Formative E-Assessment Design in Online Learning Environments

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Abstract

With the demand and significant prevalence of online learning, investigating the impacts of formative assessment designs on promoting student learning has never been more imperative than ever. The research compared the learning performance and engagement levels for a group of teachers who participated in two training workshops with the integration of two different formative e-assessment designs for their online professional development. Participants' learning of the introduced contents were assessed during the instructional process and their attitudes toward different formative e-assessment design strategies were also investigated. Research results indicated that different formative e-assessment designs made differences not only in students' learning, engagement levels, and attitudes, but also in instructors' behaviors in designing formative e-assessment for online synchronous instruction.

Keywords: formative e-assessment design, online learning environment, learner's engagement, online professional development

1. Introduction

This ubiquitous online learning and technology-based applications require educators to take a closer look at what instructional practices and assessment strategies are effective to deliver a high-quality educational experience for learners. Assessment is at the core of education. Formative assessment was defined by Gikandi, Morrow, and Davis (2011) as "the iterative processes of establishing what, how much and how well students are learning in relation to the learning goals and expected outcomes in order to inform tailored formative feedback and support further learning, a pedagogical strategy that is more productive when role is shared among the teacher, peers and the individual learner" (p. 2337). Formative assessment helps students to identify gaps in instruction by determining what contents are essential and what are not (Lemanski, 2010). It also helps teachers to identify students' needs and ultimately to modify instructional practices that lead to improve student learning. Assessment-centered instruction offers learners opportunities to self-reflect their emerging abilities.

E-assessment refers to assessment delivered via technology tools. The goal of online e-assessment is to support a successful virtual learning environment with effective technology tools. Applying technology to accurately assess a student's understanding of the instructional contents is essential in online learning process. The merge of formative assessment delivered via online technology tools conveys the idea of online formative e-assessment (Pachler et al., 2011). The integration of formative e-assessment practices embedded in online instruction is critical for improving online teaching and learning. Educators need to know how to design and deliver their instructional practices effectively to facilitate a meaningful online learning environment.

This research is significant in two perspectives. First, formative e-assessment is an essential core to ensure the quality of online education. Literature review showed that few research investigated the effects of formative e-assessment for online learning. Research which investigated and compared the differences of formative e-assessment designs was even scarce. The results of this research shed light on informing educators on how to apply effective formative e-assessment design to improve learners' engagement and overall academic performance.

Second, this research investigated how a group of Taiwanese Americans in the United States (US) used two different types of formative e-assessment designs for their online professional development. The unique of the participants in this study could not be ignored. According to the USA Facts (2021), there were 44.9 million foreign-born immigrants, comprising 14 percent of the national population in the US. Among the immigrants, 18.6 million were Asian Americans, making up 6% of the US population. Among the Asian Americans, 4.4 million were Chinese or Taiwanese Americans, comprising 24% of the Asian Americans in the US. The research findings would contribute to promote the quality of online learning for non-mainstreaming education in the US.

The purpose of this study is to inform educators, staff, and administrators on the impacts of different formative e-assessment design strategies on adult learners' engagement and overall academic performance in online learning environments. The researchers examined the effects

of two online formative e-assessment designs on adult learners' learning and how formative e-assessment designs could support teachers' online professional development.

2. Literature Review

The importance of formative assessment in online instruction had been recognized in several research studies (Elmahdi et al., 2018; Gikandi et al., 2011; Lawton et al., 2013; Pla-Campas et al., 2016; Vonderwell & Boboc, 2013). Gikandi, Morrow and Davis published a literature review on effective online formative assessment in 2011. They conducted a systematic qualitative review of relevant studies and literature on online formative assessment in higher educational settings and emphasized the essential role of feedback to both students and teachers in online learning. They further stressed that effective formative assessment could enhance learner engagement with valuable online learning experiences. Pla-Campas et al. (2016) also concluded that online learners who were evaluated with formative assessment during instructional process had a significantly higher average final grade than those who had not.

Although technology is a must in online learning, it alone is not enough. Technology must be applied effectively to support pedagogy (Beatty & Gerace, 2009). Several formative assessment tools had been applied to investigate the impacts of assessment in online instruction. First, Beatty and Gerace (2009) developed and studied a technology-enhanced pedagogy with a classroom response system (CRS), which was also known as the clicker system. They distinguished the tool and its use by emphasizing that instructors should not be satisfied with just adding technological tools to their teaching. Instead, instructors should re-think and carefully design instructional contents to integrate these tools.

