The Effects of Embedded Questions Strategy in Video among Graduate Students at a
Middle Eastern University

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This dissertation titled
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Abstract

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The Effects of Embedded Questions Strategy in Video among Graduate Students at a Middle Eastern University

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This study investigated the strategy of embedded questions in educational interactive videos. The educational videos were created and used in two versions: Video with Embedded Questions (VEQ), and Linear Video – a video without Embedded Questions (LV). Video was used as a medium to test the effectiveness of embedded questions strategy. The LV version provided the ability to control the timeline of instructions, whereas VEQ provided the ability to control the timeline of instruction and to interact with embedded questions. Both versions have covered two main topics: battery life reservation, and presentation skills. The VEQ had an embedded multiple-choice questioning system that shows a question up on an over-layered screen, with each of the three answers providing a specific scene as a confirmation feedback whether it is a wrong or correct answer.

The dependent variables were comprehension and self-efficacy. Comprehension was measured by assessment scores, and self-efficacy was measured by average percentage from each item in the assessment. The independent variable was having embedded questions system. The methodology was a sequential explanatory approach; a quantitative experiment supported by a qualitative focus group interview. The experimental approach involved dividing the participants (60 graduate students) into a
control group exposed to LV version, and an experimental group exposed to VEQ version, and testing them all via assessment designed to measure their comprehension.

The findings and discussion are based on theoretical framework of learner control, self-efficacy, and instructional design of VEQ. The results showed a significant difference in terms of assessment average scores and self-efficacy for the favor of embedded questions. Effect sizes were found to be relevant to the usage of embedded questions and levels of self-efficacy; they were irrelevant to the topic of video or participant’s gender. The effect size of embedded questions over assessment scores was 0.916 and over self-efficacy was 1.24. Participant’s gender, however, showed no significant difference in ANOVA test. The embedded questions system had an effect size of 0.13 for presentation skills topic, and 0.12 for battery life topic. Explanation of the results along with technical and instructional recommendations for future research are included in the last chapter, summarizing that embedded questions helped participants to raise self-efficacy and gain more confidence, enhance existing knowledge with new information, rehearse memory, and achieve better learning outcome.
Dedication

To my parents, family, friends and advisor.
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Chapter 1: Introduction

*I never teach my pupils, I only attempt to provide the conditions in which they can learn* – Albert Einstein (King, 1965, p. 126).

This dissertation is about the idea of embedded questions in educational interactive videos, namely the Video with Embedded Questions (VEQ). The dissertation includes a literature review regarding embedded questions, suggests how comprehension from VEQ among adult millennials can be discerned, and presents and analysis of the experimental results in this regard. Video was used as a medium to test the effectiveness of embedded questions strategy in two versions: VEQ and Linear Video – a video without Embedded Questions (LV).

The LV provides a baseline to control the time and sequence of instructions, and VEQ has the same capabilities as LV in addition to interacting with embedded questions. The VEQ has an embedded multiple-choice questioning system that shows a question up on an over-layered screen, with each answer providing a specific scene as a feedback (whether it is a wrong or correct answer). Each multiple-choice question had 3 answers, and the learner had to choose one of them. Therefore, the dependent variables were comprehension; assessment scores and self-efficacy affected by independent variable. The independent variable was having embedded questions system. This system consisted of post Adjuncts Questions (Post AQs) and confirmation feedback for each answer. The findings and discussion were based on theoretical framework of Adjunct Questions (as an instance that stimulates mathemagenic activities), self-efficacy, cognitive load and instructional design of VEQ. These theoretical aspects defined the domain of this study.
The methodology was a sequential explanatory approach; a combination of experimental approach and qualitative group interviews. In Chapter 1, the researcher defined the problem by reviewing the historical progress of multimedia learning in general, and then focusing on a specific type of newly developed multimedia, which is the interactive video and how embedded questions are applied on it. Then in Chapter 2, a review of literature highlighted the conceptual and theoretical framework within the domain of this study. Chapter 3 contained a thoroughly-itemized explanation of the methodology used to test VEQ’s effectiveness, and what instruments were used. Chapter 4 included a thorough explanation of the quantitative and qualitative data. Finally, Chapter 5 provided a discussion on the results and findings with reflections about the problem statement, and recommendations for future use of embedded questions in scientific research and for applications in video-based learning.

One of the most important multimedia learning tools is video (Ornstein, 1991; King, 1999; Zhang, Zhou, Briggs, & Nunamaker, 2006; Giannakos, Chorianopoulos, & Chrisochoides, 2015). Video is merging as a way to add more functionality to instruction by integrating audio-visual elements in the cognitive process (Mayer, 2009), and provide more control to the learner (Williams, 1996). New research founded under the term 'Video-Based Learning' has brought about a differentiation in the way instructional material are designed and presented, by implementing transformative presentation methods using audio-visual content in order to help the learner digest the course (Allam, 2006). Visualizing the concept is considered to be the essence of video-based learning and how it is transforming instruction (Mayer, 2009).
**Background of the Study**

In 1922, it was Edison who proclaimed that: "The motion picture is destined to revolutionize our educational system. In a few years, it will supplant largely, if not entirely, the use of textbooks" (King, 1999, p. 211). By the 1930s, the radio was said to do so (Muller, 1932) - the idea was to broadcast one scholar's voice directly into classrooms across the states, which aimed at developing better education for higher number of students at lower costs. The same idea of providing better and broader education at lower costs was adopted in educational television in the 1950s and 1960s (Gladwell, 2000). Educational television represented a new stage of learning experience at that time, which had some limitations too. Studies were conducted (Merrill, 1957; Payne et al, 1972) to determine whether students showed more interest in attending a lecture in person (face-to-face), or preferred to sit in a room where the same lecture was broadcasted on a TV screen. Between the pre-test and post-test scores on both lectures (face-to-face vs. TV), the results showed a significant difference; no cause-and-effect relationship was detected between broadcasted lecture and learning improvement (Merrill et al, 1957).

In the 1980s the debate shifted to another paradigm. Computers were invented and they have become available for personal and professional use. Computers were praised as the ultimate solution to the obstacles and barriers in the educational system (NYCBE, 1993). Computers are audiovisual, interactive, and can be programmed to teach almost anything. But despite that, computer’s potential was obvious - some limitations did and still apply. For example, a research by Kaleliouglu & Gulbahar (2014)
suspected that if students were taught to program -for instance- how to move an avatar on Scratch programming platform (Scratch, 2015), then their cognitive learning, assisted by procedural reasoning skills, would significantly improve. The results expounded that students achieved better learning outcomes at programming the avatar movement, but their reasoning and problem solving skills were unaffected (Kaleliouglu & Gulbahar, 2014). Programming represents the continuance of the human’s need for realization of concepts in reality, by creating objects that imitate living things (e.g. project turtle that was first designed in Logo program by Minsky & Papert (1988)).

By the 1990s, another vision by Ornstein (1991) continued to predict the next development in education using multimedia, specifically video, “Present-day and future educators are expected to know something about the use of video systems in the teaching-learning process – for use in schools, library, and home” (p. 340).

For decades, educational research has focused on comparable questions related to multimedia, such as: is audiovisual animation better than the use of static graphics? (Levonen et al. 2001; Mayer, 2003; Rey, 2010; Clark & Mayer, 2016) In the case of instructional videos and printed textual material specifically, the results of some well-controlled studies have often no significant difference between them for theoretical knowledge, according to Levonen et al. (2001) and Rey (2010). But several studies in this respect (i.e. difference between using video and printed static material) have confirmed that integrating multimedia did have a positive impact in most scientific topics and practical knowledge among variant ages (Choi & Johnson, 2005; Mayer, 2009; Donkor, 2010; Boldisevica & Dislere, 2015).
Multimedia has been a renowned part of the educational technology research. The blending of technology and education has been undergoing some debates among educators and policy makers, and some believe that education is reaching closer to the point where a 'universal teaching machine' becomes available in every hand, which does fast, well-programmed operations to basically act as a personal tutor (Anderson et al, 2012; Gunning, Chaudhri, Clark, Barker, Chaw, Greaves, & ... Tien, 2010). Using this tutor, a person would have more control over the learning material and take part in automated, well-structured lessons at their own time and place preferences. The universal teaching machine may also run on a self-teaching system to upgrade its contents using artificial intelligence, and provide appropriate and personally-tailored feedback to the users. This is all completed without the existence of a teacher in between (Gunning et al, 2010). Currently, there are many technologies and tools considered to be capable of reinventing education by applying the concept of universal teaching machine, such as smart phones, virtual reality, social media, tablets, and Massive Open Online Courses (MOOCs.).

**Mathemagenic activities.** In MOOCs, videos have been manipulated and developed to better promote learning. One of the developments is adding Embedded Questions (Hannafin & Colamaio, 1987; Domaradzki, 1990; Vural, 2013; Kim, Glassman, Monroy-Hernández, & Morris, 2015). These are applicable adjunct questions embedded in-between several segments of the video. The roots of embedded questions can be traced back to the 1960’s, when Rothkopf (1966) first coined the term ‘Mathemagenic Activities’ and defined them as the activities that make learning happen.
The literature of mathemagenic activities included studies that investigated the learning actions. These actions are essential to achieving pre-determined educational objectives. The learning actions, as concluded by Rothkopf (1970), can be attention, reflex of orientation, information processing, cognition processes, and memory rehearsal. These activities have been stimulated by the use of Adjunct Questions (AQs).

Fundamentally, the studies of AQs have been conducted using textual context (e.g. textbooks and essays) (Rothkopf, 1966; Rothkopf & Bisbicos, 1967; Darwazeh & Reigeluth, 1982; Ellis et al, 1982) and found a facilitative effect in favor of AQs. But with the implementation of video in education, there has been a necessity to extend the application of AQs and integrate them with educational video (DeBloois, 1982; Domaradzki, 1990). To distinguish between AQs in text and AQs in video, this study used the term ‘Embedded Questions’ to re-define AQs, extend and demonstrate their use with confirmation feedback in educational videos.

**Cognitive load in video-based learning.** Other audio-visual theories such as Dual Coding Theory (Paivio, 2007) and Cognitive Theory of Multimedia Learning (Mayer, 2003; Mayer, 2009) have provided justification for the usage of video in educational settings. They have presented and analyzed video-based learning mainly from a cognitive load perspective (Sweller et al, 2011), which is firmly related to the embedded questions/practices with feedback in videos (Vural, 2013; Kim et al, 2015). Developing and preparing instructional material based on the ‘learning style’ of the learner is a more effective instructional method (Bovy, 1981; Sorden, 2005). The learning style, according to Cognitive Load Theory (Sweller, 1988; Sweller et al, 2011), is viewed
in articulation of memory: individuals receive an information, process it, organize it with a group of information, then finally integrate the new information with previous knowledge in order to be stored in long-term memory.

This cognitive processing is interrelated with the definition of learning on which embedded questions is based: learning is defined as taking a new information/experience and contrasting it with prior knowledge to create, or modify new or existing knowledge (Bransford & National Research Council, 2000; Sweller, Ayres, & Kalyuga, 2011). This study used the term ‘comprehension’ to express the learning outcomes of participants. Comprehension is the act of translating information, interpreting it by combining with previous elements of information, and extrapolating it to a useful application (Bloom et al, 1956). This definition represents the second level of educational learning in Bloom’s Taxonomy. In the context of this study, comprehension consists of contrasting, relating, processing and understanding the audiovisual information from the video, then preparing it for recall and use at later time. Recalling and using the audiovisual information are two processes induced by embedded questions of different types: Find a Generality (FG), Remember a Generality (RG), Remember an Instance (RI), and Use a Generality (UG) (Merrill, 1983; Merrill, 2002).

The embedded multiple-choice questions in this study were created for a diverse array of subjects (i.e. battery life reservation, and presentation skills), and they involved diverse knowledge (conceptual and procedural). Such embedded exercises affect cognitive functions, information processing and memory rehearsal in multiple dimensions (Rothkopf, 1966; Kim et al, 2015).
Current situation of video-based learning. Video-based learning is continuously developed to foster more interactivity in instruction. The theoretical focus of the current study was embedded questions in educational videos. Answering in-video questions was expected to promote constructive, active and interactive learning. The ICAP framework ranked these activities from least to most learning impact: passive < active < constructive < interactive (Chi & Wylie, 2014). LV is a semi-interactive video that provides passive and active experience to the learner. According to Chi & Wylie (2014), passive learning is when the learner is being oriented toward instructions without overly doing or controlling anything. In LV, for example, a learner can be covertly and deeply processing information while watching a video, but without overtly appearing to be engaged (e.g. basic time-controllers offer pace and sequence manipulation if needed). Alternatively, VEQ provides active manipulation (e.g. pause, play, forward, rewind), constructive generating (e.g. contrast and compare to prior knowledge, explain concepts, apply examples), and interactive dialoguing (e.g. problem solving, discussing, clicking, and reading/watching feedback) (Chi & Wylie, 2014).

The general hypothesis was that if the learner was given embedded questions within educational video, then this could have led to a better comprehension (elaborated in the next section). Specifically, what this research sought to find was: within educational video setting, does video with embedded questions promote better learning than video that has no embedded questions? Post-AQs were used (AQs embedded after each segment of the video). This research has been tackled and examined from the theoretical basis of embedded questions strategy.
Significance and Purpose of the Study

Significance. There is evidence that video can make information more accessible and aesthetically appealing (Mayer, 2009; Donkor, 2010; Giannakos et al, 2015). But is this enough for a better learning? Video, in its current passive form with time controllers (e.g. play, stop, and forward), has been effective in communicating course content, and a valuable source of information. Participants in many studies were commonly commenting on video-based learning experience as concise and easy to understand (Muller & Sharma, 2005; De Boer, Kommers, & De Brock, 2010).

However, videos with basic features can hardly be considered as a sole source of learning. And even with a variety of video viewing behaviors, as inserted by De Boer et al. (2010), there is no evident connection between the learner characteristics and the video viewing behavior. The relevant learner characteristic here is the short-term memory capacity. Despite that some findings from De Boer et al. (2010) contradict Huai’s (2000) evidence of correlations between learning behavior and the capacity of processing memory in a learner, the viewing behavior reveals that even with the static nature of non-interactive (passive) video, viewers will always watch it with different viewing patterns based on their own preferences (De Boer et al, 2010; De Boer et al, 2016). To summarize, there are four reasons why educational video was studied as an instructional medium: 1) video diversifies education and illustrates concepts very well (King, 1999; Trevisan et al, 2010), 2) video is commonly and widely using time controllers only, which may not be enough for highly-interactive experience (Rapt Media, 2015; Merkt, Weigand, Heier, & Schwan, 2011; Vural, 2013; Merkt & Schwan, 2014; Stigler et al,
2015), 3) there has been a significant growth of people who have Internet access, and according to Cisco (2014, p. 2), 80% of all consumer Internet traffic will be video by the year 2019, and 4) rising popularity among adult millennials (Roodt, 2013). A national survey by the Pew Research Center (2013, p. 1) showed that nearly 78% of adult Internet users watch or download online video for entertainment and educational purposes – in the last four years, the percentage of adult Internet users who post video online has doubled.

