielsen Archibald, 2010), and their satisfaction (Hernando et al., 2014; Khalil & Ebner, 2015).

These positive findings can be related to different aspects of Merrill's first principles of instruction. According to Gardner (2011), these principles as a whole can be a powerful framework for encouraging active learning strategies such as problem-solving. There is a consensus among researchers that having students learn and solve the problems actively increases their meaningful learning (Prince, 2004), and satisfaction (Chanchalor & Chomphutong, 2004). Problem-centred principle positively influences students' learning outcomes (Clark & Choi, 2005) by initiating their engagement (Merrill, 2013). Especially when it comes to real-life issues, it may contribute to their active involvement in the learning process by cultivating a sense of ownership of the problem (McNeil, 2014). Furthermore, this active involvement can increase learners' motivation and satisfaction (Maya-Jariego et al., 2020), which further can enhance their learning achievement (Eom et al., 2006).

Moreover, Nordhoff's (2003) research findings indicate that activating students' prior knowledge can contribute to the students' achievements. Gardner (2011) argues that providing an appropriate problem-centred demonstration can facilitate student selection of the information related to that problem and organisation of information related to the context. Finally, the application and integration principles can improve student application of knowledge as they provide students with relevant experiences in different contexts, which can further increase their ability to act appropriately in the future (Merrill, 2002).

Table 5. Tests of between-subjects effects.

Dependent Variable: Learning						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Pre-test	47.41	1	47.41	8.39	.004	.04
Group	152.44	1	152.44	26.99	.001	.21
Error	1112.59	197	5.65			

Conclusion, limitations and future studies

Based on the findings of the study, incorporation of Merrill's first principles of instruction in designing MOOCs can improve participants' learning and satisfaction. MOOCs should be centred on *real-world problems* and *tasks* to facilitate participants' active learning and engagement. The essence of the problem should be delivered to the participants before presenting the main content of each session in order to increase their learning enthusiasm. Moreover, participants' prior knowledge should be *activated* at the beginning of each session, new knowledge must be *demonstrated* to them during each session, and they should be encouraged to *apply* their new knowledge and to *integrate* that knowledge into their lives at the end of each session. The application and integration principles can also be presented in the form of homework assignments, since doing homework in MOOCs can further contribute to the participants' learning outcomes as well (see Lee et al., 2020).

The main limitation of this study was the use of a convenient sampling method. Hence it is recommended to use random sampling techniques in future research to increase the generalisability of this study. Also, in this study, we used self-made surveys to assess participants' learning outcomes and satisfaction. Although the surveys passed the relatively robust validation procedure, and their validity and reliability were confirmed, it is recommended to repeat the same study, also in the other context, using other standard surveys to assure the repeatability of the findings. Finally, since participants' satisfaction is a significant intermediate outcome (Donohue & Wong, 1997), which can predict their retention (Edwards & Waters, 1982), future studies can measure participants' retention as well while designing a MOOC based on Merrill's first principles of instruction.

Disclosure statement

The authors reported no potential conflict of interest.

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