



A Framework for Formative Assessment within Interactive Video Lectures and its Relation to Reading Comprehension Skills

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Abstract: The current research aimed at designing a framework for formative assessment within interactive video lectures (IVLs) and examine its effect on graduate students reading comprehension skills in English language. A formative assessment framework within IVLs was designed. It has three main components: introduction, watching the IVLs & formative and summative assessment. To examine the effectiveness of the proposed framework, a quasi-experimental approach was used. The proposed framework was applied on a sample of six graduate students representing the first experimental research group. The second experimental research group was also made up of six graduate students who studied using sharable video lectures. The research instrument consisted of a reading comprehension test to examine graduate students' reading comprehension in terms of overall reading comprehension and the reading comprehension in the literal, interpretive, critical and creative levels. The Non-parametric Mann-Whitney Test was used. The results showed that the proposed framework for formative assessment within IVLs was effective in enhancing graduate students' overall reading comprehension skills and the reading comprehension in the literal, interpretive, critical and creative levels.

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Introduction

Video lecturing is a trending topic in the field of higher education that has come about as a result of advances in the Internet infrastructure that facilitated sharing high bandwidth streaming content (Altinpulluk, Kilinc, Firat, & Yumurtaci, 2019; Klefodimos, Lappas, & Evangelidis, 2020). The popularity of video lectures is associated with the recent trends of massive open online courses (MOOCs) and flipped classrooms (Hung, Kinshuk, & Chen, 2018; Marrhich, Lafram, Berbiche, & El Alami, 2020; Wachtler & Ebner, 2019). Nevertheless, lack of interactivity in video lectures is a weakness that can negatively impact their effectiveness and eventually students' learning (Klefodimos et al., 2020; Ronchetti, 2010). In this perspective, researchers (Bater & Jordan, 2020; Lin & Chen, 2019; Wachtler & Ebner, 2019; Zhang, Zhou, Briggs, & Nunamaker Jr, 2006) indicated that in video-based learning environments, students' attention span tends to be limited and selective. Thus, interactions and interactive elements are needed in video lectures to overcome this issue (Ewais & Samara, 2020; Wachtler & Ebner, 2019). Interactivity is a key component for the success of online courseware design (Hung et al., 2018). Therefore, increasing the interactivity of online video lectures can make teaching more effective compared to noninteractive ones (Andajani & Wijastuti, 2020; Aprianto & Purwati, 2020; Laws, Willis, Jackson, Koenig, & Teese, 2015;

Marrhich et al., 2020; Najmi, 2020; Songkram, Songkram, Chootongchai, & Samanakupt, 2021).

Studies conducted by Altinpulluk et al. (2019) also suggest that flexible and interactive videos segmented into smaller meaningful chunks are preferred and recommenced compared to long educational videos. To make such a practice effective, studies advocate the use of student-centered, interactive instructive "active-engagement" practices (Wright, Newman, Cardinale, & Teese, 2016). Interactive elements in video lectures can be used to assess students' understanding of the video contents (Wachtler & Ebner, 2019), and they can be also used to provide interactive learning activities (Hung et al., 2018). Hung et al. (2018) further explained that interactive learning activities are indispensable elements of interactivity in video lectures and they can assist students to obtain timely constructive support to produce effective learning outcomes. Therefore, enriching interactive video lectures (IVLs) with interactive learning activities such as formative assessment elements seem to make IVLs more effective and engaging and eventually can enhance students' learning and reading comprehension (Wright et al., 2016).

This study is guided by the following research questions and hypothesis:

(A) Research Questions

1. What is the proposed framework for formative assessment within IVLs?

2. What is the effect of the proposed framework for formative assessment within IVLs on the graduate students' reading comprehension skills?

(B) Research Hypothesis

1. There is a statistically significant difference at the level of (0.05) between the sum of ranks of the two experimental groups on the reading comprehension skills levels (literal level / interpretive level / critical level / creative level / overall reading comprehension skills) in favor of the first experimental group that studied using the IVLs based on formative assessment.