Applying embedded questions in educational videos provided several benefits as well: 1) embedded questions provide feedback, which can strengthen the active learning that has been used in the recent past time (Andre & Thieman, 1988), 2) they influence the selection mechanism (Reynolds & Anderson, 1982, p. 17) they reciprocally interact with self-efficacy (Bandura, 1986; Williams, 1996; Collazo, Elen, & Clarebout, 2012, p. 906), and 3) they can aid the process of learning by acting as a rehearsal to improve memory, and save the information for future recall (Sweller, Ayres, & Kalyuga, 2011; Mayer & Moreno, 1998; Landauer & Ainslie, 1975; Glover, 1989).

**Purpose.** The purpose of this study was to measure and investigate the impact of embedded questions on learning. Video was used as an instructional medium to test the effectiveness of embedded questions strategy in two versions: Video with Embedded Questions (VEQ) and Linear Video (LV) – a video without Embedded Questions. VEQ provided the ability to control time and sequence of instruction, in addition to interacting with embedded multiple-choice questions and confirmation feedback to each chosen answer. The LV provided the ability to control only the time and sequence of instructions.
In order to evaluate an interactive feature as embedded questions, this study used an explanatory sequential approach (Creswell, Plano Clark, Gutmann & Hanson, 2003); a quasi-experimental methodology followed by a collection and analysis of qualitative data (i.e. focus group transcribed meeting), to assist in the explanation and interpretation of the statistical results. This method is used to testify the following argument:

VEQ promotes better learning than LV, by providing a viewer the ability to interact with embedded questions and feedback.

**Research Question**

The research question has been accordingly composed to include the use of embedded questions. It highlighted the comparison between two versions of instructional videos: the VEQ and LV, in contrast with using the strategy of embedded questions and feedback. A VEQ allows the viewer to control, click buttons, and engage with more options on the screen than LV (Vural, 2013; Merkt & Schwan, 2014). Therefore, the question was formed to determine if there was a significant difference in comprehension between these versions of instructional video. The central research question was:

Concerning knowledge acquisition in an interactive setting, does Video with Embedded Questions (VEQ) promote learning better than Linear Video without Embedded Questions (LV) for adult millennials at a university in the Middle East?

Based on this question, the researcher has considered two domains: cognitive domain (e.g. active processing, gaining knowledge, and information recall), and affective domain (e.g. confidence, self-efficacy, and attitude) (Bloom et al, 1956; Bloom et al,
This study investigated and measured the comprehension from VEQ videos using assessment technique, and then compared the results of the assessment to LV experiment results. Accordingly, there are three research sub-questions considered for data collection and analysis based on the central research question:

1. Does VEQ with confirmation feedback and post-AQs improve comprehension compared to LV?
2. Does VEQ with confirmation feedback and post-AQs improve self-efficacy compared to LV?
3. What are the advantages and disadvantages of using embedded questions in a video that is instructionally designed to tell, show, and ask?

These questions are pertaining to the comprehension and self-efficacy of a specific population. Adult millennials in the Middle East, specifically in Jordan, were chosen. They have been provided with some extent of technology in higher education (Al-Shboul, 2011). And as the Middle East region is undergoing major changes on political and economic levels, this study highlighted the adult millennials’ self-regulated abilities and perceptions about interactive video technology that is being fostered as advancement in higher education (Roodt, 2013). No pre-test was used in this research in order to maintain the authenticity of open online education setting; students may encounter any video that has information identical to their prior knowledge, or one that has a completely new knowledge to provide (Thomas, 1983; Rias & Zaman, 2013; De Boer et al, 2016).
The research questions were answered by investigating the significance of embedded questions using assessment scores. The assessment included 10 questions (Appendix A, and discussed in Chapter 3) to measure what the participants, who are divided into a control and experimental groups, would learn from the video they saw (LV) versus the video they interacted with (VEQ). These two videos were designed and developed by the researcher as a primary instrument in this study. Questions tested the participant’s ability to recall specific information from what they watched, and also apply the perceived knowledge to new cases and examples.

Watching and controlling a video was intended to affect two domains of learning, which are the cognitive and affective learning (Bloom et al, 1956) in a way that understanding the concepts, facts and procedures would lead to remembering them. Cognitive Domain is affected by VEQ in its first three levels: knowledge (recalling, remembering), comprehension (understanding), and application (use of gained knowledge in problem-solving and apply it on new example(s)) (Brame, 2015). The Affective Domain is also affected by VEQ -as an interactive video- by influencing the values, appreciation, confidence and attitude of the learner (Williams, 1996). Examples from VEQ embedded questions were discussed and analyzed in Chapter 2. Coming to a conclusion, a series of statistical tests were operated to examine the significance of the difference between average scores of both groups.

**Research Hypothesis**

The hypothesis, therefore, was determined through experimental research – two groups (control and experimental) engaged in VEQ and LV then took an assessment.
There were two experiments to conduct: in experiment 1, the participants in experimental group watched two videos, which were the VEQ version of battery life and presentation skills topics. In experiment 2, the participants in control group watched LV version of both topics. These two experiments were conducted so that each participant watches and interacts only with VEQ or LV version of two different topics. Such intervention was expected to have a unique effect on the participant’s total experience, because it differentiates the perception and interactivity among both topics (Rey, 2010; Clark & Mayer, 2016). The results of assessments were then compared and studied as discussed in Chapter 3. After having the participants complete their assessments, the researcher continued to interpret their interaction and thoughts with both video versions by conducting a focus group meeting. The focus group consisted of 15 participants: 7 participants who previously participated in the experiments, and 8 new participants.

Using the assessment average scores and the results of statistical tests, the experimental and control groups' comprehension were compared based on the following hypothesis:

\( H_0 \): the VEQ scores are not significantly different that LV scores for learners.

\( H_1 \): the VEQ scores are significantly different than LV scores for adult learners.

As previously mentioned, it was expected that both cognitive and affective educational learning domains were subject to be influenced or changed. The research questions guided the literature review and covered the objectives of this research: to find if embedded questions in video are effective for learning, and to explain why they are effective/non-effective for learning.
The experimental research method was conducted using quantitative approach (i.e. collection of answers and data), supported by qualitative approach (i.e. focus group discussion). The focus group meeting was conducted with new participants joining the original study sample to insure variety of responses. The results were based on the following logically-related formulas:

- If the scores of VEQ assessment are significantly lower than scores of LV for both topics, then the VEQ does not promote better learning than LV.
- If the scores of VEQ assessment are significantly higher than scores of LV for both topics, then the null hypothesis is rejected; VEQ does promote better learning than LV.
- If the scores of VEQ and LV assessment for both topics show no significant difference, then the null hypothesis is rejected and VEQ does not promote better or less learning than LV.

Note that the main objective of this research was to conduct a strategy comparison, not a media comparison. Video was used as an instance of multimedia for its adequate audio-visual learning experience. The VEQ and LV were tested to reflect on embedded questions strategy, in order to reveal its potential and effects in learning process among graduate students, who were labeled as adult millennials.

**The Domain of the Study**

The domain of this study was the union and intersection of the AQs and video-based learning. The intersection of these two fields encouraged the study of embedding questions into instructional material, interactivity in video technology, the design of
video instruction to deliver conceptual and procedural knowledge, and the learner’s abilities and characteristics.

The significance of this study may confront some counter-arguments against the effectiveness of embedded questions in educational videos; that is the results may likely show no significant difference in comprehension between VEQ and LV. But with a well-controlled situation and constant time-on-task, this study has revealed useful information and recommendations for teachers and designers who are attempting to use embedded questions strategy in their instruction. Furthermore, embedding questions along with feedback to each answer have the potential and ability to increase cognitive processes through multiple-choice questions, practice on memorizing the facts and procedures in short-term and long-term memories (Bloom et al, 1956; Rothkopf, 1966; Merrill, 1980; Vural, 2013), and hence to raise self-efficacy and enhance attitude towards higher quality of instruction (Collazo et al, 2012).

Adding more scientific advancement to the interactive videos, as one of the educational tools used in the 21st century, and contributing to global education were the two main goals that highlighted the significance of the current study. The researcher was also disciplined to broaden a large, public, Midwestern university's global presence in the field of Instructional Technology, fill the gaps and limitations of video-based interactive learning, develop a better understanding and provide evidence-based recommendations for effective embedded questions’ design in higher education. In order to achieve these goals, there were some limitations and obstacles to surpass.
Limitations and Delimitations of Research Outcomes

Cultural aspects. Research methods essentially enable the researcher to learn and know about the groups and phenomena that are being studied. But all of the findings are limited by the methodology that is used (Ember & Ember, 2009). At some points, methods limit what is able to be understood, that is why a culturally-appropriate method of research is fundamental in the pursuit of having findings in a technology-rich situation, such as studying the effects of using video as a tool of education in a location out of the United States (William & Kelly, 2012, p. 8).

Implementing a culturally-appropriate method was essential in this research, due to the research question that specified the location at a Middle Eastern university. Specific preparations can be conducted in this matter, such as composing and conducting best communication during experiments and assessments, using proper embedded questions, and designing video materials that suit and respect the cultural perceptions (Ember & Ember, 2009). Furthermore, people from different cultures think differently (Heine, 2011), and this is a fact that articulates the need of well-designed instruction to fit with cultural differences and abilities. In addition, despite having improved abilities and advanced knowledge, the characteristics of adult learners from millennial generation often show less usage of technology compared to newly-merged digital citizens (Mossberger et al, 2008; Ohler, 2012). Nevertheless, adult millennials usually have more coherent and more advanced background knowledge than younger generations (Knowles, 1990), which highlights another limitation in this study because the researcher did not use a pre-test to measure the participant’s prior-knowledge.
There are certain technological divides to take into consideration, and these divides are to be treated as limitations relevant to the characteristics of the population and the country where the study is conducted (Heine, 2011). For example, Knowledge Divide and Digital Divide (Den Hoven, 2013) are two issues that the higher education sector in Jordan is addressing and troubleshooting, by encouraging more private sector organizations to help in establishing e-learning centers across the country (Issa et al, 2014; Al-Shboul, 2011), with the anticipation that such efforts could enhance Jordan's educational ranking among developing countries around the world.

Culturally speaking, this study delimited some obstacles by implementing bilingual multimedia instruction, language concordance and translation (Presser, 2004), supportive facilitation (Light et al, 1990), e-learning compatibility among educational institutions, treating bias in higher acquiescent responses (i.e. when people culturally tend to agree with the researcher) (Ember & Ember, 2009), and appropriate test instruments using Google Forms (2015).

Another limitation to consider while dealing with adult millennials, that there is a lack in studies covering and focusing on this specific type of participants and their relationship with educational multimedia in general (California State Univ., 1999; Smith, 2013). This research represented an attempt to document a historical chronicle for a generation that witnessed the shift from digital immigration to digital citizenship.

**Applying embedded questions.** There are some limitations in embedded questions system in videos: limited input mode, difficulty of design, and the absence of thought process. First, the limited input mode is about how learners are supposed to
answer or interact with an embedded exercise. Kim et al (2015) suggested that enabling multi-modal input function to videos can further enhance their effect in learning, by engaging students to record their voices, write notes and even draw sketches on the video screen.

Second, due to the difficulty of designing interactive videos, it may take a huge amount of effort and time. Despite that HTML5-based platforms for video programming are now made to be very user-friendly (Rapt Media, 2015; Stigler et al, 2015), the composition and editing of video require some advanced skills which are not found in many teachers. Third is the absence of thought process, which is related to the fact that answering embedded, multiple-choice question only captures the final outcome of the learner’s thought process (Hannafin & Colamaio, 1987; Kim et al, 2015). Multiple-choice questions are useful in aggregating quick responses, but they do not capture the on-going process of thinking. It is difficult to capture the problem solving process in pre-recorded educational videos that are not live. However, in an attempt to control the time-on-task of problem-solving, the researcher allowed participants 12 seconds to respond to each question and answer it.

The embedded questions system in this study was created and tested to maintain the simplicity of usage, and to properly deliver conceptual and procedural knowledge through video. All these limitations of using embedded questions are challenging for teachers, video programmers and designers. It was important to fundamentally consider them during this research.
Definition of Terms

*Adjunct Questions (AQs)*: questions embedded into instructional material (Rothkopf & Bisbicos, 1967). They are mainly used in textual content. AQs are extended in this study to be used in educational videos, and hence they are part of the embedded questions system.

*Cognitive Load*: the total amount of a person’s working memory effort (Sweller, 1988). In order to reduce the cognitive load in learners, instructional design can be used to limit the amount of audio-visual information in video, and maintain the limits of information processing model and memory (Mayer & Moreno, 2003).

*Confirmation Feedback*: a scene of image and text that lasts for 7 seconds, and informs the viewer of their answer: check mark if the answer is correct, or an expressive image with text to illustrate error if the answer is wrong. It is either a correct or self-correction feedback.

*Embedded Questions*: a system of Adjunct Questions (AQs) built and inserted after the relevant instructional segment within an interactive video. It consists of ten multiple-choice questions, and each multiple-choice question is shown in a text box and has three answer buttons – one of them is the correct answer button. Each answer is clickable and shows a specific feedback scene (Vural 2013; Kim et al, 2015; García-Rodicio, 2015). A learner has to pick the correct answer in order to proceed to the next segment of the video.

*Linear Video without Embedded Questions (LV)*: a video that is showed and controlled with a basic set of time controllers, which includes: play, stop, rewind, forward
and pause. The learner has the ability to watch and go over the content entirely or skip to certain points of the timeline, in order to control pace and sequence (Hannafin & Colamaio, 1987). LV has no embedded questions.

**Millennials:** the generation of people who were born in between year 1980 and year 2001 (Howe & Strauss, 2000). This study dealt with adult millennials to measure their interaction with VEQ and LV. The reason of choosing millennials is related to their characteristics as independent, self-regulated learners who witnessed the shift from digital immigration to digital citizenship.

**Multimedia:** communicating information between a technological platform and a human being using multiple sorts of media such as audio, radio, image, animation, virtual reality, and video.