Second, Cohen & Sasson (2016) studied online formative assessment via Online Moodle quizzes. They found that the average grade on online quizzes was notable predictors of the grade on the final examination and students significantly improved their scores on the last attempts of the online quiz as compared to their first attempts. They also found that students' attitudes towards online quizzes revealed a generally positive attitude.

Self-regulated learning theory provides a great theoretical framework to support the integration of formative e-assessment in online learning. Formative assessment reinforces learners to engage learning productively and assists them in the disposition development of self-regulated learning. This in turn helps learners to take responsibility for their own learning that is an imperative requirement to be successful in online learning (Baleni, 2016). Furthermore, "formative assessment does not benefit all students if they do not fulfil their responsibility to learn" (Smith, 2007, p. 32).

3. Research Questions

This research investigated and compared how two different types of formative e-assessment design in online learning could support a group of non-mainstreaming teachers' professional

development. Thus, the researchers proposed the following research questions for the study.

• What were the differences of students' learning in two synchronous trainings with two formative e-assessment designs in online learning environments?

• What were the students' attitudes and behaviors towards the integration of the two different formative e-assessment strategies?

• How did formative e-assessment designs help in teacher's online professional development?

4. Method

The research compared the learning outcomes and engagement levels of 30 teachers who participated in two synchronous online training workshops with the integration of two different formative e-assessment designs for their professional development. The two formative e-assessment designs were described as below.

4.1 Formative E-assessment Plug-in Design

Formative e-assessment plug-in design referred to a type of formative assessment in which instructors provided questions to check online students' understanding by adding another software application onto a presentation tool that they used during instruction. With the plug-in tool, instructors could add interactive questions to their presentations, to check students' understanding from the answers collected by the tool, and to provide immediate feedback during presentation. Types of quiz questions could include multiple choice, true/false, fill-in-the-blank, drag/drop, and open-ended. Learners were able to use their hands to write, click, type, or drag/drop to submit their answers to interact with the instructor. In this research, the instructor exercised formative e-assessment plug-in design by adding Pear Deck onto her Google Slides presentation. Figure 1 showed a sample question with formative e-assessment plug-in design. The topic and instructional contents for the training design was about culture comparison between countries and races. After the training, students would receive a grade point for a final artifact assignment. The assignment was graded based on a 5-point scoring rubric with 5 as the best and 0 as the worst or without submitting the assignment.
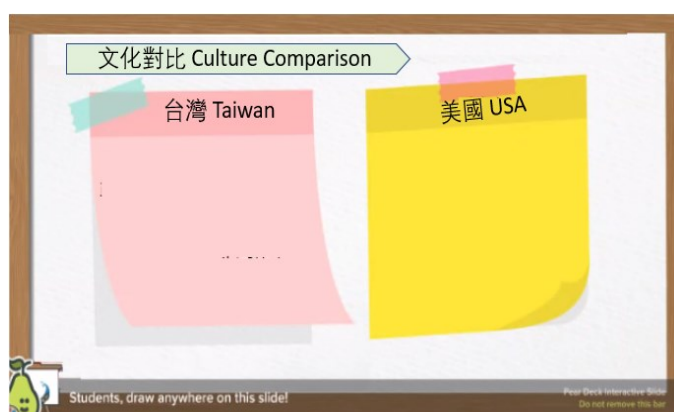

Figure 1. Sample Question with Formative E-assessment Plug-in Design

4.2 Formative E-assessment Built-in Design

Formative e-assessment built-in design implied that instructors utilized the built-in features offered by a presentation tool to create questions for checking students' understanding during their online instruction. Built-in design also allowed instructors to add questions to their presentations and to check students' understanding from their answers in the tool function features offered by Zoom, such as chat, polls, white board, and audio. Instructors could provide immediate feedback during their presentation, too. Types of quiz questions could also include multiple choice, true/false, fill-in-the-blank, drag/drop, and open-ended. Learners were able to use their hands to write, click, draw, and type to show their answers to interact with the instructor or peers. In this research, the instructor simply used Google Slides presentation tool to present check-for-understanding questions throughout her instruction. Questions were directly typed in the presentation slides to serve for the purpose of formative assessment. Students typed their answers in Zoom chatroom or simply spoke out via Zoom audio. Although Zoom offered whiteboard and poll functions to allow learners to click, type, or draw their answers, the instructor did not utilize these two functions. Figure 2 showed a sample question with formative e-assessment built-in design. The instructional topic and contents for the training were about culture identity. Again, students would receive another grade point for the final artifact assignment for the training. The assignment was also graded with the same 5-point scoring rubric.