Literature Review

1- Interactive Video Lectures (IVLs)

Interactive video Lectures (IVLs) are influential educational tools that have gained a lot of popularity as an essential component of online education and are increasingly used by many online learning and training providers such as MOOCs and Khan Academy (Scagnoli, Choo, & Tian, 2019). IVLs refer to non-linear, interactive digital video lectures that make use of e-learning systems to facilitate students' interaction and random access to video content (Palaigeorgiou & Papadopoulou, 2019; Zhang et al., 2006). IVLs can be also defined as digital video lectures enriched with interactive elements such as quick access links, information nodes, quizzes and hyperlinks that are placed on specific segments of the video sequence paths. Such a technology enables students to actively interact and engage with the content (Hung et al., 2018; Zhang et al., 2006). IVLs support student-centered learning by fostering hands-on and inquiry learning, engaging students in real-world problems and reflecting on their own learning (Wright et al., 2016). IVLs can improve students' learning, perceptions, and attitudes toward the learning subject, and help constructing mental models (Smithwick et al., 2018). IVLs are deemed effective means for delivering web-based course content, reinforcing new information and facilitating students' interaction with the contents at their own pace (Scagnoli et al., 2019). IVLs can also guide students' attention, trigger reflection, and enable self-paced learning (Palaigeorgiou & Papadopoulou, 2019).

Increasing interactivity in online lectures can make them more effective compared to passive online video lectures, (Laws et al., 2015) reinforce learnt concepts and provide an avenue for on-demand learning (Zhang et al., 2006). The interactive elements within video lectures can enhance learning by providing greater opportunities for student-content interaction and by providing greater flexibility and nonlinearity in how students pace their learning. (Smithwick et al., 2018; Zhang et al., 2006). Wessels, Fries, Horz, Scheele, and Effelsberg (2007) indicated that interactivity in video lectures signifies "an opportunity for the learner to shape the flow of information by

participating in the communication taking place and actively influencing the learning process rather than remaining a passive recipient". Importantly, "with more interactive and richer media available, a learner who prefers an interactive learning style has more flexibility to meet individual needs"(Zhang et al., 2006).

Previous studies (Vural, 2013; Wright et al., 2016; Zhang et al., 2006) have summarized the characteristics of the IVLs as follow:

- Interactivity: content of IVLs can be interacted with via many interactive elements that allow quick access to any segment of the video lecture content. Interactivity can be activated via links, hyperlinks, quick access links, voice nodes, information nodes, and quizzes.
- Self-control: interactive video lectures provide tools and elements that enable students to control the sequence width and the progress of their learning.
- Embedded learning activities: IVLs allow interactive activities and tasks to be added to the students' experiences while watching the video lectures.
- Personalized: IVLs provide personalized learning experiences with more choices and control for the students.
- Engaging: IVLs are immersive and can engage students in the learning process via interactive learning activities.

2- Formative Assessment

Researchers tend to differentiate between two main types of assessment namely formative assessment and summative assessment. Summative assessment is an assessment that is conducted to measure what students have learnt at the end of an educational unit, or to measure the efficiency of a curriculum. Formative assessment on the other hand is a planned process that is used throughout teaching to provide students and teachers with assessment-based feedback, monitor their progress and guide teachers' instruction (Hammerman, 2008; Marzano, 2011). The purpose of this feedback is to assist students and teachers in making adjustments that can improve students' learning of the intended curricular objectives (Popham, 2008). In a similar Bell, Bell, and Cowie (2001) explained that formative assessment is "the process used by teachers and students to recognize and respond to student learning in order to enhance that learning, during the learning" process (p.536).

Formative assessment is an integral part of effective teaching and learning (Wiggins & McTighe, 2005). It is a process used to judge students' learning and obtain feedback on the extent to which the objectives of the lesson are achieved (Brookhart, 2010). Such feedback can be valuable in modifying the path towards achieving the learning objectives and developing the teaching process. Similarly, Black (1993) asserts that an assessment

can be regarded as formative if it aims to enhance students learning, not to grade them. In addition, Bell et al. (2001) added that formative assessment refers only to the assessment which provides feedback to students and teachers about learning, which occurs during the teaching and learning processes.