**Self-efficacy:** the learner’s inner credence in his/her ability to achieve a specific task or succeed in a situation (Bandura, 1986). The self-efficacy of a person is an important substance of the overall comprehension in this study.

**Video:** sequence of images moving in a fast speed to create a motion, and this motion is integrated with voice and sound effects (Goodman & McGrath, 2002). Video is the instrument used in this study to transfer knowledge, and it is designed and created in two versions: Linear Video without Embedded Questions (LV), and Video with Embedded Questions (VEQ).

**Video with Embedded Questions (VEQ):** a video that is shown and controlled with a basic set of time controllers, which includes: play, stop, rewind, forward and pause. The viewer has the ability to interact with embedded questions and confirmation feedback,
watch and go over the content entirely or skip to certain points of the timeline (Merkt et al, 2011; Kim et al, 2015). VEQ has an embedded questions system.

**Summary**

In this chapter, the researcher has reviewed the background of video-based learning and embedded questions, provided the problem statement, explained the purpose of this study in view of its problem, presented the research question and the research hypothesis, and pointed out the significance of this study with possible limitations. In addition, the definitions of key terms were stated. The next chapter includes a comprehensive review of literature about embedded questions in educational videos.
Chapter 2: Literature Review

The literature review was made in the gradual order of user's experience with the VEQ, and in parallel with the research questions: learner control over video, supported by a learner control guide showing types of time and display controllers. The chapter then continues to illustrate the types of knowledge presented in each video of this study, introduce the concept of mathemagenic activities, and explain how adjunct questions are related to the use of embedded questions. After adjunct questions are reviewed, a deeper discussion of embedded questions is presented, demonstrating what happens in each question, types of questions, types of responses (overt or covert), and types of feedback. Finally, the instructional design basis and learner motivational and emotional aspects are discussed to cover the rest of research questions.

The Learner Control over Video

This study introduced the literature of embedded questions in educational video starting from the perspective of learner control. Learner control is a student-centered strategy of teaching, where the learner has the ability to control several functionalities such as the amount, pace, sequence, time and/or level of received instruction (Williams, 1992; Merrill, 1984). In this strategy, a learner is able to make a choice of how and which Computer-Based Instruction (CBI) they receive, whether on macro-level or micro-level depending on their characteristics and learning abilities (Williams, 1996). On a macro-level, a learner can choose whether to have a video lesson or not. On a micro-level, a learner can control the pace, sequence and navigation within the video. Since the current
study has focused on embedded questions in educational video, the micro-level control was taken into consideration for further analysis in Chapter 5.

Learner control, as a learning strategy, has been modified and manipulated through a number of studies to investigate what degree of control should be given to the student. A basis of instructor control versus learner control was adopted to find possibilities of better learning outcomes. For example, in a study conducted by Merkt & Schwan (2014), navigation through different sections and chapters of a video lecture was provided to an experimental group. This treatment aimed to find the impact of the navigation/index control on the learning experience. Merkt & Schwan (2014) found a significant difference between controlling and navigating through video indexed chapters compared to non-indexed chapters; students with indexed chapters scored higher than students with lack of index control. In the case of instructional control in a micro-level (i.e. navigation), learners can go back to certain sections that they did not understand, spend less time on what they do understand, or might skip several sections and learn at alternative order (Merkt & Schwan, 2014; De Boer et al, 2010). Another type of control is repeating: Shyu & Brown (1992) investigated the use of video with choice of repeating the scenes (learner control) in comparison to a linear video presentation with no choice of repeating (program control). The results have shown a significant difference in comprehension from students with learner control in procedural learning (Shyu & Brown, 1992).

As previously mentioned, learner control is a strategy that is based on certain instructional designs that allow learners to make their own learning decisions. These
decisions can be related to (and can affect) the amount and flow of instructions (Williams, 1996). Amount and flow can be controlled by the timeline and display controllers in video (Shyu & Brown, 1992; Goodman & McGrath, 2002). Display control can take many forms, such as: writing notes, adding and dropping elements and objects, clicking and processing objects shown on the screen, making choices and clicking answers on multiple-choice questions. In Figure 1, the types of time and display controls are summarized in a video example. For the purpose of this study, only one type of display control was studied, which is the embedded questions system.

*Figure 1.* Researcher’s design to represent a hypothetical video sample: showing a combination of types and examples of sequence, pace and display controls with reference to their studies.
The Knowledge Acquisition from Videos

There are two types of knowledge provided in the videos used in this study: conceptual knowledge and procedural knowledge. The conceptual knowledge is basically having an internal sense of explicit or implicit understanding about some principle, and to know why this principle is happening in a certain way (Hiebert & Lefevre, 1986). The procedural knowledge is providing or simulating applicable sequences to understand how some principle happens in a certain time and space (Rittle-Johnson & Alibali, 1999).

Embedding questions into a video lesson can work well in delivering conceptual and procedural knowledge because VEQ is interactive, and it raises the level of understanding (Chi & Wylie, 2014). Video by its nature is a passive experience especially while watching television and films. With the implementation and progress of the Internet since 1994, the current attention span is becoming shorter over the years (NCBI, 2013). Having a particular instructional event (i.e. multiple-choice question) show up on the video every few minutes raises the interaction and increases the attention span (Taylor, 2014; Brame, 2015), which allows an opportunity for focusing on the content and repeatedly reviewing the video segment before each instructional event.

Considering Bloom’s Taxonomy – the revised version (Bloom et al, 2001), passive video (i.e. video without time or display controllers) can reach the second tier of understanding at maximum. Creating educational videos with embedded questions can raise the level of understanding to the third tier by allowing the learner to think about and review each segment upon a question (second tier) (Kim et al, 2015), and by applying the concepts through interaction: implementing, demonstrating and interpreting information
to answer questions correctly and advance within the video (third tier) (Vural, 2013; Rapt Media, 2015). Due to the fact that adjunct questions are useful practices/activities to perform as a rehearsal to strengthen the memory (Rothkopf, 1970; Landauer & Ainslie, 1975; Landauer & Bjork, 1978), providing embedded questions with feedback mechanism sets a workable, programmable model for effective conceptual and procedural information recall using videos.

The amount of interaction between the learner and VEQ sat the domain of research in this study. There are many aspects to look at the process of learning from. In this study, according to the following research question: ‘Does VEQ with confirmation feedback and post-AQs improve comprehension compared to LV?’ the embedded questions are initially defined and reviewed based on the notion of Adjunct Questions (AQs) as part of mathemagenic activities.

Mathemagenic Activities

The term ‘Mathemagenic Activity’ was first coined by Rothkopf (1970). It is defined as: the set of actions, sequences, or events that make learning happen. Rothkopf (1970) specifically referred mathemagenic activities to the actions that learners make when they learn something, for example: paying attention, focusing, rehearsing, and information processing. Some of these actions are covert and some of them are overt.

Learning is sought by instructional designers to be achieved in the most effective, reliable and flexible ways (Merrill, 2002). Mainly there are two goals of instruction: to promote thinking and improve learning. Asking questions within instruction is a way to accomplish these goals and stimulate mathemagenic activities (Rothkopf, 1966;
Questions inserted within the body of textual content to draw attention and rehearse memory are called Adjunct Questions (AUs), and the research findings of AUs have been extrapolated to computer-based interactive instructions, such as video (DeBloois, 1982; Domaradzki, 1990). As claimed by DeBloois (1982), video is a unique medium that needs to be researched for all possible learning strategies.

Video can be designed to give maximum control to the learner over the instructional content. But using AUs requires that video stops at some points, and imposes learner to answer AUs and read/watch the feedback according to the picked answer. In this case, assessing the effectiveness of using AUs and implementing them in video need to be based on a solid understanding of the types, position, and learning levels of AUs.

**Types of AUs.** The research on AUs has studies about types and position of the inserted questions in instructional material. Based on cognitive processes, the types of embedded questions used in this study were post-AUs mainly categorized in two types: memorization and application. This categorization is founded based on the literature of AUs types, in which educational research has mainly categorized them under memorization-level AUs and application-level AUs (Watts & Anderson, 1971; Darwazeh & Reigeluth, 1982). The memorization level AUs ask the learner about a specific information that was mentioned, stated, shown or read previously. Whereas application-level AUs ask the learner to apply the previously mentioned information to a new situation or context (Darwazeh & Reigeluth, 1982).
Recognizing the type of AQ. As shown in Figure 2, and according to Darwazeh & Reigeluth (1982), memorization-level AQS can further be partitioned into two types: recognition questions and constructed recall questions. Corresponding to these types, the application-level AQS also has two sub-types: the identifiable example and producible example. The position of AQS is classified to be inserted before, after, or both (before and after) the instructional material. Instructional material in video is a mixture of animation, series of static images, and audio (Mayer, 2003).

![Diagram](image)

Figure 2. Types of questions based on Darwazeh & Reigeluth (1982) categorization.

Embedded questions system is subject to change relatively to the type of AQS designed in it. AQS have been studied with respect to type and position. For example,
Felker & Dapra (1975) tested the effect of receiving application-level AQs after reading a passage. The study found that identifying new examples of principles (using application-level AQs) has affected the students’ post-test grades, and made them score significantly higher than the two other group of students: a) the group who received memorization-level AQs (asked to recall a specific information), and b) the group who received no AQs at all. In the case of this study, embedded questions applied memorization and application levels in post-AQs, which converges with Watts & Anderson (1971) study. Watts & Anderson (1971) have conducted another study to examine the effect of having both recall and application AQs (i.e. memorization-level and application-level). They have found that embedding both types of AQs together aids learning better than embedding recall AQs only – to recall exact text words or pieces of information (Watts & Anderson, 1971).

**Consistency of type.** Categorizing AQs took different forms in other works. Kirschner & Brink (1979), for example, have categorized AQs into two types: knowledge and comprehensive questions. In their study, eight combinations of three treatment conditions were formed: video with AQs (knowledge vs. comprehensive), position of questions (before or after), and feedback (receive feedback or no feedback) – all of which compared to video without AQs and feedback. Kirschner & Brink (1979) found that AQs’ influence not only the direct learning of information (relevant learning) but also indirect information (incidental learning).

However, until 1980, some other studies have failed to support the results in favor of AQs utilization. Andre et al. (1980) reported that out of seven studies which examined
the use of AQs on memorization and application levels, there were five studies that found no significant differences between both main types of AQs when embedded in textual instruction. In this regard, Darwazeh & Reigeluth (1982) have proposed that this inconsistency can be resolved by considering the position of AQs in addition to the types.

**Position of AQs.** The position of AQs feature was studied in textual passages:

**Recognizing the position of AQ.** The position of AQs can be located before or after the instructional segment or both; before and after. Rothkopf (1966) and Rothkopf & Bisbicos (1967) found that when AQs were presented after each textual passage, they had both intentional (direct) and incidental (indirect) learning effects. In other words, embedding an AQ after the instructional segment improves learning, whether the content learned was addressed by the AQ intentionally, or was not addressed by the AQ (incidental case).

**Consistency of position.** One type of AQs can be more effective than the other types when inserted/presented after the instructional segment, but not before. Other types can be more effective when embedded-inserted/presented before instructional segment (See Figure 3). Consistency of AQs position has been investigated in relation to their learning effects. These AQs can serve in intentional and incidental learning and make mathemagenic activities happen. Rickards (1976), Sagaria & Di Vesta (1978), and Frase (1968) also supported the idea that AQs promote intentional and incidental learning, except that Rickards (1976) found a special case, which is: embedding conceptual AQs before the instructional segment produced higher retention rates among students than embedding them after the instructional segment. These retention rates were investigated
in contrast with intentional and incidental learning by adjusting the immediate and delayed retention of information (Rickards, 1976).

The position of AQs alone has inconsistency when measuring the main effect of AQs on learning progress (Darwazeh & Reigeluth, 1982). This inconsistency was sought to be resolved by Darwazeh & Reigeluth (1982), Rickards (1976) and Andre et al. (1980), and they all have concluded that the type and position of AQs can interact significantly based on the presented video and the levels of learning.

![Diagram](chart.png)

**Figure 3.** Position of AQs: before instructional material, after instructional material, or both. Adapted and designed based on Darwazeh & Reigeluth (1982).
Learning levels of AQs. In education, there are several taxonomies developed to address the levels of learning (Bloom et al, 1956; Gagne & Briggs, 1979; Merrill, 1983). One of these taxonomies was developed by Merrill (1983), and it was used in this review to link and explain the interaction between type and position of each AQ, and hence to formulate a compatible level of learning. Merrill’s (1983) model has primarily indicated and identified different levels of knowledge acquisition, which are applicable to the definition of ‘learning’ stated in Chapter 1. In that sense, embedded questions are subject to change not only because of the instructional material, but for the attributes of type, position, and learning level.

According to the previously reviewed studies for the types and position of AQs (Rothkopf & Bisbicos, 1967; Frase, 1968; Felker & Dapra, 1975; Rickards, 1976; Sagaria & Di Vesta, 1978; Kirschner & Brink, 1979), the results were still maladjusted due to the lack of distinction or differentiation between levels of learning. Same lack can be found in several recent studies that examined the use of questions in instructional videos, in addition to the absence of type description and position of these questions (Domaradzki, 1990; Vural, 2013; Merkt et al, 2011). It is possible that the effect of AQs type and position can be altered by, and affected by the desired level of learning.

Recognizing the learning levels of AQ. Merrill’s (1983) model from Component Display Theory (CDT) distinguishes among four levels of learning, they are: Find a Generality (FG), Remember a Generality (RG), Remember an Instance (RI), and Use a Generality (UG) (Merrill, 1983):
• Find a Generality (FG): from a set of examples, learner is required to find or derive a new principle (e.g. which one of these you can also use to practice for presentation: mirror, camera, or poster?).

• Remember a Generality (RG): from a set of examples and information, learner is required to recall and recognize specific instances, principles or rules from memory (e.g. what is the consequence of continuous D/C charging?).

• Remember an Instance (RI): from a set of examples and information, learner is required to recall and recognize one or more specific information (e.g. what is the name of PC menu in which you can find the Disk Defragment function?).

• Use a Generality (UG): after encountering a set of principles, learner is required to apply some (or all) of these principles to a new -unknown- case (e.g. If someone asked you a difficult question with respect to your presentation, how would you react?)