Figure 2. Sample Question with Formative E-assessment Built-in Design

Both formative e-assessment plug-in designs and built-in designs shared similarities and differences in their design features. A comparison table was made to contrast the two designs (See Table 1). In the table, a check mark meant that students could provide their responses or answers during online synchronous instruction.

Both training workshops were delivered via Zoom, a cloud-based video conferencing technology tool that participants could virtually interact with each other. Both training sessions were recorded. A social media chat group was also created for the participants to ask questions and to discuss instructional problems mainly for outside the synchronous online instructional time. Both online synchronous training sessions lasted for four hours, and the

training were delivered on two different Sunday afternoons. The workshop with formative e-assessment built-in design was delivered in June 2022 and the other workshop with formative e-assessment plug-in design was delivered in July 2022.

Table 1. Comparison of Student Response Option between the Two Designs

Design Features / Students' Response Options	Formative E-Assessment Plug-in Design	Formative E-Assessment Built-in Design
Types of Quiz Questions		
Multiple Choice	√	√
True/False	√	√
Fill-in-the-Blank	√	√
Drag/drop	√	
Open-ended	√	√
System Collection of Students' Responses	√	
Need of an Additional Tool	√	

The 30 bilingual participants in this research were teachers who taught Chinese in various Chinese schools throughout a bay area in northern California. They spoke both Chinese and English. Twenty-seven out of the 30 participants taught Chinese as a part-time job during weekends. Only three out of the 30 participants had a full-time teaching job in public schools. All of them had online learning and teaching experiences with Zoom and were familiar with the tool. All of them were female Asia Americans and Chinese was their native language. Their ages ranged from 30s to upper 60s. Specifically speaking, there were two learners at their 30s, seven learners at their 40s, twenty learners at their 50s and only one learner at her 60s.

The instructor for the two online synchronous training workshops received California state issued teaching credential in foreign language, specifically in Chinese, and had a professional teaching job to teach Chinese in a public high school in northern California. She spoke both Chinese and English fluently. The instructor used both languages to carry out the online trainings. The instructor was proficient using technology and had extended experiences in using Zoom to deliver online teaching for four years.

This research study adopted an exploratory mixed method approach designed to investigate and compare adult learner's performance with the application of two different designs of formative e-assessment in synchronous online learning environments. Both qualitative and quantitative data were collected via various data collection methods. Specifically, qualitative data was collected from synchronous online class observation, Zoom recordings, Zoom chatroom discussion, social media group discussion, and interviews with the instructor and ten selected participants. For the online synchronous class observation, one of the researchers adapted a qualitative research approach, researcher-as-instrument (Hammersley & Atkinson,

2019), to be an active respondent and participant in both training workshops. Online synchronous Zoom class observation notes were member checked to ensure the notes were true to what the researcher observed and triangulated with other data, such as Zoom recordings, chatroom discussion and the social media group discussion. Interview transcriptions were also member checked to increase the validity and reliability of the data.

Quantitative data consists of quantified grade points for the artifact assignments, interactive activities among the instructor and learners, number of posts in Zoom chat, number of posts in the social media group, and learners' answers to the instructor's formative questions. Multiple data collection methods were applied to counterbalance the limitations of each method.

5. Results

An analysis of both qualitative and quantitative data collected from the research revealed several remarkable results and findings. First, in terms of students' performance, a T-test was run to compare student's final grade points received from the artifact assignments for both training sessions. The purpose of running the T-test was to determine if the two sets of data were significantly different from each other. The results from the final artifact assignment in the online instruction with formative e-assessment built-in design (M = 3.1, SD = 1.99) showed a statistically higher scores than the online instruction with formative e-assessment plug-in design (M = 3.067, SD = 1.68) although the differences were minimal, $t(29) = 0.14$, $\alpha = .05$ (See Table 2).