Formative assessment is “characterized by the intention to use ongoing assessment information to enhance learning and sitting within this concept lies the term ‘feedback’ and ‘feed forward’ (Richardson, Dann, Dann, & O'Neill, 2017). Therefore, formative assessment is not a test but a planned process (Popham, 2008), and its information is collected for the purpose of monitoring progress, directing students’ learning and adjusting teachers’ teaching practices (Bell et al., 2001; Hammerman, 2008; Popham, 2008). Furthermore, formative assessment keeps students focused on tasks and on learning objectives, and it helps students to be aware of any gaps that exist between their desired learning objectives and their current knowledge (Brookhart, 2010). Formative assessment allows students to receive feedback on precisely what they need to improve as it provides feedback and correctives at each stage of the learning and teaching processes (Bennett, 2011). Formative assessment is an assessment-based evidence to adjust ongoing learning and teaching (Black & Wiliam, 1998).

3- Reading Comprehension

Reading is a cognitive activity that entails reader thinking and interaction with the written text in order to extract information and meaning from it (Lepola, Lynch, Kiuru, Laakkonen, & Niemi, 2016). Concannon-Gibney and McCarthy (2012) supported this by stating that reading comprehension is “an interactive, socially mediated and deliberate process involving the orchestration of cognitive strategies and the activation of personal schema in order to construct meaning”. Arguably, reading comprehension is the ultimate goal of the reading process and reading without comprehension is worthless (Sari, 2016). Furthermore, reading comprehension is one of the most important skills that need to be learned because learning largely depends on the comprehension of information obtained from text sources (Gilakjani & Sabouri, 2016). Reading comprehension is affected by many factors such as reader characteristics, text properties, background knowledge, reading strategies and semantic and syntactic knowledge (Gilakjani & Sabouri, 2016; Nergis, 2013). For instance, readers’ background knowledge helps them to make inferences, which are necessary for their reading comprehension (Gilakjani & Sabouri, 2016).

Reading comprehension is comprised of several levels namely literal, interpretive, critical and creative (Sari, 2016).

- Literal Comprehension: Literal comprehension is the understanding of information and facts

directly stated in the text. It is recognized as the basic level of reading comprehension. Literal comprehension is the foundation for the other levels of reading comprehension.

- Interpretive Comprehension: At the interpretive level, students are supposed to be able to read beyond the literal words. They are expected to grasp the main ideas, determine points of views, make inferences and predict or summarize events.
- Critical Comprehension: At the critical comprehension level students move further beyond the text and make judgments of what they read. Students at this level are expected to make decisions about what they read. For instance, they can judge the accuracy and reliability of the text and determine if a statement is a fact or opinion. Critical comprehension level involves the evaluation of written texts.
- Creative Comprehension: Creative comprehension level entails students’ involvement with the information presented in the written texts to use it to formulate or rethink ideas of their own. Therefore, creative level of comprehension requires formulating and rethinking ideas.

Theoretical Framework

The use of IVLs is supported with some common learning theories. For example, constructivism encourages student engagement via interactivity for effective and deep learning. Therefore, in order to engage students and provide opportunities for them to be more active in their learning, more interactive elements need to be added to the video lectures (Al-halafawy & Tawfiq, 2014; Alhalafawy & Zaki, 2019; Zaki, 2019; Zeidan, Alhalafawy, & Tawfiq, 2017; Zeidan, Alhalafawy, Tawfiq, & Abdelhameed, 2015). Likewise, reading comprehension is an interactive and deliberate process involving consistency between cognitive strategies and the activation of personal schema in order to construct meaning (Concannon-Gibney & McCarthy, 2012).

Cognitive load theory is another theoretical framework that can scaffold the use of IVLs. Cognitive load theory assumes that learning is constrained by the limited processing capacity of the learner’s working memory. Such a limitation should be taken into account in the design of teaching material in order for this material to be effective for learning (Sweller, Van Merriënboer, & Paas, 1998). Since videos are transient, cognitive activities needed for dealing with them may impose extra cognitive load on students working memory. The segmentation of the video contents caused beneficial effects on cognitive load and learning because they gave students time to perform the cognitive activities needed for learning on smaller chunks of information (Moreno & Mayer, 2007; Spanjers, Van

Gog, Wouters, & Van Merriënboer, 2012; Zaki, 2019)

Methodology

1- Participants

Participants were twelve graduate students at the department of Educational Technology in the faculty of graduate educational studies in King Abdulaziz University studying a course called “English Reading in Education”.