**Consistency of learning levels.** Because of the richness in instructional material used in video, all four levels (FG, RG, RI, UG) can be used in AQs. The interaction between type, position and level of learning in AQs have found to be significant in comprehension (Rickards, 1976; Andre et al, 1980; Darwazeh & Reigeluth, 1982), where pre-AQs (AQs inserted before instruction) were more effective when based on RI or RG, and the post-AQs (inserted after instruction) had better effect when based on UG. Figure 4 shows the integration between levels of learning with AQs. In addition to Merrill’s (1983) model, the videos of this study were designed and created to meet at least three of Gange’s standards, which are commonly found in educational videos: gain attention,
stimulate recollection of prior learning, and provide proper learning guidance (Gagne, Briggs, & Wager, 1992).

Figure 4. The levels of learning in AQs based on Merrill’s (1983) taxonomy.

The conclusion from using AQs with consideration of all attributes (type, position, and level of learning) is that AQs have backward and forward effects (McGraw & Grotelueschen, 1972): pre-AQ serves as a method or tool of stimulating the learner’s attention and motivate their focus to look forward at specific details; a learner tends to focus on details and ideas that were mentioned in pre-AQ. Thus, pre-AQs are motivators, whereas post-AQs are rehearsals that take the learner backward; they reinforce the
remembrance level of learning, and encourage learners to build explanations and expectations to go beyond the instructional material and apply in new situations (Andre et al, 1980; Merrill, 1983; Merrill, 2002).

**Responding to AQS and getting feedback.** Responses to AQS are often classified to be overt or covert (Grabowski, 2004). The learner-generated responses (overt), according to Grabowski (2004), are more effective than instruction-generated responses (covert). But these responses are subject to change in terms of amount and interaction, depending on the type, position, and feedback from AQS.

Feedback is basically an information formulated and given to the learner about the correctness of their response (Andre & Thieman, 1988). Confirmation feedback was used in this study: it consisted of a textual information presented with an expressive image for 7 seconds to let the learner know about the correctness of their answer(s). The confirmation feedback can vary from a simple presentation of the correct answer, to a more complex information that illustrates/elaborates related idea(s) about the answer whether it was correct or incorrect (Andre & Thieman, 1988). The learner actively processes and interacts with the instructional material during presentation, problem-solving and answering (Felker & Dapra, 1975), this is similar to the case of watching video and thinking about the correct answer. The learner is not necessarily involved in active processing for the feedback information itself.

Felker & Dapra (1975) and Watts & Anderson (1971) based their studies on the amount and type of feedback to demonstrate the facilitative effect of AQS. While they found a facilitative effect of AQS with informative/correcting feedback specifically on
concept learning, other studies have not succeeded in finding this facilitative effect (Andre, 1979; Andre et al., 1980; Andre & Thieman, 1988). Consequently, Andre & Thieman (1988) suggested that the type of AQs affects the feedback type and the amount of active processing the learner should do. In addition, a study by Rickards & Di Vesta (1974) also showed evidence that the type and nearness of AQs to the instructional material, with frequent occurrence, had a facilitative effect in learning (Rickards & Di Vesta, 1974, p. 358). Both works of Hamaker (1986) and Rickards & Di Vesta (1974) conclude that when AQs are inserted near the instructional material and asked more frequently, then they are more likely to aid as a facilitative strategy to help learners. With all these evidences, it is concluded that confirmation feedback is correlated with AQs, because each feedback is limited to the way embedded question was designed and written (Andre & Thieman, 1988; Williams, 1992; García-Rodicio, 2015).

Response and feedback represent the essence of interaction between the learner and educational video. Therefore, Figure 5 shows and concludes the definition of embedded questions based on the review of AQs.
Embedded Questions in Educational Videos

Since the current study is about embedding questions in educational videos, it is important to notice the difference between AQs and embedded questions. The facilitative effects of AQs have been mainly under investigation when used in textual content (Rothkopf, 1966; Rothkopf & Bisbicos, 1967; Rickards & Di Vesta, 1974; Darwazeh & Reigeluth, 1982; Andre & Thieman, 1988). Over time, there has been a need to re-define the use of inserted questions to be more applicable with interactive, programmable and

From AQs to embedded questions. Darwazeh & Reigeluth (1982) summarized - in general- the types of questions and the types of learning accordingly. Darwazeh & Reigeluth (1982) have examined the intervention and combination between the types and position of adjunct questions. Their goal was to specifically find out the level(s) of adjunct questions’ learning (FG, RG, UG, RI) that were more facilitative for learning, the question position (pre- or post-question) that helped more in processing and retaining information, and to determine whether there was an interaction between the type and position of these questions or not. Using a retention exam on a 450-words essays, with a number of experimental groups assigned to take three types of questions (RG, UG, RI) and two types of positions (before passage and after passage), the results showed significant interaction between the types and positions. Darwazeh & Reigeluth (1982) indicated that pre-questions were more effective in learning when they were based on remembering level (RG or RI), and the post-questions were more effective when based on the level of application (UG). However, the study found no localized effect for the question type or position separately, meaning that the interventions between type and position were the reason behind improvement in learning.

AQs have been extrapolated to computer-based interactive video by Domaradzki (1990). Domaradzki (1990) used an educational video that taught techniques of studio lighting, and this video was either supported by a question sheet (as an adjunct aid for
Domaradzki (1990) observed that students who chose to have embedded practices significantly outperformed those who chose not to have any embedded practices while watching the video. However, the aid of question sheet had no significant effect in post-test scores of both groups. Domaradzki (1990) summarized that the use of AQs as embedded questions in educational videos is needed. This need was supported by suggestions from DeBloois (1982), Domaradzki (1990), Shyu & Brown (1992), Merkt et al. (2011), Vural (2013) and Kim et al. (2015).

Vural (2013) has studied the impact of embedded questions in instructional videos. The study attempted to find whether there was a difference between using embedded questions in video and avoiding them. The difference was in terms of time-on-task (i.e. time spent by a learner to fulfill a certain learning task (Prater, 1992)), and the amount of observed interaction. The study aimed to conclude if there was an improvement on student’s learning achievement or not. Research instruments included: a survey of basic computer knowledge, a pretest that was used as a covariance to reduce the bias of results, a post-test to evaluate learning outcomes, and a recording of student’s interaction with the video. With the usage of quasi-experimental design (Johnson & Christensen, 2014) to compare between students’ achievement in a computer literacy course, the results showed that students who had the embedded questions treatment (multiple-choice questions show up between video segments) have spent more time-on-task, fulfilled more interaction, and achieved significantly higher scores (Vural, 2013).
Video has been taken into a higher level of interactivity by embedding multi-task exercises. For instance, Kim et al. (2015) worked on a 3-parts study about a program called Rich Interactive Multimedia Exercise System (RIMES). In RIMES, Kim et al. (2015) have tested the ability of having multimedia exercises in pedagogical learning progress. The idea was to develop educational videos by embedding exercises of different kinds (e.g. audio input, drawing on screen, inking, and open-ended questions) rather than just having short multiple-choice questions within the video content. The study of Kim et al. (2015) provided a workflow of designing, recording, authoring, and reviewing the responses of students, as well as an applicable workflow of how teachers can use programs with rich multimedia in classroom and formative assessment. However, programs like RIMES can be critical due to the fact that too much information, loaded with interaction, can result in adding redundancy to the cognitive capacity (Mayer & Moreno, 1998; Mayer & Moreno, 2003; Sweller et al, 2011), also the audio-visual channels in the learner’s mind become overwhelmed (Paivio, 2007).

García-Rodicio (2015) has also investigated the usage of embedded questions to find if having to answer makes a difference in learning or not. Their experiment was closely related to this study: two groups were tested using an educational video about geology. The first group were exposed to an interactive version of the video with embedded questions that had 3 answers and a confirmation to each answer. The second group were exposed to a non-interactive video treatment, in which the participants had to watch the whole video with content of questions and feedback shown linearly without having to answer them. After taking a post-test to measure the retention and knowledge
transfer, the results showed that the interactive video condition (i.e. embedded practice and feedback) allowed participants to outperform those who had semi-interactive and non-interactive video conditions. García-Rodicio (2015) concluded that the act of participating in the embedded questions itself was the critical factor that made the difference in learning.

Therefore, in order to optimize learning from AQs, not only the type of question and its corresponding learning level should be approached in instructional design, but also embedding these questions in a suitable position within the learning material is also important. This is why the term ‘Embedded Questions’ was used in the current study to take AQs to the next level: using videos instead of textual material (Domaradzki, 1990; Kirschner & Brink, 1979; Merkt et al, 2011; Vural, 2013; Kim et al, 2015), optimizing questions with different types to facilitate and support multi-levels of learning (Darwazeh & Reigeluth, 1982; Brame, 2015), and utilize a confirmation feedback (Andre & Thiemann, 1988; Schunk, 2008).

**Additional questioning techniques for effective learner engagement.** There are many techniques to use in order to make videos more effective for learning. For example, the interactive features can give students more control over video: display control, control of movement, pace, selecting and reviewing sections. These features have been compared by Zhang et al. (2006) and they were found to be an effective solution for students in computer science class. The participants in Zhang et al. (2006) study were able to demonstrate better comprehension and showed higher satisfaction.
Another technique to consider is guiding questions. The use of guiding questions has been examined by Lawson et al. (2006) to explore their effect in social psychology class. Lawson et al. (2006) have built their work on Kreiner’s (1997) study by providing a group of students with questions that give guidance on instruction, and another group of students who received plain instructions without guiding questions on video. It was observed that the participants who were treated with guiding questions scored significantly higher on the comprehension test than those who did not have that treatment.

Integrating the questions into educational video is now accessible and doable (Rapt Media, 2015; Stigler et al, 2015). Using passive/semi-interactive video only does not guarantee a successful learning experience. It was recommended by Brame (2015) and Stigler et al. (2015) that video can be made as part of a larger course model. Stigler et al. (2015) have explained the platform of Zaption – an online builder for interactive video lessons. In Zaption, not only embedded questions are used, but also a feature called Tour Builder (Stigler et al, 2015). This feature makes it able to design a video lesson with a multi-path tour for students, so that the video automatically skips to a certain segment/clip based on the student’s clicks, responses, and answers. Teachers can follow up accordingly with student activities and interactions by monitoring and analyzing the behavior on each interactive video lesson, and finally help in developing the learning outcomes and setting up new video tours.
Environmental and Motivational Aspects of using Embedded Questions

The second research question was: ‘Does VEQ with confirmation feedback and post-AQs improve self-efficacy compared to LV?’ In knowledge acquisition using VEQ, there is a substantial relevance between the learner’s characteristics and learning achievement. The aspects of this relevance can be prior knowledge, emotions and motivation, and learning strategies and abilities (Kozma, 1991).

Learners are different in terms of their personal constraints and learning abilities. As explained by Kozma (1991), the learner’s internal knowledge structure, as well as the external constraints of learning environment, both define the way they gain knowledge. The term ‘learning environment’ does not necessarily mean a location or a place; it is rather the educational setting that involves time, effort, delivery method (e.g. online or face-to-face courses) as concluded from Allam (2006), self-efficacy, and informational cognitive load (Mayer, 2009). This study focused on one of these aspects and added it to the domain of VEQ, which is the Self-Efficacy.

Self-efficacy of the learner. There are personal variables that influence the learner’s persistence and confidence in their knowledge, and one of these variables is the self-efficacy (Bandura, 1986). Self-efficacy, as defined by Bandura (1986), is the person’s own belief in their abilities to achieve a certain task or succeed in a situation.

The reason of including self-efficacy as a measurement in VEQ was due to its importance as a substance of comprehension. Regardless of which learner's psychological characteristic is being studied, the embedded questions strategy is a multimedia
intervention that is aimed to produce the best learning experience in terms of persistence and making choices (Williams, 1992; Collazo et al, 2012).

Self-efficacy, as indicated by Seifert (2004), is identical to and synonymous with confidence levels. Learners who have low self-efficacy tend to generate self-doubt and become less confident about their task (i.e. choosing the correct answer), whereas learners with higher self-efficacy are more persistent, continual and confident (Schunk, 2008; Bandura, 1986). The outcome expectations, such as predicting the right answer and believing in personal ability to achieve a score, are closely related to self-efficacy (Bandura, 1986; Bandura, 2006). Answering an embedded question is an action attempted by the learner, and the learner may anticipate or predict the possible consequences of this action.

Despite the fact that expectation of correct answers alone does not guarantee a higher motivation (Schunk, 2008), learners are more engaged when they expect a correct answer and believe in their ability to continuously expect and choose correct answers; expectation together with self-efficacy lead to more engagement in learning (Schunk, 2008; Bandura, 1986). Moreover, Schunk (2008) pointed out that some factors as instant feedback can strengthen learner’s engagement and self-efficacy.

**Cognitive load of video information.** In order to reduce the cognitive load in learners, instructional design can be used to limit the amount of audio-visual information in video, and maintain the limits of information processing model and memory (Mayer & Moreno, 2003). By pausing and segmentation (Mayer, 2009), VEQ has the potential to control and reduce the amount of cognitive load on the learner. One of the primary
considerations about designing and creating interactive videos is the Cognitive Load Theory (Sweller, 1988). According to cognitive load theory, and based on the construction of memory (Figure 6), learners retain information best when they learn it in a way that does not overload their mental capacity (Sweller, 1988; Sweller et al., 2011). Trying to learn too much information at one time can stress the brain, overwhelm the sensory memory and make it difficult to recall the material from long-term memory at a later time (Mayer & Moreno, 2003).

\[\text{Figure 6. Memory structure for audio-visual content (Mayer & Moreno, 2003).}\]

According to Ayres (2006) and Sweller et al. (2011), there are three main types that formulate and contribute to the total cognitive load: 1) the Intrinsic Cognitive Load, which is intentionally or unintentionally created by the complexity of instructional
material itself, 2) the Extraneous Cognitive Load, which results from techniques and methods that are used to present the material to a learner, and 3) Germane Load, which refers to the level of desired/proper cognitive activity that does not produce redundant load (Ayres, 2006; Sweller et al, 2011). The ultimate goal of using cognitive load in educational videos is to make the video more engaging, less overwhelming and instructionally effective (Kim et al, 2015; Vural, 2013). Cognitive load is critical when using embedded questions, but maintaining the simplicity in a well-designed video instruction can further promote better memorization (Mayer, 2003) and engage the learner in a schema of richly connected ideas.

**Instructional Design of VEQ**

The third research question was: ‘What are the advantages and disadvantages of using embedded questions in a video that is instructionally designed to tell, show, and ask?’ There is another aspect to study in the subject of embedded questions in educational videos, which is the instructional design of the material over which the learner is supposed to interact with (Sorden, 2005; Soto, 2013; Merrill, 2002). Video content and embedded questions scheme are described in Chapter 3. Therefore, here is a review of the instructional sequence used to demonstrate information in an interactive video setting.