Table 2. T-test Results Examining Student's Performance on the Artifact Assignments

	Built-in Design	Plug-in Design
Mean	3.1	3.066666667
SD	1.988761528	1.680175141
Observations	30	30
df	29	
t Stat	0.143464187	
P(T<=t) two-tail	0.886915846	
t Critical two-tail	2.045229642	

Second, 13% more interaction happened between the learners and the instructor, and 40% more interaction occurred among the learners and their peers in the online training with formative e-assessment plug-in design than in the workshop with built-in design. In this study, for learner-instructor interaction, the researchers quantified interaction by counting number of questions being asked and answered, the instructor's feedback and comments to learners' response and assignments. For learner-learner interaction, the researcher also quantified the interaction by counting the number of discussions among learners in Zoom

chatroom and the social media group. For example, if a question was asked, an issue was raised, or a content-related conversation occurred either orally via Zoom audio, in Zoom breakout room, or in text via chat room during the instruction, and the instructor or a peer answered the question or issue, then it would be counted as one interaction. The outcomes of the interaction for the two online training with different formative e-assessment design could be found in Table 3.

Table 3. Student Participation Outcomes

	Learner-instructor interaction		Learner-learner interaction		Zoom chatroom posts		Social media group posts		Assignment completion	
	n	%	n	%	n	%	n	%	n	%
Plug-in Design	17	53	14	58	78	57	83	78	23	52
Built-in Design	15	47	10	42	59	43	23	22	21	48

Third, it was found that students tended to make more posts in both Zoom chatroom and the social media group chat during the instruction with formative e-assessment plug-in design than the one with built-in design. Specifically, there were 32% increase on the discussion posts in Zoom chat and 260% increase in the instruction with plug-in design than the instruction with built-in design.

Fourth, the instructors tended to provide more questions to check for students' understanding during the online instruction with formative e-assessment plug-in design than the one with built-in design. In this study, there were five questions presented throughout the online instruction with formative e-assessment plug-in design, yet there were three questions presented in the one with built-in design. A notable assessment data from the research was that all learners' answers to the instructor's five questions created with Pear Deck for formative e-assessment purposes were collected. However, the researcher could not collect all students' answers to the three questions from the online instruction with formative e-assessment built-in design because students' answers or responses to the questions were random. The collected data in Figure 3 on students' answers to the five questions for formative evaluation purpose showed that most learners were able to answers the five questions correctly.
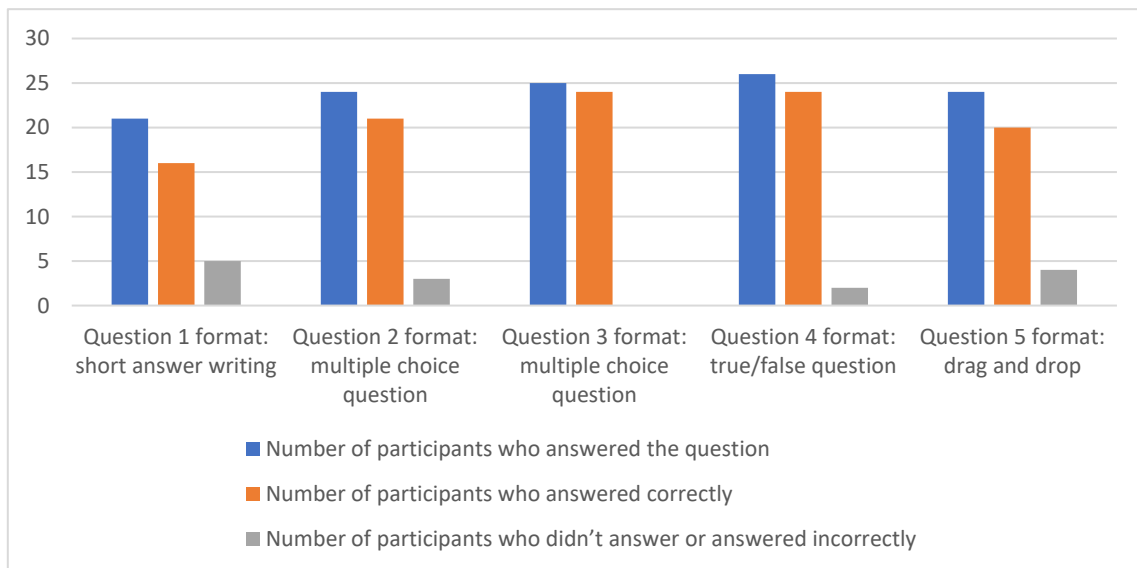
Figure 3. Learners' Answers to the Instructor's Questions with Formative E-assessment Plug-in Design