2- Procedures

2-1 Designing a framework for formative assessment within IVLs:

The proposed framework has three main components: introduction, watching the IVLs & formative assessment and summative assessment (see Fig.1). All the three components are essential for integrating IVLs to develop students’ reading comprehension. In each component, there are a number of important steps and activities. The framework starts with the “introduction” component which paves the way for the following components. In this component, students are familiarized with the

description and the objectives of the IVLs and answer warming up questions. The second component of the framework is the “watching and formative assessment” component and it is an indispensable component of the proposed framework. In this component, students started with watching the IVL clip until the first node and then do the related formative assessment questions. The formative assessment questions are followed with appropriate feedback to direct students’ learning and adjust teachers’ teaching practices. This component is repeated until all the following IVLs clips are watched and formative assessment questions are answered. The final component is the “summative assessment”. In this component, final summative assessment questions and activities are presented to the students. They are made of all the previously presented formative assessment questions offered in an attached closing form. This is also followed by some extra reading activities in which students are recommended to read articles related to the topic of the article they have studied via the IVLs.

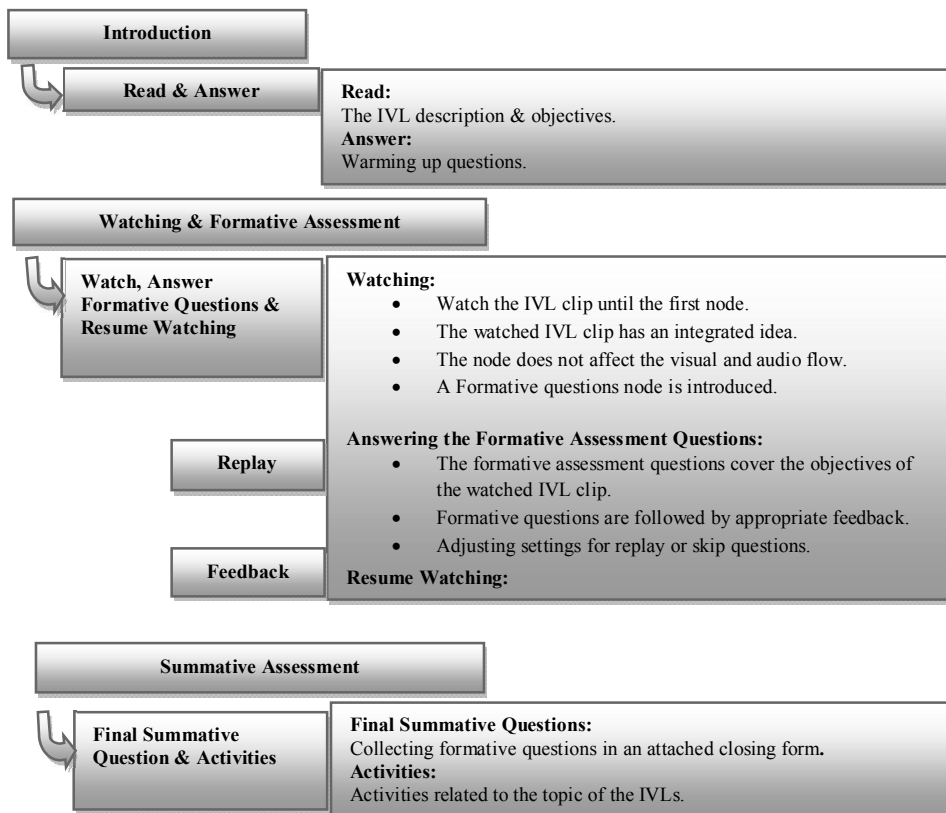


Fig. (1): Framework for Formative Assessment within IVLs (Prepared by the researcher).

2-2 Identifying the objectives for the IVLs:

The objectives for the IVLs in the current research were identified from those stated in the course specifications of “English Reading in

Education” taught to the master graduate students in the educational technology department. The objectives included reading and analyzing research papers on flipped learning, e-learning and digital

learning platforms in terms of the following learning objectives: 1) Analyze the structure of the research paper. 2) Identify the main variables of the research paper. 3) Discuss the main ideas and claims mentioned in a research paper. 4) Learn some English terminology in relation to the field of educational technology. 5) Criticize and summarize a number of English research studies in the field of educational technology. 6) Discuss the research methodology, procedures, and results in a number of English research studies in the field of educational

technology. 7) Find the meaning, synonyms and antonyms of some words in a number of English research studies in the field of educational technology.