Merrill (2002) explained the use of instructional events. The technique of instructional events is used to properly teach or provide an information to the learner using 4 forms of events, they are: Tell, Show, Ask, and Do. The first one is ‘Tell’ and it can take many forms as an instructional event, such as text, animation, lecture, video or a
presentation. The instructional event ‘Show’ is firmly connected with ‘Tell’ because the instruction needs to be told as a general information, and also to be showed as a portrayal simulation (Merrill, 2009). However, telling and showing information alone cannot be an effective way of teaching (Merrill, 2002). Likewise, in case that ‘Tell’ and ‘Ask’ were the only events used, then this sequence would explicitly be the least efficient instructional strategy (Gagne et al., 1992; Merrill, 2002). Figure 7 is a diagram that illustrates the typical instructional sequence. Arrows represent the ‘Tell’ event, and circles represent the ‘Ask’ event. The use of instructional events and their sequence vary depending on the topic and type of transferred knowledge.

![Figure 7. Adaption of instructional sequence by Merrill (2002): showing a combination of topics and examples of sequence accordingly.](image)

After telling the information, another form of events can be used, which is to ‘Ask’ a question. This question can be categorized based on CDT theory with respect to
the type of knowledge that needs to be transferred to the learner. Continuous telling of the information then asking a question at the end was not considered as a promising approach by Merrill (2009). Therefore, the next step was to redefine the use of questions by adding the instructional event ‘Do’, which is asking the learner to apply a hands-on task that is related to the instruction, or to apply the comprehended information on a new, often more complex situation.

As shown in Figure 8, arrows fused with squares represent the instructional event of Tell-Show. The difference, however, between the instructional designs of LV and VEQ videos specifically existed in the sequence of instructional events: LV videos were designed to Tell-Show then finally Ask-Do, while VEQ videos were designed to Tell, Show, and Ask to Do in between.

*Figure 8. Adaption of instructional sequence by Merrill (2002): showing LV and VEQ video models of sequence.*
Summary

Typically speaking, theories of embedded questions’ effectiveness have been merged into more applications to promote better learning. Knowledge transfer has been a main issue for more than 100 years, and yet it is not likely to be fully-resolved due the various educational and philosophical agendas that drive research on this field. An ongoing research is exploring and studying the impact of different features embedded in video specifically. Teaching and learning in higher education using interactive video is currently examined through newly-developed strategies, like embedded questions, in order to increase its odds of achieving learning objectives for learners.

Vural (2013) and Merkt et al. (2011) have recommended to use more coherent and stable system that can handle display-controlled, multi-featured videos in the future (e.g. Rapt Media (2015)), moreover suggested that videos may cover and present different topics (e.g. History, Chemistry, Physics), that are targeted for students at different levels (undergraduate or graduate). In Domaradzki’s (1990) study, it was indicated that students used video lecture with question sheets for the first time – it was a new instructional tool to them. Domaradzki (1990) also indicated that the same type of knowledge that assessment questions treated should be identical and integrated with the embedded practices. Domaradzki (1990) predicted that the continuous usage of educational videos, with more improved technology that can integrate quizzes and question within video presentation could significantly enhance the learning experience. The same idea was supported by Hannafin and Colamaio (1987) stating that embedded
questions are “the most powerful influence among the treatment variables studied in learning from interactive videos” (p. 7).

With all these points and recommendations from past studies and research, it was convenient to include more technological advancement in video-based learning, which is interactivity, and base it on embedded questions strategy. As a conclusion, the literature gap was highlighted by the following: this study worked and contributed by providing a model of video with embedded questions that has been designed to facilitate conceptual and procedural learning. This model is flexible and workable in online courses, and maintains compatibility to work within a variety of learning management systems. This model was instructionally designed and implemented with considerations of environmental and motivational aspects of learning process.

In this chapter, the researcher reviewed the literature of embedded questions in videos. The organization of this research went through studies of learner control and mathemagenic activities, and tackled the issue of AQs from these points. Then, the review continued to demonstrate several integrations of AQs in textual contexts, extrapolated and extended them to the use of video by calling them embedded questions. The learner’s characteristics and attitudes towards embedded questions were reviewed under the scopes of environmental and motivational aspects, with more focus on self-efficacy. Finally, the instructional design of VEQ and LV versions were reviewed from the perspective of CDT theory. In the next chapter, the methodology is presented.
Chapter 3: Methodology

After reviewing the literature on embedded questions in Chapter 2, the researcher presents the methodology in this chapter to measure and evaluate the comprehension from VEQ and LV, and to investigate the participants’ implications and thoughts about embedded questions in terms of self-efficacy and instructional design. The research was based on mixed method, which is the explanatory sequential approach; meaning that a quantitative approach was used with the support of qualitative approach. The quantitative part consisted of collecting questionnaire input to demographic questions and assessment answers. The qualitative part consisted of a focus group discussion (i.e. transcript) blended with newly-added participants to insure variety of responses. The focus group consisted of 15 participants: 7 participants who previously participated in the experiments, and 8 new participants. This methodological style was designed to answer the following central research question:

Concerning knowledge acquisition in an interactive setting, does Video with Embedded Questions (VEQ) promote learning better than Linear Video without Embedded Questions (LV) for adult millennials at a university in the Middle East?

Note that the main objective of this study, using the experimental methodology, was to test a new function added to one technology (i.e. video), which is embedded questions system, in order to reveal its effects on the learning process; a strategic comparison rather than a multimedia comparison.
The hypothesis, therefore, was to be examined through experimental research with assessment scores after watching VEQ and LV videos, and investigate the participants’ interaction with them. In this research, two videos were designed and created with VEQ version, and LV version (total of 4 videos). In accordance to the assessment items, these videos were the research tool used to transfer conceptual and procedural knowledge about battery life and presentation skills:

- $H_0$: the VEQ scores are not significantly different that LV scores for learners.
- $H_1$: the VEQ scores are significantly different than LV scores for learners.

There are several research sub-questions considered for data analysis and discussion in Chapter 5 based on the hypothesis:

1. Does VEQ with confirmation feedback and post-AQs improve comprehension compared to LV?
2. Does VEQ with confirmation feedback and post-AQs improve self-efficacy compared to LV?
3. What are the advantages and disadvantages of using embedded questions in a video that is instructionally designed to tell, show, and ask?

The experimental research method was conducted using quantitative approach (i.e. answers of assessment), and qualitative approach (i.e. focus group discussion; additional participants joining to insure variety of responses). The results were analyzed based on the following logically-related formulas:

- If the scores of VEQ assessments are significantly lower than scores of LV for both topics, then the VEQ does not promote better learning than LV.
• If the scores of VEQ assessments are significantly higher than scores of LV for both topics, then the null hypothesis is rejected; VEQ does promote better learning than LV.

• If the scores of VEQ and LV assessments for topics show no significant difference, then the null hypothesis is rejected and VEQ does not promote better or less learning than LV.

Assessment scores and self-efficacy percentages were found by measuring the average outcome of each experiment:

• Assessment score of topic 1 + Assessment score of topic 2, divided by 2.

• Self-efficacy of topic 1 + Self-efficacy of topic 2, divided by 2.

The reason for these equations was to maintain consistency with the research hypothesis: if scores of VEQ posts tests are significantly higher than scores of LV for both videos and both groups, then the null hypothesis is rejected. In the following sections, a justification of the methodology, along with more elaboration on research design are discussed.

**Mixed-Method Research to Investigate Embedded Questions in Videos**

This was a mixed-method study; a single study that used multi-methods of data collection and further analysis. Specifically, the researcher applied the concept of sequential explanatory approach, and this approach was based on Creswell et al. (2002) Model 3 of sequential procedures (refer to visual presentations, Creswell et al, 2002, p. 214). To determine the mixed method design, the researcher first decided to implement a sequential-quantitative-first basis, sat the priority to quantitative data collection, then
applied a qualitative approach to collect interpretive data, and finally combined them to formulate an implicit theoretical perspective (Creswell et al, 2002).

**Experimental vs. non-experimental research guidelines.** There is a difference between experimental and non-experimental research, and this difference is fundamentally related to the predictor variable. The predictor variable is a portion, factor or element of the experiment that needs to be manipulated in order to detect its effect on the dependent variable (Johnson & Christensen, 2014). Therefore, experimental research prolongs the opportunity to mediate or adjust the predictor variable or the subjects to identify a cause-and-effect relationship (Johnson & Christensen, 2014).

Every researcher needs to found a guideline of their studies. Typically, conducting the study in a lab setting is what a researcher needs – with one group of participants being treated as an experimental group, and the other is placed in a control group (Thyer, 2012). Having both experimental and control groups, as concluded from Thyer (2012), helps a researcher to adjust better treatments in a laboratory-based, technologically-rich experiment. High levels of control would help in obtaining perspicuous results.

Non-experimental research is the term given to a study where researchers are not able to do or process what they can in experimental research. Meaning that the benefits of higher control, better manipulation, or alteration of the predictor variable or subjects are not available (Johnson & Christensen, 2014). The non-experimental research offers the ability to conduct a study that relies more on the researcher’s observations, interactions, reflections or connections to come to a set of conclusions. Typically, this means that a
non-experimental research relies on surveys, in-depth interviews, phenomenological or case studies (Johnson & Christensen, 2014). In which case, it cannot demonstrate a solid cause-and-effect relationship like the experimental research does. The ability to find a cause-and-effect relationship is a desired outcome in the world of science.

**Mixing of experimental and non-experimental approaches.** The methods of study in non-experimental research are often correlations or case studies; they cannot confirm cause-and-effect, and they cannot manipulate the predictor variable (Thyer, 2012; Johnson & Christensen, 2014). However, in non-experimental studies, researchers have the ability to take some variables that are often uncontrollable in experimental approach, and cannot be altered by the researcher (e.g. age, ethnicity, opinion). Now that the experimental research can manipulate predictor variable(s), investigate cause-and-effect, and replicate the same study under the same circumstances, it can be used and invested along with non-experimental methods to complete the variations of what is missed by both methods of research (Creswell et al, 2002; Benz & Newman, 2008). This would allow both experimental and non-experimental researchers to study various cases and pick up what is neglected from both sides (Thyer, 2012).

Based on the research questions of this study, the quantitative part was outcome-based and the qualitative part was explanatory. Thus, data collection was held using instruments and interviews. The data analysis then was based on these statistic and descriptive outcomes, and fulfilled the search for connectedness among themes and categories as prescribed by Creswell et al. (2002) and Benz & Newman (2008). The
researcher attempted to obtain a contextualized data; collected and interpreted in a larger-sense for the use of embedded questions.

Since this research studied the effect caused by embedded questions in educational video, the researcher investigated this effect on comprehension, by assigning the predictor variable to be the embedded questions system, and the dependent variables to be comprehension - which was the average score of assessments between the experimental group (VEQ participants) and the control group (LV participants), and the average percentages of self-efficacy. The dependent variables were studied from three main perspectives: AQs attributes and confirmation feedback, instructional design of VEQ and LV, and the self-efficacy and attitude of learners. The focus group, alternatively, provided more elaboration on their experience with interactive videos, and their input was thoroughly analyzed, coded for further analysis, and matched with the scoring results of the assessment. In the next section, the research design is explained.

Research Design

Variables of the study. Due to the nature of the study, which revolved around embedded multiple-choice questions strategy on one multimedia (video), the following variables were assigned to reveal the cause-and-effect relationship in interactive videos:

- Independent Variable: Embedded Questions System (i.e. post AQs with confirmation feedback).
- Dependent Variables: Comprehension (i.e. assessment scores and self-efficacy percentages).
These variables represent an attenuation to control the groups of participants who were subject to the study. The independent variable was labeled by whether a test video has interactive and clickable embedded questions inside it or not. Accordingly, the dependent variables were the averages of assessment score and self-efficacy percentage of each group. The average score difference between both groups was analyzed from multiple perspectives in Chapter 5 according to the research question: attributes of embedded questions (type, position, and feedback), instructional design of videos, and self-efficacy. It was predicted that providing embedded questions with confirmation feedback (VEQ) would affect the scores and raise them significantly.

**The population.** The population consisted of adult millennials who were graduate students at the time of the study. Millennials are the people reportedly born in between the years 1980 to 2000 (Howe & Strauss, 2000). The researcher introduces and defines a special kind of participants in this study, they are Middle Eastern adult millennials. In the Middle East region, millennials in adulthood are known for being socially diverse, economically stressed and politically liberal (Bayt, 2014, p. 8). According to Pew Research Center (2014), adult millennials build the majority of their own networks through social media rather than through civil or political parties. And despite all the obstacles around higher education (e.g. expensive tuition and fees), these characteristics of adult millennials put them at the center of this world's customizability (Howe & Strauss, 2000), in order to define and shape better education for advanced thinking in the 21st century. The characteristics of this population reflect the affective and cognitive
sides of each adult millennial participant; they highlight the main merits of each participant who participated in this study.

Since the current study took place in a Middle Eastern country, the population consisted of graduate students (adult millennials) from the University of Jordan. Name, e-mail, major and contact numbers of each graduate student were requested for contacting purposes only. These details were requested from the Admission and Registration Unit, and the Center for Strategic Studies, which are the two main entities in charge of providing such information and data (JCSS, 2012). All personal information and data were not included or published in the study. All the treatments and experiments were conducted in a research room designed for the purpose of this study at the Arabian Education and Training Group (AETG) (See Appendix F for approval). There were two ways of communication and invitation that the researcher has used: e-mail invitations, and departmental public announcement (both included in Appendix G).

First, in the email invitation, the researcher provided a synopsis of what the study entails, the reason why embedded questions in videos were being investigated in Jordan, and the impact and contribution of the outcomes to scientific spectrum on a global scale. The invitation was written in English and Arabic to insure the validity of communication and instruction for interested students. Second, the departmental regulations in Jordanian universities allow for meeting with graduate students in face-to-face meeting sessions, focus group sessions, and lectures with an opportunity of granting 1 credit hour of social work for each participant (JCSS, 2012). The printed announcement provided a description of the study and the researcher’s contact information to interested students.
The intended total number of participants was 50 graduate students, with an acceptable raise of up to 70 participants.

Afterwards, interested graduate students were contacted, sampled and randomly categorized into groups, as suggested in the following section.

**Sampling procedure.** Several factors are capable of playing a role in defining the sampling procedure of any research. Some of these factors are the nature of population, the situation of the country, the responsiveness of targeted sample, and the available funding resources (Johnson & Christensen, 2014). The sample of this study was chosen from the graduate students’ population. The ideal situation of a sampling procedure is to have each targeted participant fall under the same probability of being chosen. This way, with each targeted participant being equally-likely to be chosen from the graduate students’ population, the sample is more probable to be unbiased, hence more representative of the population itself (Johnson & Christensen, 2014).