Fifth, the learners experienced more technical issues in finding and answering the questions in the online training with the formative e-assessment plug-in design than the built-in design. At the beginning of the workshop with formative e-assessment plug-in design strategy, there were five learners who had difficulty to load and view the instructor's google slides presentation. They had to seek assistance from the instructor and the peers to properly view the instructor's presentation. It took about 30 minutes for all the five learners to get used to the instructor's presentation with the add-on of Pear Deck platform. On the other hand, for the built-in design, learners did not have any issues in viewing the instructor's presentation.

Finally, mix results were found from the interviews with ten selected students and the instructor. Each selected participant and the instructor received a brief 10-minute interview that was carried out synchronously online via Zoom meetings. Four interview questions were asked. They were: How did you feel about the two online synchronous trainings? How did you feel about the use of the Pear Deck in the online presentation? How did you like the questions presented throughout the instruction? What challenges did you encounter for the two online training sessions? Results indicated that the learners overall had a positive attitude toward the training by indicating something like "I like the information delivered in the two online training. The training provides a nice review on the contents, and it helps me to enhance my teaching at Chinese Schools." "I enjoy working on completing the artifact assignment. They are fun." However, there were three participants indicated that the integration of Pear Deck in the presentation was not user-friendly. One participant even stated that the add-in tool made her feel that she was "in an extraterrestrial planet" and she got lost during the instruction constantly.

An interview with the instructor was also conducted by asking the same questions. The

interview data disclosed that the instructor tended to create more various types of on-going questions throughout her instruction when she incorporated formative e-assessment plug-in design in her online instruction. In this study, the instructor offered five questions with different formats, such as multiple choice, true/false, drag/drop, and open-ended in the online training with plug-in design. For the online instruction with built-in design, there were only three questions presented by the same instructor and the questions were all in open-ended format. The instructor stated that "The integration of the Pear Deck constantly reminds me to compose questions and I would like to make the most use of it."

6. Discussion

Discussions on the results and findings from this research would be addressed based on the focus of the above-proposed three research questions: students' learning, engagement levels, attitudes, behaviors, and the impacts of formative e-assessment designs on online professional development. The effects of students' learning in the two online training sessions with different formative e-assessment designs could be reflected from the interactive activities happened during the synchronous online instructional process, the discussion posts that the participants made in Zoom chatroom as well as social media group, and the artifact assignment. First, contradictory results were found for students' learning performance on their artifacts assignment in the two online trainings with different formative e-assessment designs. Although assignment completion rate for the online training with formative e-assessment plug-in design were 0.07% higher than the one with built-in design, the evaluation of the assignment quality showed an opposite outcome. Sauro (2011), in his research on 1200 usability tasks, concluded that an average task-completion rate was 78%. In this research study, the assignment completion rate for online training with formative e-assessment plug-in design was 77% and for the built-in design was 70%. The assignment completion rates for both designs were lower than the average rate published by Sauro (2011). In addition, an analysis of the t-test results from the artifact assignments also did not find significant differences between the two online synchronous instruction with different formative e-assessment designs.

Second, interaction was critical to learner success in online learning. The importance of interaction for online instruction had also been acknowledged (Online Learning Design Studio, n.d.). This research found that there were more learner-instructor interaction and learner-learner interaction in the online training with formative e-assessment plug-in design than the one with built-in design. Although most of the interaction contents in the plug-in design were relevant to the technical problems, there were still more interaction activities relevant to the content essence occurred in the training with plug-in design than the built-in design after the researchers conducted a closer examination of the interactive contents by removing the interaction related to technical issues.

Third, the in-meeting Zoom chat for online instruction could increase the effectiveness of instruction by improving student engagement, providing voice for students, and fostering camaraderie among teachers and students. Using the chat room in online Zoom instruction offered students and teachers opportunities to communicate, collaborate, and connect. More

students' posts during online instruction implied more communication, collaboration, and connection among teachers and students. In other words, more posts suggested higher student engagement level in instruction. In this research, learners made more posts in the online instruction with formative e-assessment plug-in design than the built-in design.