2-3 Designing the IVLs:

An initial scenario for the IVLs was designed in the form of a graphic story of the content, accompanying verbal explanation methods, and the 2-3 components of the formative assessment in the lecture. a visualization of the formative assessment system was developed as shown in Fig. (2).

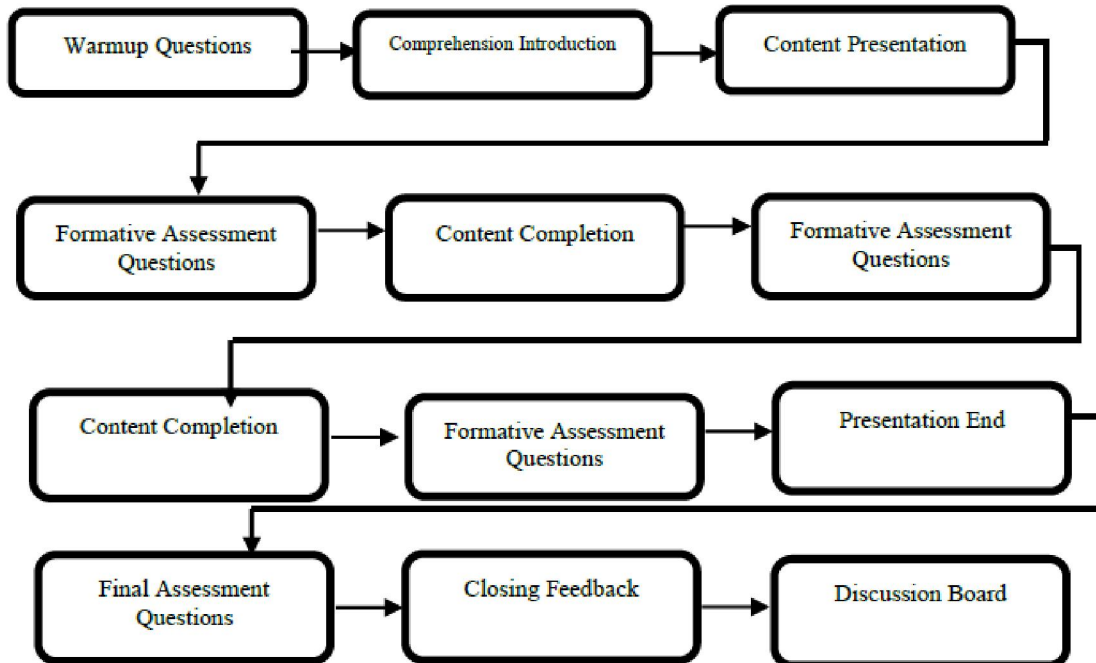


Fig. (2): Formative Assessment System in IVLs.

The formative assessment system in the IVLs in the current study consisted of the following elements:

- Warmup questions: a set of questions at the beginning of the interactive video that act as an introductory organizer to prepare students for the content.
- Comprehensive introduction: An introduction by screen tutor on the content to be presented in the interactive video lecture.
- Content presentation: at this stage, chunk of the content is displayed and explained.
- Formative assessment questions: a set of multiple-choice questions that cover part of the content that has been presented so far.
- Completion of the content presentation: after receiving appropriate feedback, students complete watching the new chunk of the IVL content. Then, they are to answer the formative questions related to them.
- Final assessment questions: after completing watching the IVLs, all the formative questions that were previously presented will be displayed at once in the form of a final assessment, and then students receive appropriate feedback.
- Discussion boards: after the students have watched the IVLs and answered all the formative questions included in it, they move to a discussion board on the topic of the lecture. This discussion board is supported with a copy of the article that was explained throughout the IVLs.

In addition, the following criteria have been considered in the design of the IVLs: 1) The duration of each video clip should not exceed 10 minutes. 2) There should be a balance between the interaction nodes in the video clips. 3) Students should be exposed to appropriate meaningful chunks of the IVLs' content before they are exposed to the formative assessment questions. 4) The provided feedback should enable students to recognize the

accuracy of their answers and direct them to the next question, or retry answering the questions.