However, due to the need of reaching to graduate students who might be interested in this type of studies, the researcher used a non-probability sampling method, which was the convenience sampling (Johnson & Christensen, 2014). Concerning the mixed-method adopted in this study, the researcher attempted to reach a population of graduate students who were difficult to be available at all times, and not usually found in large numbers (Benz & Newman, 2008; Thyer, 2012; Johnson & Christensen, 2014). The researcher also attempted to reduce the chance of using a highly-consuming technique in terms of time and money (e.g. population availability and responsiveness may require payment for participation) (Benz & Newman, 2008).
The sampling frame included adult millennials (i.e. graduate students at the University of Jordan), aged 22 years and above, who were registered and obligated to studying in higher education programs (whether online, blended, or face-to-face). In addition, there was no preference of having participants with higher/lower visual literacy and technical capabilities, in order for the sample to be more representative of graduate students as much as possible. But the focus group had 8 new additional participants who were selected based on purposive sampling (Johnson & Christensen, 2014). These 8 participants were professional educators, video directors and designers. A convenient sample, with a potentially large sample size that has a high participation rate and rich experience in the educational field, was what this study used.

The participants were contacted using the letter attached in Appendix G. Then, interested participants were randomly divided and allocated into two groups to conduct the experiments: the experimental group, and the comparison or control group. The groups were randomly partitioned by labeling them with master code numbers, whereas participants with even numbers were added to the control group and participants with odd numbers were added to the experimental one. This randomized partitioning was due to the need to avoid another attenuation of the cause-and-effect relationship (Thyer, 2012; Johnson & Christensen, 2014). The experimental group was exposed to the video products that were being manipulated (VEQ). Those in the control group were exposed to the standard treatment or the condition (Johnson & Christensen, 2014), so the same video that was provided with embedded questions to the experimental group was shown to the
control group in its plain, standard format without the embedded questions modification (LV).

People naturally change from one day to another, even without being in a study (Townsend & Townsend, 1992; Johnson & Christensen, 2014). For this reason, the average change for each group is not necessarily a generalizable result of the study. A focus group is formed and invited to a meeting after the tests of experimental and control groups have finished. This focus group partly consisted of same participants from previous experiments, with 8 new participants (15 participants in total). They received no tests, but they were asked to screen the videos and share their thoughts in an open discussion about the content and the concept of embedded questions using a semi-structured interview (Saldaña, 2013). The additional, new participants were chosen to examine the perceptions of the videos from a vivid, novel point of view without taking any tests. These new participants were joining the study from a professional background (academic and business) in order to enrich the discussion with thoughtful inputs.

No pre-test was intended in this study. The researcher did not attempt to conduct a prior-knowledge exam, and the purpose of this was to match the situation of open online learning environments; students may view any online video with a content that provides the same prior-knowledge, or a video that could be with new, unknown knowledge (Rias & Zaman, 2013; De Boer et al, 2016). Pre-experiment biographic questions were used for identification purposes only (e.g. behavioral preferences and video usages), not for sampling purposes.
**Instrumentation.** There are two instruments that the researcher has used: a questionnaire, and a focus group transcript.

*The questionnaire and video material.* Attached in Appendix A and Appendix H, the questionnaire included a biography section and an assessment section, and both sections were provided to the participants before and after showing the video, respectively. The first section asked basic biographic questions, and then the second section asked 10 multiple-choice questions about the material shown in the VEQ or LV to measure what the participants have just learned and what they can remember. Figure 9 shows how the questions were distributed relatively to the video version and group type.

*Figure 9.* Two-trials design for two versions of video applied on both groups. Designed by the researcher.
The total number of participants was 60 graduate students. They were sampled and equally assigned to both trials shown in Figure 9. These participants did the experiment as follows:

- Trial 1: experimental group consisted of 30 participants who watched the VEQ version of battery life and presentation skills videos.
- Trial 2: control group consisted of 30 participants who watched the LV version of battery life and presentation skills videos.

Each participant watched either the VEQ or LV version of both topics. The reason of having two trials was to replicate trial 1 with a different version; VEQ versus LV, same time-on-task, but a different version. A significantly higher score average for the experimental group in both topics leads to concluding that the null hypothesis is rejected. Despite the variety of topics, they had the same conceptual and procedural knowledge style presented in both videos.

The researcher thought about both options: testing one video (one topic) or two videos showing two different topics. The decision was made to use two videos with two different topics in order to replicate the results, and to allow the researcher to qualitatively compare them and investigate deeper changes that happened to the learning experience from having 2 videos. Such intervention was expected to be an extraneous attenuation factor, or have an effect on total learning experience, because it may differentiate the interactivity among both topics up to some extent. In addition, shifting the experiences between two topics helps in extending, elaborating or contrasting with multimedia theories (Rey, 2010; Clark & Mayer, 2016).
Figure 10 shows the network of paths that represent the possibilities (feedback scenes) of chosen answers. This scheme is part of the design platform used to create both VEQ and LV. The Rapt Media (2015) platform is open for users and it provides trial accounts.

Figure 10. Screenshot of Rapt Media (2015) dashboard.

Video specifications. The first video was an instructional production that provided 10 main tips to preserve a laptop's battery life (VEQ version and LV version). The second video was another instructional production that explained some of the most recommended presentation skills with 10 main tips (VEQ version and LV version). Both videos were filmed in high definition aspect ratio (1280 x 720 pixels), compressed and saved in MP4 format to be compatible for viewing in online platforms, and presented for duration of 5 minutes and 15 seconds. The expressive scenes in both videos were
provided and licensed in an agreement by Video Blocks (2015). The topics (battery life and presentation skills) were discussed in a conceptual and procedural approach; mentioning the concepts that would affect the viewer’s knowledge around both topics, and presenting a procedure to apply the techniques of saving battery life and performing a successful presentation based on these concepts.

*Video’s mechanism.* Note that the VEQ versions included 10 quiz-style, multiple-choice post-AQs (Clips 3 and 4 in Appendix C) that were pausing the video at chosen spots in the timeline, and waiting for the participant's response to the content. The participant then had 12 seconds to make a choice and click on one answer to proceed; if the answer was wrong, then the video would show the consequences as a confirmation feedback for that choice and get back to the same question to give another chance; if the answer was correct then the learner got a confirmation feedback, and presentation of the video proceeded. Alternatively, the LV version of these videos only played the content and presented the feedback information linearly until the end, without asking or pausing for any questions at any spot in the timeline unless the participant clicks ‘pause’ on it intentionally. LV did not show any consequences or confirmation feedback scenes.

A vital part of the VEQ mechanism was the implementation of Segmenting Principle (Mayer, 2009; Clark & Mayer, 2016). This principle suggests that deeper learning occurs when the video material is divided into user-paced, time-based and well-synchronized segments rather than having a continuous one-segmented video (Clark & Mayer, 2016). The principle of segmentation was applied to maintain enough time to
process the information between every two embedded questions, hence to reduce the chance of cognitive overloading.

*Video’s time-on-task control.* Time-on-task is the total time spent to complete the interactive video. Due to the nature of video, it is possible that each participant views it in a different way, which means there could have been a variation in time-on-task. This study was not treating time-on-task concept as a variable. Therefore, the time-on-task was set as constant and controlled by two things in the experiments: 1) all the videos (VEQ and LV versions) had the same exact linear duration, which was 5 minutes and 15 seconds. And 2) the total experience of videos was timed to a maximum of 6 minutes, then each participant was asked to move to the next page (assessment test page). This maximum duration of 6 minutes was to insure the same time-on-task for each participant, and to allow extra 45 seconds to recap, or re-watch several sections of the video before heading to the assessment (i.e. if the participant watched the video linearly for 5 minutes and 15 seconds, they would have 45 seconds remaining). If the participant did not complete the video in total of 6 minutes, due to skipping, repeating and/or making too many mistakes, they were asked to proceed to the assessment regardless of completion or not – this guaranteed a constant time-on-task.

*Video’s instructional design.* All video contents used in the study were designed to meet at least three of Gagne's standards: a) gain attention, b) stimulate recall of prior learning, which is critical due to the case that adult learners may have broader prior-knowledge and refined cognitive abilities, and tend to have more experience and
knowledge in several topics (Knowles, 1990), and c) provide learning guidance (Gagne et al., 1992).

First, the laptop battery video began by providing facts to stimulate prior knowledge and gain attention, like ‘There is a universal issue in laptop machines, which is the power a lithium battery can handle’, and ‘Did you know that a battery can live longer than its original life span?’ Then, it proceeded with the presentation by showing where the battery is located and how to diagnose it (i.e. prior knowledge), and presenting the main topics and techniques that were covered in the video before proceeding to the next segment (i.e. learning guidance). Second, in the presentation skills video, the lesson began by showing multiple public presentation examples, then a person’s point-of-view style while standing on the stage, to motivate the learner into thinking and considering what would they do if placed on that stage (gain attention). And then, it declared the techniques to be shown and illustrated (learning guidance), with each technique explained from basic gestures and clarity of information (prior knowledge) to more complex techniques like answering the difficult questions and interacting with audience. Also, VEQ and LV videos utilized at least two instructional events: Tell-Show in LV version, and Tell-Show-Ask in VEQ version (Merrill, 2002).

**Video’s embedded questions.** The embedded questions system was designed and implemented in each topic by inserting questions after the relevant segment. These questions, as show in Figure 11, were adapting the levels of learning as presented in the Component Display Theory (Merrill, 1983). The types of knowledge that embedded questions and assessment items have tackled were: Find a Generality (FG), Remember a
Generality (RG), Remember and Instance (RI), and Use a Generality (UG) (Merrill, 1983; Merrill, 2002).

Figure 11. Design and Integration of Embedded Questions. Based on Merrill’s (1983) CDT and Merrill (2002).
The focus group transcript. The second instrument was the transcript of a focus group meeting. The focus group meeting was conducted using semi-structured interview style (Appendix E), and provided more elaboration on their experience with interactive videos. Their inputs were manually transcribed, thoroughly analyzed, coded for further analysis using descriptive codes, categorized and matched with the findings and scores of the assessments to find out if any correlations and connections occurred. The descriptive coding was a code-to-describe model; consisted of three cycles: first to analyze the transcriptions on a paragraph level, second to filter keywords and concepts and classify them to excerpts, and third to summarize the primary topic of each excerpt (i.e. categorize it) (Saldana, 2013). A consent form (Appendix B) was provided for the security and privacy of participants. In order to approve the accuracy, credibility and validity of the reported responses, a complete member checking has been achieved.

Finally, to conduct this study, the researcher prepared an educational environment (i.e. experiment room) that allowed the control of variables in a well-guided manner. The researcher also facilitated and guided the participants through each step to insure comfortable participation.

Scoring procedures. Scoring the participant’s answers and input is related to the research sub-questions (Chapter 1 – Research Hypothesis). The questionnaire of this study was created online via Google Forms (2015) (Appendix A) in three parts: a) a demographic background, b) a VEQ or LV, and c) an assessment. The demographic part contained basic questions about major, profession, age and websites that are often accessed/used by the participant in daily life. After filling the first part, the participants
were asked to watch a VEQ video or LV video (two different topics for two experiments) based on their groups. Then after they have finished the video screening, they were asked to proceed to the next page and answer the last part of the questionnaire (assessment test) depending on what they have just watched. The total timing of the experiment was 5 minutes for demographic background, 6 minutes for one video screening, and 10 minutes to complete the assessment – a total of 21 minutes.

By the end of participation, each participant was expected to view two videos, and answer the questions of an assessment afterwards. The reason for having each participant view two different topics was to avoid the familiarity effect on each version. The familiarity effect (Krueger, 1975) is the participant’s ability to respond more quickly to a familiar treatment than to an unfamiliar treatment. And this familiarity with VEQ or LV videos, since they were both presented in a conceptual and procedural way, can affect the comparison between the results of both groups if the participants simply watched VEQ and LV versions of the same topic.

The groups were randomly partitioned by labeling them with master code numbers, whereas participants with even numbers were added to the control group and participants with odd numbers were added to the experimental one. This randomized partitioning was due to the need to avoid another attenuation of the cause-and-effect relationship (Thyer, 2012; Johnson & Christensen, 2014). Also, according to Merkt & Schwan (2014), semi-interactive videos like LV could be negatively perceived as a treatment if they were followed by VEQ of the same topic. This is the reason why each
participant had to watch only the video assigned to their group. Each participant watched only one version of each topic.

**To measure learning.** The assessment (Appendix A) had 10 multiple-choice questions that were equally distributed among the facts/concepts and procedural steps mentioned in the video. Each question was worth 1 point, which brings a total of 10 points for the assessment. Each multiple-choice question in the assessment was followed by: ‘how confident are you that you chose the correct answer?’ to which the answers ranged from 20% to 100% in order to measure cumulative self-efficacy as a primary concept of this study and to reflect on learning progress. The outcome expectation of each answer (i.e. confidence level) is treated as a substance of self-efficacy (Bandura, 2006). The expectation item provided a percentage scale up to 100% based on the self-efficacy assessment guidelines recommended by Bandura (2006). This treatment was based on a specific distinction that outcome expectation largely depends on self-efficacy (Bandura, 1977; Bandura, 2006).

**To investigate interactivity.** In addition to the assessment, the focus group interview transcript revealed an insightful connection between comprehension and learner characteristics. Focus group questions were composed in a semi-structured style, which allowed for more elaboration about the learning experience, self-efficacy, and the advantages and disadvantages of the video’s instructional design (Appendix E). At this point, all instruments are explained and the research questions are covered.
Description and Validity of the Assessment

The assessment included several multiple-choice questions -discussed in the previous section- to measure what the participants have learned from the video they saw, and the video they interacted with. The recall of information in embedded questions is an indicator of problem-solving (Rothkopf, 1965; Felker & Dapra, 1975). The recall of information in assessment items with vivid video experience is an indicator of learning progress (Sweller, 1988; Mayer, 2003; Sweller et al, 2011). A series of statistical tests were used to compare the average scores of both groups, and then to reveal if the differentiation between them was statistically significant or not. When two score distributions are to be differentiated, there are two primary characters to be analyzed: the mean, and the variance (Thyer, 2012). The mean and variance analysis provides a preliminary answer to whether the null hypothesis should be rejected or not. The statistical tests revealed data of assessment average scores and self-efficacy average percentages, and they are discussed in Chapter 4.