In terms of students' attitudes and behaviors towards the implementation of these two different formative e-assessment designs, the research indicated an ambivalent finding. Most participants showed a positive attitude toward both trainings, yet some participants did not like the user-unfriendly platform presented by the plug-in design. Although the formative e-assessment plug-in design offered learners with an opportunity to answer their questions privately and individually without worrying about quality or accuracy of their answers to be viewed by their peers, its non-intuitive platform intimidated some users.

A thought provoking finding from the research was about the instructor's responses for using both designs. In formative e-assessment built-in design, there were three ways that the learners could provide their answers for formative assessment: via Zoom audio, Zoom whiteboard function, or Zoom chat. However, no matter which way to provide answers, some learners' voice might be overlooked; timid leaners might choose to be silent; some learners might not provide their answers; and the instructors were only able to identify some students' answers, not everyone's. In formative e-assessment plug-in design, the instructors could easily view all learners' answers individually in her presentation so that instructors could target specific learner's needs and provide appropriate feedback. This research found that the instructor tended to compose more various types of on-going questions throughout the instruction when she incorporated formative e-assessment plug-in design. Via the interview, the instructor indicated that when embedded Pear Deck into google slides, the tool constantly provided question hints. It was hard for instructors to overlook forming questions for checking students' understanding when designing and preparing their presentation. In short, the hints provided by the plug-in tool encourage the instructors to continue creating questions for checking students' understanding.

This study also found that effective formative e-assessment design could support teachers' online professional development by shifting the design of traditional quizzes with multiple choices or true/false questions to problem solving questions. The traditional multiple-choice or true/false questions were usually used to test conceptual understanding (Martin-Blas & Serrano-Fernandez, 2009). To promote higher-order thinking skills, online formative e-assessment contained questions with problem solving was needed. In online learning environments, effective presentation of formative e-assessment might provide a state-of-the-art pedagogical approach to facilitate learners' deeper thinking and learning.

Last, the technical issue on viewing the instructor's presentation with the plug-in design could be attributed to the need to open another Internet browser for viewing the instructor's presentation. In regular synchronous Zoom online teaching, instructors could share their presentation screen with their online learners. In this research, the instructor could share her presentation screen with the online learners, too. However, when formative questions were presented with the plug-in design, the learners had to open the instructor's

presentation with another Web browser so that they could write, draw, type, drag, or click to answer the questions. As most of the participants were the first-time users for the plug-in design in this study, navigating the online instruction with such design became an issue. A pre-training on how to use the plug-in design would ease the situation.

7. Conclusion and Suggestions

The field of education play a vital role in our global society. Because of this, educators must learn, practice, and implement effective instructional design strategies to challenge and engage learners. Challenging and engaging in a way that allows for self-regulation, maximizes student engagement and performance, and promotes a deeper connection to learning outcomes so the next generation is well prepared to handle any challenge they are confronted with. The future of our children's education requires that current professionals in the field take the necessary steps to ensure that students are engaged with relevant curriculum and are motivated to learn in a way that successfully utilizes functional technology in the classroom and at home.

In this study, two formative e-assessment design formats, plug-in design and built-in design, in synchronous online instruction were investigated and compared. Findings from this study contributed to the literature from two perspectives. First, different formative e-assessment designs made a difference in learners' engagement level, attitudes, and academic performance. Second, online instructors' presentation of their course materials was impacted by different formative e-assessment design strategies.

For both designs examined in this research, formative questions to check the adult learners' understanding of the contents were presented along with the instructor's presentation. How was other designing strategies or formats for formative e-assessment in online learning environments? Further research on different designs to effectively present formative e-assessment in online learning could be investigated. Suggested research might focus on the improvement of the assessment design strategies investigated in this study or on promoting the formative characteristics of assessment. Particularly, implications for the development of formative e-assessment in online professional development for adults should be considered its potential to promote learners' self-regulatory learning processes.

It is difficult to deliver effective online instruction without getting acquainted with major online instructional design components, learners, learning objectives, e-learning activities, e-assessments, and all necessary online instructional tools. The study sheds light on investigating formative e-assessment design with a hope to help educators who are interested in online instruction or online professional development in promoting the quality of online instruction.

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Note

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