- Designing the Questions of the Formative Assessment in the IVLs: When designing the questions, it was taken into account that they should be concise and clear, and that their alternatives are accurate. They should be provided with the appropriate feedback, with the possibility of retrying in the case of the student's failure to answer the question and the possibility of displaying the IVL content again if a student needs to do so.

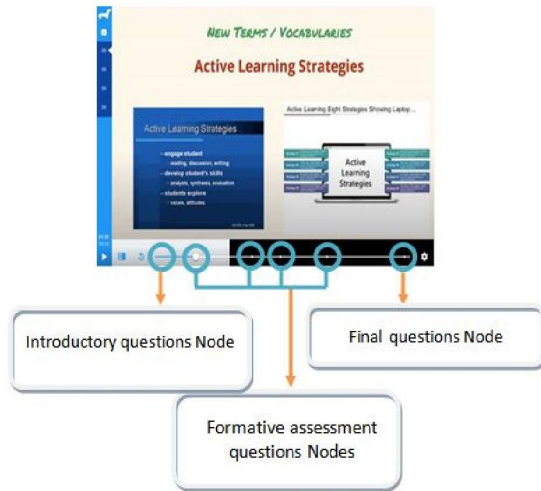


Fig. (3-A)

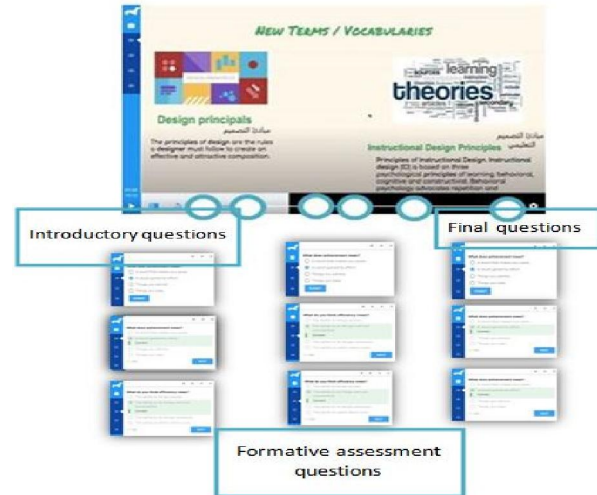


Fig.(3-B)

Fig. (3): Interaction Nodes of the Formative Assessment Questions in the IVLs and the Organization of Questions on the Timeline.

3- Research Instrument

A reading comprehension test was prepared by the researcher. The test aimed to measure graduate students' reading comprehension skills. These skills are represented in four basic levels, namely, literal, interpretive, critical and creative skills. Test instructions were formulated in easy and clear language. The instructions included the test objective, test time and the number of the test items. The test consists of (30) multiple-choice questions that measure the students' reading comprehension skills at four levels: literal, interpretive, critical and creative. One score was given for each correct answer and zero for each incorrect answer. The total full-mark score of the test mark is (30) points. Content validity of the test was estimated by a group of expert arbitrators specialized in instructional technology. The percentage of the arbitrators' consensus on the relevance of the test objectives to the questions was 86% for each goal. Moreover, the test was applied on a pilot sample of (5) graduate students to ascertain that the test's instructions and questions are clear and to calculate its reliability.

- Design of the Interaction Nodes in the IVLs: To design the interactions in the IVLs, the time for displaying the content on the timeline of the video clip has been determined, and the interaction node that allows adding question, return and response settings has been added. Fig. (3-A) shows the design of the interaction nodes for introductory questions, formative assessment questions and final summative questions. As for Fig. (3 -B), it shows how to organize questions on the timeline and their display sequence.

The test's reliability was calculated using half-split method of Spearman & Brown, and the value of the test reliability coefficient was (0.79), which is an acceptable value for the test's reliability.