For example, if the embedded questions treatment is implemented in the video, then test scores may get lower from both topics due to additive/redundant cognitive load and accelerated active learning (Trevisan et al, 2010), distraction of modality and segmentation principles (Mayer, 2009), or lack of self-efficacy in learner (Bandura, 1977; Seifert, 2004). Whether theoretically or practically, any other unidentified reasons are sought to be discovered by setting the focus group meeting. In the focus group, a deeper discussion with follow-up questions was conducted to allow participants to screen over
the video material again, and give them the opportunity to relate to other participatory experience outcomes.

Consider another case: if embedded questions were provided with feedback over the video to foster learning, then test results might increase by 15%. This calculation allows to conclude that learners would gain better knowledge with embedded question strategy over interactive video screening, rather than passive/semi-interactive screening of the content. This would also serve as an evidence of learning without being overwhelmed by continuous and linear video instruction (Mayer, 2009; Merkt et al, 2011), and may also gain self-efficacy and better attitude towards interactive videos.

**Validity of multiple-choice questions in the assessment.** The interventions of learning situations are able to influence and/or narrow down the changes of the scores, for example: Mayer & Anderson (1992), Mayer & Sims (1994), Mayer & Moreno (1998), and Mayer (2003) are multimedia studies that applied different interventions such as adjusted instructional design, split-attention effect, and controlled 2D animation. These interventions were essentially considered for the type of each question asked in the assessment. The way in which these questions were composed was slightly different to match the video manipulation and to be thought-provoking to the participant. The multiple-choice style in the assessment also replicated the type of questions asked within the VEQ for validity of instrument. The type of knowledge of assessment items were applying the four categories discussed in Chapter 2: FG, RG, RI, and UG. Categorization of the questions is included in Appendix L. The embedded questions were instructionally designed to Tell, Show, Ask, and Do (Merrill, 2009). ‘Do’ is an instructional event that
happens by completing an unfamiliar task, or by solving a new-situation problem. 

Solving a new-situation problem was what ‘Do’ representing in this study. Participants were asked to solve specific new-situations via UG and FG embedded questions.

Validity of outcome expectation items in the assessment. Each question in the assessment test was immediately followed by an outcome expectation item: ‘How confident are you that you chose the correct answer?’ giving a scale of up to 100%. This outcome expectation item was based on the self-efficacy assessment guidelines by Bandura (2006). The treatment of self-efficacy, however, is strongly related to a specific distinction that Bandura (2006) has made: “The outcomes people anticipate depend largely on their judgments of how well they will be able to perform in given situations.” (p. 309). Therefore, the participant’s cumulative answers to outcome expectation add up to a total self-efficacy percentage. In other words, self-efficacy is equivalent to the average of outcome expectation items. It is essentially-required to note that self-efficacy is somehow distinct from confidence: confidence is a broad notion and self-efficacy is a specific one (Bandura, 1977; Seifert, 2004).

In addition to the assessment part, the focus group meeting has also consisted of questions regarding the previous participants’ self-efficacy (Appendix E). Bandura (2006) indicated that phrasing self-efficacy assessment items should be in the form of ‘can do’, not in the form of ‘will do’ (Bandura, 2006, p. 308). For example, one of the self-efficacy questions in focus group was: ‘Were you confident that you could answer all questions correctly in the assessment?’. The answer to such question illustrated the overall self-efficacy experience.
Translation of the Questionnaire

To bring the questionnaire content into an authentic setting, which is sought to properly apply for Middle Eastern graduate students, it needs to be translated two times using the double translation method for validity (Presser, 2004). The questionnaire was translated from English to Arabic for the first time by the researcher and a bilingual translator. Then it was re-translated back to English by another bilingual person to insure the clarity of instructions and correctness of verbs, objects, and grammatical structure.

Each participant used the questionnaire form in Arabic translated to English as well, due to the fact that Arabic is the main spoken language in Jordan, and English is the second one (Ethnologue, 2015). The researcher facilitated and insured that all participants were receiving their questionnaire forms, to provide help with understanding the content if needed, and to troubleshoot any technical problems during the video screening and tests.

The Pilot Study

The work on this research was gradually developing to insure proper outcomes, hence the researcher planned to conduct and use pilot study as a prop to better craft the final format of instruments. As stated by Wiersma (2000) in regards to preparations of studies, the pilot study is usually run with 5 to 10 participants, but can rarely be with more than twenty participants. Light et al. (1990) stated that if researchers face difficulty in explicitly specifying a certain design feature, then they should consider testing their research concepts in an exploratory pilot study. They added that a small-scale pilot study
is the way to assisting the organization and development of a larger, more coherent and advanced study (Light et al, 1990).

In Fall Semester 2015, and out of a personal effort, the researcher has conducted a pilot study that was basically designed to accommodate and investigate the interaction of 8 participants. The participants were responsive and collaborative, and the test was applied on them individually by conducting online interviews via Skype (2015). Each participant was asked to watch either a LV video (either Clip 1 or Clip 2 provided in Appendix C) or watch VEQ designed and produced using Rapt Media (2015) (either Clip 3 or Clip 4 provided in Appendix C).

The participants have watched the material that was assigned to them while being observed in the video call, and have also answered some questions directly to the researcher. All participants agreed to be recorded on screen using a screen casting recorder (Screen-Castomatic, 2015) for documentation purposes. Four participants were assigned to watch the same LV video (Clip 2 of Appendix C), and four participants were assigned to watch the VEQ one (Clip 4 of Appendix C). After watching these videos, the participants were asked to answer each item in the assessment related to each version. Finally, the researcher asked the following additional questions:

1. Mention the tips that you have just learned from the video and explain them briefly. Were you certain and confident of your answers?

2. In your opinion, and based on the version you saw, what are the advantages and disadvantages of using embedded questions?
The preliminary results and findings of the pilot study showed that the participants who watched the LV videos have mentioned and explained an average of 6 tips out of 10, which is equivalent to 60% average score. The participants who watched the VEQ video were able to mention an average of 9 tips out of 10, which is equivalent to 90% average score. The difference between both results indicates that embedding multiple-choice questions with prompt feedback have helped learners in recalling and illustrating the tips they have learned, due to more cognitive processes involved in remembering the mistakes and correct answers, and reading the feedback that prompted out of each answer.

In addition, participants of VEQ averaged 88% in self-efficacy, whereas participants of LV averaged 45%. Rounding up the average numbers, participants of VEQ video showed more confidence and certainty in their answers, surpassing the participants who watched LV videos with 1:2 rate; for every 1 highly-certain answer by participants of LV experience, there were 2 highly-certain answers by participants of VEQ experience.

The advantages of having embedded questions in videos varied from making the concepts ‘easier to understand and remember’ to making the video more engaging and ‘enjoyable’. The participants who watched VEQ indicated that continuously asking questions after each segment in the video aided the process of memorization, and helped them later in applying these perceived tips and concepts into new examples when asked about them in assessment questions. However, participants also indicated that having embedded questions changed their perspectives about educational video in general, and
expressed some frustration caused from the load of information and challenging ideas presented at some points of the video.

This pilot study has dramatically widened the researcher’s perceptions and thoughts about conducting studies, and developed research skills with hands-on experience. To moderately and punctually improve the research, the researcher has taken the findings of the pilot study into consideration, and developed the questionnaire items by distributing them among other PhD members and sharing them with colleagues from The Patton College of Education at Ohio University. The colleagues' input and feedback, along with notes from the dissertation committee members, have thriven this research.

**Summary**

Sometimes the simplest questions have the most amazing answers. This research started with a simple question that occurred to mind, when the researcher used video tutorials for learning strategic and statistical functions in SPSS program on YouTube: how do these videos help in learning?

The way to answer this inquiry is to design and execute a proper methodology. In this chapter, the researcher presented the sequential explanatory approach from a basis of mixed-methods in educational sciences – experimental and non-experimental approaches were explained. The research design was demonstrated by indicating the variables of the study, defining the population, mentioning the sampling procedure, explaining the instruments, and clarifying the scoring procedure. Finally, the validity of instrument was justified and a pilot study was shared to complete the comprehensive vision of measurement and data collection.
Up to this point of the dissertation, the researcher has justified the most important element of the research, which is the alignment between the research question, the gap in the reviewed literature, and the methodology. By reviewing the literature and significance of the methodology, and what it adds to the multimedia learning in general and to the embedded questions studies in specific, the researcher has come to firmly realize the importance of conducting this study that illuminated the usage of a brand-new technology, which was the embedded questions system in educational videos.
Chapter 4: Findings

The results and findings are presented in this chapter. The three research questions were addressed here:

1. Does VEQ with confirmation feedback and post-AQs improve comprehension compared to LV?

2. Does VEQ with confirmation feedback and post-AQs improve self-efficacy compared to LV?

3. What are the advantages and disadvantages of using embedded questions in a video that is instructionally designed to tell, show, and ask?

Quantitative data answered research questions 1 and 2; qualitative data answered research question 3. The total number of participants was 60. Each participant’s input was gathered and processed separately by exporting their answers via Google Forms. The forms were then converted and downloaded as Excel sheets to grade the answers. All answers were compared and graded to a key-answer sheet that was previously prepared.

Additionally, the assessment scores that indicated comprehension, and self-efficacy percentage, were both measured by calculating their average values from both videos for each participant. For example, a participant in the control group watched two Linear Videos (LV): battery life and presentation skills. This particular participant scored 8 out of 10 in battery life topic, and 6 out of 10 in presentation skills topic, hence their total LV experience average was 7 out of 10. The same calculation has been applied on self-efficacy for each participant.
Research Questions 1 and 2: Results and Descriptive Data

In this section, Research questions 1 and 2 were investigated. Research question 1 asked: Does Video with Embedded Questions (VEQ), with confirmation feedback and post-Adjunct Questions (AQs) improve comprehension compared to LV without embedded questions? Research question 2 asked: Does VEQ with confirmation feedback and post-AQs improve self-efficacy compared to LV?

The results reported that scores of VEQ assessments were statistically and significantly higher than the scores of LV for both videos (effect size = 0.916). Therefore, the null hypothesis was rejected; VEQ did promote better learning than LV. Furthermore, based on the statistical comparison between control and experimental groups, it was reported that self-efficacy for VEQ participants was statistically and significantly higher than what it was for LV participants (effect size = 1.24). These two results supported the argument that VEQ promotes better learning than LV by providing learners the ability to interact with embedded questions and feedback.

Comprehension result between groups. Using an independent-samples t test, the researcher compiled the first statistical comparison in order to test the significance of difference in average scores between the control group and experimental group. As shown in Table 1, the test has revealed that the average score for VEQ assessment \((M = 8.77, SD = 1.50)\) was significantly different than the average score for LV assessment \((M = 7.33, SD = 1.70)\). There was a significant impact from embedded questions, \(t(58) = 3.45, p < .001\) with VEQ participants achieving higher scores than LV participants. Cohen’s \(d\) (Cohen, 1977) was measured to find the effect size of this difference, and it
was 0.916. In addition, the test revealed that the average self-efficacy percentage for VEQ answers ($M = 92.40, SD = 5.34$) was significantly different than the average self-efficacy percentage for LV answers ($M = 82.17, SD = 13.55$), $t(58) = 3.83, p < .001$, with an effect size of 1.24.

As indicated in Table 1, there was a probability of 95% confidence that the true difference between the means of average score was CI = [0.602, 2.264], and between the means of self-efficacy was CI = [4.87, 15.53]. These results showed that the difference between both groups’ average scores was unlikely to have occurred due to randomness in sample selection. This difference was more likely to be genuine and significant because:

a) the sample size was large enough, b) the difference between average scores was notable, or c) standard deviation was low, which means that responses and answers were consistently close to the average values and not widely diffused.

Table 1.

*Results of t-tests and Descriptive Statistics Average Scores and Self-Efficacy*

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Group</th>
<th>95% CI for Mean Difference</th>
<th>M</th>
<th>SD</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>n</th>
<th>t</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scores_Avg</td>
<td>VEQ</td>
<td>8.77, 1.50, 30</td>
<td>7.33</td>
<td>1.70</td>
<td>30</td>
<td>0.602, 2.265</td>
<td>3.45*</td>
<td>58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self_Efficacy</td>
<td>LV</td>
<td>92.37, 5.39, 40</td>
<td>82.17, 13.55</td>
<td>40</td>
<td>4.87, 15.53</td>
<td>3.83*</td>
<td>58</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p < 0.05
**Comprehension between topics: battery life and presentation skills.** In order to investigate the correlations between control and experimental groups based on video topics, an additional one-way Analysis of Variance (ANOVA) test has been compiled. This ANOVA specifically tested the significance in average scores between VEQ and LV versions of the same topic: VEQ and LV of presentation skills, and VEQ and LV for battery life. The ANOVA was significant, $F(1, 58) = 8.75, p = .004, \eta^2 = 0.13$ for presentation skills topic, and $F(1, 58) = 7.99, p = .006, \eta^2 = 0.12$ for battery life topic.

There were three main assumptions for using one-way ANOVA test: average scores were normally distributed in each group, observations were independent, and variances were homogeneous. The effect size of embedded questions on presentation skills topic was measured by eta-squared of 0.13, and on battery life topic was eta-squared of 0.12. According to the guidelines of Cohen (1977), these measurements are relatively high, and they provide more information about the statistical changes that can take place in each group (further discussion in Chapter 5).

The mean plots in Figure 12 show the difference of means between both groups among two topics. In this figure, the difference between both VEQ and LV versions happened to be significant in each topic. The distinction between both versions is closely identical in both topics. However, the significance between topics does not provide a straight justification to the hypothesis of this study; it was formulated that the total assessment score was measured by finding the score mean of both topics: VEQ topic 1 added to VEQ topic 2, divided by 2. Same measurements were applied on LV version.
Figure 12. Caption of mean plots from SPSS program: showing the differences in scores between control and experimental groups for both topics.

Finally, the significance of mean’s difference between both topics has been tested using an independent-samples $t$ test. The test has revealed that the average scores for VEQ assessment in presentation skills topic ($M = 8.73, SD = 1.68$) showed no significant difference from the average scores for battery life topic ($M = 8.80, SD = 1.77$). The same comparison was made for LV version of both topics, spotting no significant difference either: presentation skills ($M = 7.30, SD = 2.05$) and battery life ($M = 7.36, SD = 2.14$). These findings lead to a conclusion that regardless of the topic, VEQ average score was significantly different than LV average score.

**Correlations within groups.** In this test, the researcher attempted to deeply investigate additional details about further differences that may have occurred in comprehension results based on gender. The independent variable was embedded questions system (i.e. having post AQs with confirmation feedback). The participant’s
gender, however, was not an independent variable of this study, rather it was added here as an external manipulation to provide a glance at a deeper comparison within the groups, and to enrich the results with a different scope of statistical testing.