Findings

1- The proposed framework:

A proposed framework has been developed for designing IVLs based on formative assessment. The framework has three main components: (introduction / learning via watching IVLs based on the formative assessment / summative assessment) (see Fig. 1). A number of procedures and activities for each component have been suggested. The first component "introduction" includes general description of the content of the IVLs, general and procedural objectives and introductory organizations. The second component "watching and formative assessment" involves watching the content provided in the IVL clip, answering the formative assessment questions. The formative assessment questions in this component of the proposed framework are followed with appropriate feedback

to direct students’ learning and adjust their teachers’ instructions. This component is a recurring one until all the IVLs clips are watched and formative assessment questions are answered. The final component is the “summative assessment”. In this component, final summative test that is made from all the previously presented formative assessment questions are presented at the end.

2- The effect of the proposed framework on the graduate students’ reading comprehension:

What is the effect of using IVLs based on formative assessment on graduate students’ reading comprehension skills (literal level / interpretive level / critical level / creative level / reading comprehension skills at all the levels combined)? To answer this research question, the research hypothesis has been verified using a non-parametric Mann-Whitney Test. Table (1) shows the significance of the differences between the two experimental groups in the Reading Comprehension Skills (RCS).

Table (1) The Significance of the difference between the two Experimental Groups in the Reading Comprehension Skills Levels (RCSLs)

Reading Comprehension Levels Skills	Groups	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	Sig
A. Literal Comprehension	G1 (IVLs)	6	9.5	57.00	.012	-2.918	.004
	G2 (SVLs)	6	3.5	21.00			
B. Interpretive Comprehension	G1 (IVLs)	6	9.00	54.00	1.500	-2.704	.007
	G2 (SVLs)	6	4.00	24.00			
C. Critical Comprehension	G1 (IVLs)	6	9.33	56.00	1.000	-2.776	.006
	G2 (SVLs)	6	3.67	22.00			
D. Creative Comprehension	G1 (IVLs)	6	9.25	55.50	1.500	-2.699	.007
	G2 (SVLs)	6	3.76	22.50			
E. Overall Test	G1 (IVLs)	6	9.50	57.00	.000	-2.887	.004
	G2 (SVLs)	6	3.50	21.00			
Total		12					

G1 (IVLs) Interactive Video Lectures based on Formative Assessment
G2 (SVLs) Sharable Video Lectures

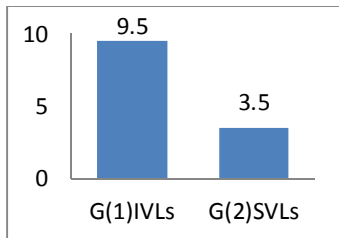


Fig. (4- A) The Literal level of reading comprehension (LRCS)

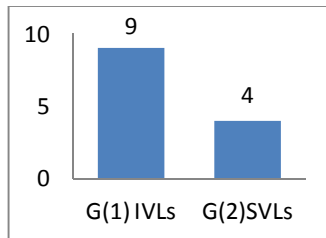


Fig. (4- B) The Interpretive level of reading comprehension

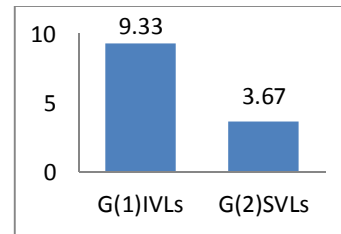


Fig. (4- C) The critical level of reading comprehension

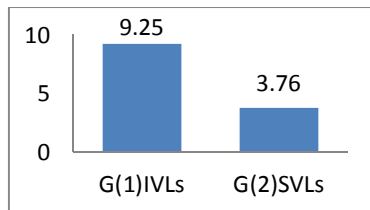


Fig. (4- D) The creative level of reading comprehension

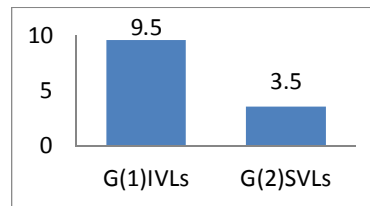


Fig. (4- E) reading comprehension skills (all levels)

Fig. (4): The mean ranks of the two experimental groups on the levels of the Reading Comprehension Skills (RCSLs)

A-Literal Level of Reading Comprehension Skills (Literal RCS)

Table (1), shows that the value of Z for LRCS is (2.918), which is a statistically significant at the level of (0.05). This indicates a significant

difference between the mean sum of ranks of the two experimental groups on the LRCS – Fig (4-A) in favor of the first experimental group that studied using the IVLs based on formative assessment according to the proposed framework.

B. Interpretive Level of Reading Comprehension Skills (Interpretive RCS)

With regard to the IRCS, table (1), reveals that the value of Z for IRCS is (2.704). This result implies that there are statistically significant differences at (0.05) between the mean sum of ranks of the two experimental groups on the IRCS – Fig (4-B) in favor of the first experimental group that studied using the IVLs based on formative assessment according to the proposed framework.

C. Critical Level of Reading Comprehension Skills (Critical RCS)

Table (1), also shows that the value of Z for CRCS is (2.776). This indicates a significant difference at (0.05) between the mean sum of ranks of the two experimental groups on the CRCS – Fig (4-C) in favor of the first experimental group that studied using the IVLs based on formative assessment according to the proposed framework.

D. Creative Level of Reading Comprehension Skills (Creative RCS)

Regarding CRCS, Table (1), illustrates that the value of Z is (2.699) and it depicts that there are statistically significant differences at (0.05) between the mean sum of ranks of the two experimental groups on the CRCS – Fig (4-D) in favor of the first experimental group that studied using the IVLs based on formative assessment according to the proposed framework.

E. Reading comprehension skills for all the levels (Combined RCS)

The results in table (1) also depicts significant difference between the mean sum of ranks of the two experimental groups on the reading comprehension skills at all the levels (combined)– Fig (4-E) in favor of the first experimental group that studied using the IVLs based on formative assessment according to the proposed framework.

Discussion

The results revealed the effectiveness of the proposed framework for formative assessment within IVLs on graduate students' reading comprehension skills both in the overall reading comprehension skill and in the literal, interpretive, critical and creative levels of reading comprehension. This result can be attributed to the features of interactivity and formative assessment elements in the proposed framework of IVLs. The literature in the field (Wachtler & Ebner, 2019; Zhang et al., 2006) has asserted that using interactive video lectures for e-learning environments can enhance students learning and that increasing the interactivity of video lectures can make them more effective compared to sharable video noninteractive linear lectures. Such results can be linked to the features of IVLs that are based on formative assessment which have high level of interactivity. IVLs based on formative assessment allow students to randomly access video content, be

exposed to the content for a longer time and be involved in active learning activities through interaction nodes that include formative questions presented in the interactive video lectures segments.

The results can be also explained in light of the cognitive load theory which assumes that the processing capacity of the learners working memory is limited in duration and capacity. Since the transience of video contents often impose cognitive load on learners working memory, the segmentation of the video contents may reduce the cognitive load. That is, by segmenting the video contents into meaningful chunks and providing pauses for formative assessment, students were given time for performing the necessary cognitive activities. Therefore, in the current study, the segmentation of the video content into meaningful units provides a form of temporal cueing which scaffolded the learners in perceiving the video contents and answering the formative assessment questions.

With the interactive video lectures IVLs content, students can engage in self-paced and independent learning activities. In the current study, IVLs proved to increase students' interaction, flexibility and navigational freedom of working with IVLs playlist made of meaningful learning clips. Similar results have been found in (Dror, 2008), suggesting that learners tend to be more focused and committed when they have control over their learning. The results coincide with those of (Altinpulluk et al., 2019; Laws et al., 2015; Palaigeorgiou & Papadopoulou, 2019; Wright et al., 2016; Zhang et al., 2006). Furthermore, the inclusion of formative assessment questions contributed to the clarity of meaning, the organization of content and therefore students' comprehension. The inclusion of formative assessment questions could help students to realize what part of the IVLs content they did not fully comprehend so they can reinforce their learning of it. Such realization is likely to prompt a mental review or replay of the IVLs until that part is comprehended (van der Meij & Böckmann, 2020).

Conclusion

The results of the present study confirmed that the proposed framework for formative assessment within IVLs was effective in enhancing graduate students' overall reading comprehension skill and the reading comprehension in the literal, interpretive, critical and creative levels of reading comprehension. The use of IVLs based on formative assessment enabled students to randomly access video contents, expose it to them for a longer time, and engage in self-paced learning activities. Adding formative assessment elements to the video lectures facilitated student-content interaction, engagement and comprehension.

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