In order to investigate the correlation between gender and comprehension, an additional factorial ANOVA test was compiled. The factorial ANOVA specifically tested the significance across two samples from both control and experimental groups. These samples were: male participants and female participants. The descriptive statistics associated with average score across two-gender groups were reported in Table 3 and Figure 15 – both included in Appendix M.

**Research Question 3: Findings**

As this study has been prepared to support the quantitative findings using sequential explanatory approach, the answer to research question 3 ‘What are the advantages and disadvantages of using embedded questions in a video that is instructionally designed to tell, show, and ask?’ was determined using the transcript of focus group meeting. This transcript has revealed connections between the participant’s overall experience, self-efficacy, and instructional design of VEQ.

The focus group partly consisted of some participants from the previous experiments with eight new participants (15 participants in total). They received no tests, but rather they were asked to screen the videos and share their thoughts in an open discussion about the content and the concept of embedded questions, using a semi-structured interview (Appendix E). The additional, new participants were chosen to
examine the perceptions of interactive video from a vivid, novel point of view without taking tests.

Their input data were manually transcribed, thoroughly analyzed, and coded for further analysis using descriptive codes. Then, in order to improve the accuracy, credibility and validity of each participant’s responses, a complete member checking has been achieved. Finally, the coded data were categorized and matched with the findings and scores of the assessments to highlight if any connections occurred. A sample of the transcript is provided in Appendix (K).

Each participant was given a code name in this format: P (Xx), where P stands for participant and (Xx) are the first two letters of his/her name. During the discussion, some points were agreed upon by some members of the group. The researcher has collectively put their code names with each of these points. For example, 14 out of 15 participants indicated that videos are useful learning aid; so their codes were also mentioned with that point to indicate the conformity of their answer in a surveyed manner (See Appendix J).

The researcher completed the task of summarizing and translating the transcript, and finally defining concrete examples that fall into certain coding categories. Thus each category had its own colored label. In addition, the timing of answers and some extra dialogue notes were written vertically on each page.

**Experience.** The experience of participants consisted of several aspects, such as the overall usage in experiment, control over video, memory rehearsal, and self-efficacy:

**Usage of instructional videos.** The participants were asked first about their video experience in daily life. There were 14 out of 15 who have indicated that interactive
video is useful method of learning. The participants asserted that they used instructional videos later in the graduate level, not during undergraduate study. The reason was due to the lack of video popularity in general; online videos were uploaded to YouTube mainly for entertainment and sharing purposes (Haitao et al, 2014). Participants mentioned that it took some time to see new videos being produced for educational purposes and for a variety of topics in science.

One of the participants, namely P (Sa), expressed that she did not prefer instructional videos as a learning tool, emphasizing that text books were better for studying regardless of what the topic was. Most of the participants used instructional videos during their graduate studies, and most of these videos were screencasts that taught programming skills, financing, social media promotional techniques, and new technological trends. However, P (Sa) said:

No, I prefer to read books. Books give me the ability to imagine and reach to more specifics ideas or concepts that cannot be found in any online video. You can put marks on the text book to follow up with certain points, but you cannot highlight or put yellow marks on a video. This gives a better way to follow the details than a video in many cases.

The rest of participants realized that through ‘visualization’ videos can help in learning complex concepts and mechanisms.

**Learner control over embedded questions.** In terms of learner control, 13 out of 15 participants found VEQ an enjoyable learning experience, and deemed it as a game. They commented that having multiple-choices with multiple-trials led them to treat VEQ
as a gaming experience. And 9 out of 15 participants pointed out that it was easy to figure out what was happening after getting into the first question of VEQ. As for the LV videos, it was obvious how to control them. LV videos were playing on a YouTube platform, and YouTube is very common and easy to use (Roodt, 2013). VEQ was playing on Rapt Media (2015) platform, which was fairly new. But nonetheless VEQ was easy to control – none of the participants faced any technical problems in using embedded questions treatment. The total experience length of each video was 6 minutes.

Alternatively, some participants expressed that embedded questions were thought-provoking and overwhelming at some spots of VEQ. Specifically, these overwhelming spots were pointed out by participants between minutes 2:00 and 3:00 of battery life VEQ, and during the last minute of presentation skills VEQ. Three out of fifteen participants found embedded questions interrupting their thinking and distracting attention with the presented video material at these spots. One of these participants, P (No), said:

I would never forget this experience because it was the first time in my life I use video with embedded questions. It was thought-consuming and overwhelming at some points.

**Memory rehearsal.** Regarding the memory rehearsal benefit from embedded questions, one of the participants shared a special case, which was the deficiency of vitamin B-12 that caused memory weakness (Growdon, 2015). This particular participant, P (Kh) said:
I have a health problem, which is lacking vitamin B-12 in my blood. I easily forget many things in daily life. But I found VEQ very helpful. VEQ trained me to keep remembering the information, especially in the battery life video. Despite not being interested in a topic like this, I managed to remember most of the information presented about preserving the laptop’s battery life. I like to watch videos online for long hours, and eventually I forget many of them by the end of the day. But with embedded questions in VEQ, I still remember many of the ideas and points I have learned from both topics.

In addition, 10 out of 15 participants have found embedded questions very helpful in recalling information at later time, saying “When we used to study, it was mostly memorization of the information regardless of whether we understand the reading or not. That was mostly the case back in our schools in the Middle East region”. Therefore, a typical Middle Eastern student tends to memorize information in order to pass the exam. Once the exam is complete, the student forgets most of what they memorized. From this point of view, participants assured that VEQ was far away from indoctrination, because it linked the information with audio and visual elements, challenged the concepts they already know, and provided new facts and applications.

**Confidence.** The last note about experience was related to the attitude of each participant towards VEQ and LV, specifically their confidence and self-efficacy. The 7 previous participants expressed their experience regarding the total confidence they have gained from embedded questions, “We wanted to choose 100% on many of the questions,
but it was hard to pick 100% unless you were really confident about the answer. VEQ provided much better test experience than LV”.

To evaluate the total experience, 8 out of 15 participants attributed the joy of learning to the background knowledge. These participants thought that background knowledge had a huge role in performance and interest in instructional video, regardless of the topic and version whether it was VEQ or LV.

**Self-efficacy.** “I think it depends on people. All people can imagine, but not all people can visualize. Some prefer to read texts over watching. These preferences define how far we can read or watch.” Said P (Fe), summarizing most of the inputs and answers provided by participants regarding self-efficacy. All participants recommended applying and developing VEQ in schools and universities – they were also willing to repeat the embedded questions experience again.

**Effects of technical aspects.** Some technical features of embedded questions were found to be helpful for participants while interacting with the videos, while some others were adding more redundancy. Four of the fifteen participants found that the first embedded question in both VEQ videos was prompt and somehow unexpected. But once they have answered the question and proceeded to the next one, they realized the pattern and how the video actually worked.

Regarding familiarity, 10 out of 15 participants have felt that because VEQ was shown on a different platform (Rapt Media), which was not a common tool, they needed to know more and explore what Rapt Media was. Getting familiar with the main platform
may have reduced the anxiety in the beginning of both VEQ videos, these participants inserted.

P (Sa) elaborated, “Embedded questions are distracting to me. When I watch a video, I like to watch it completely in one shot without any interruptions.” This opinion has intervened with the discussion about self-efficacy, hence participants started to connect between the concepts of VEQ versus LV in terms of their instructional design and add suggestions to refine the videos.

**Designing videos to maintain self-efficacy.** Based on a suggestion to refine the instructional design of VEQ, 11 out of 15 participants preferred having questions that give the user a straight feedback, then go back directly to the same question to try one more time, rather than watching the last scene again. This way, based on participants’ suggestion, the VEQ version would raise the sense of challenge. The student would try to think and solve the problem without having to go back to watch the latest scene again.

The participation in experiments was found to be effective, challenging, but overwhelming to some extent. In this regard, 5 out of 15 participants, who were also previous testers, have expressed their feeling towards participating in the experiment:

We felt like taking an exam 4 times: 2 times while watching both VEQ topics, and 2 times in the assessments after watching them. And that raised the anxiety in us, because exams develop tension and pressure.

Based on a suggestion to maintain and improve student’s behavior towards VEQ, 12 out of 15 participants indicated that it would have been better to replace the ‘ding’ sound of correct answers with a point system. Participants strongly believed that reward
by collecting points (and knowing the current total score) can raise the hype of challenge, establish a sense of gaming, and strengthen self-efficacy.

**Interest, anxiety and background knowledge.** All previous participants (7 out of 15) indicated that the battery life reservation was not an interesting topic to them. They agreed that the lack of interest has created a challenge for them against watching the uninteresting topic, and reduced their efficacy to succeed in its assessment. They also agreed upon the following:

We were not confident about some questions in both VEQ and LV, which reduced the efficacy level on other questions. For example, when we picked an answer for question 5 in battery life assessment, the level of confidence was relatively low for that answer (average of 50%). This low confidence feeling kept following us immediately in the next question (question 6) and affected our confidence percentage too. The confidence percentage of each answer has revived when multiple confident answers were chosen sequentially.

All participants (15 out of 15) agreed that, “The fear of failure drives us all not to fail.” It is culturally common in the Middle East that individuals need to avoid the shame of failure. Therefore, this type of feeling might be the main motivation to try to succeed in VEQ and LV. Previous participants articulated the reason their first reaction after finishing the experiment: ‘Did I pass?’ was due to the desire to succeed.

**Instructional design and technical suggestions.** “Perhaps videos can give you - as a user- a main/general idea or a process in a nutshell. But if you want to get into more details, and find more about a certain concept or topic, then these details can be found in
text books.” Said P (Mu), who was the first to insert their comments on the way VEQ and LV were instructionally designed. P (Ha) and P (Sa) then added that highlighting and marking certain points in the video could be a beneficial tool, like the way students read and mark on text books.

The general impression about the instructional design of embedded questions system was positive. There were 13 out of 15 participants who agreed that, “When VEQ proceeds, the student would realize how user-friendly it is.”

**Interruption and timing.** There were 3 out of 15 participants who felt that embedded questions continuously interrupted their thinking, and avoided them from focusing on the presented material at some points of each VEQ. They added that some embedded questions guided them to think and focus about specific details, and also made them forget about/miss some others. Nevertheless, all participants agreed that rather than having to indoctrinate students with information in a traditional way, VEQ can be used as an “entertaining tool for memorization.”

P (Li) pointed out that they have seen some video models that used embedded questions technique too, and these models were noted as effective tools for giving some ‘free spots’ in the video, such as fading-out screen, random scenes with background music, and time-lapse. These free spots were inserted in these video models in order to help the student digest and process the information, take notes, re-think about what is being presented until the moment and then proceed with the next section.

One participant, P (Om), has realized and brought attention to the VEQ version of battery life topic, and pointed to a scene in between two embedded questions where there
were only two sentences. Popping another question after two sentences (nearly 10
seconds) was a very short time to watch and follow up with. Participants added:

Perhaps a lecture video, say 20 – 30 minutes, would be a better application for
embedded questions. It can also handle embedded questions in a quiz. For
example, consider a 30-minutes long instructional video. After 2 to 3 minutes of
the total video, give an embedded quiz that consists of few embedded questions
shown up together, and also give students the ability to repeat or re-watch the last
2 to 3 minutes. We think this is a better way to handle and treat memorization.

Adding more suggestions to refine timing for and interaction with embedded
questions, 5 out of 15 participants thought that note-taking is a traditional method of
education; video is non-traditional method of education. They added, “Note-taking is
suitable when you are sitting in a meeting or class room with 10 people; everyone is
talking and exchanging ideas; so you need to follow up and keep with the flow of what is
being discussed. But in the case of video, it is one-to-one communication.” Note-taking,
as asserted by these participants, may have worked with VEQ only if it was long enough,
and had some spots where a student can write key words and terms on their note paper to
remember their extended ideas afterwards.

*Error treatment and feedback.* Some notes were given by participants about the
sounds used in VEQ. There were 3 out of 15 participants who found the voice of error
louder than the rest of sound effects and music. However, the sound of correct answer
‘ding’ was found to be moderate and acceptable.
Automatic repeating of the scene after each mistake was not well-received by most participants. As 11 out of 15 participants said:

The idea of automatically repeating the scene after a wrong answer is not accepted. We would prefer having the questions giving you a straight feedback, then go back directly to the same question to try again rather than repeating the last scene. Another option: give an alternative choice (on the corner of the screen) to the student whether they want to repeat the last scene or not.

**Variations of confidence during videos and assessments.** In accordance with self-efficacy discussions, all previous participants (7 out of 15) wanted to pick 100% on many of the questions’ confidence level, but it was difficult for them to pick 100% unless they felt fully-confident about the answer. Previous participants asserted that VEQ gave a better test experience than LV. In LV, they had to remember the whole video as a package in order to process the information, and find and pick the correct answer(s) for assessment items. While in VEQ, some assessment items were familiar to them because they asked about the same points that embedded questions were asking about.

**Suggestions and recommendations.** Table 2 is enclosed in Appendix K, and it outlines the collection of technical and instructional suggestions made by the focus group participants. These technical and instructional suggestions are provided with number of participants who agreed on them, along with an explanation to better illustrate each item.

**Summary**

This chapter presented the results of experiments on two comparative groups. The statistical part was provided to answer the research questions about comprehension and
self-efficacy of participants among VEQ and LV. The qualitative part was descriptive and explanatory, hence it has explained the relative merits of embedded questions experience, and extended the implications of results to include self-efficacy and instructional design of the video material.

In general, the researcher has found that interactive video diversify education and illustrate concepts well. Video was commonly and widely used in the participants’ daily life, but with basic time controllers only. Participants were introduced to a new system that they have never tried before: the embedded questions system, which engaged them in a highly-interactive experience. With embedded questions, a higher degree of learner control over video was available, and participants expressed their experience by confirming the need to provide more time to follow up with questions and instructional events. All these statistical results and qualitative input were analyzed taking into consideration the cognitive abilities and educational settings during the experiments. A discussion of the results and findings about embedded questions system follows in the next chapter.
Chapter 5: Discussion

In this chapter, the researcher cohesively brings together all the basics and aspects of this study. The main objectives of Chapter 5 are to return to the original problem statement in the same order of research questions, to offer the researcher’s interpretation and reflection of the results, to discuss the strengths and weaknesses of embedded questions, and to provide recommendations for studies to come.

This study supports the hypothesis that Video with Embedded Questions (VEQ) promotes learning better than Linear Videos without Embedded Questions (LV). Specifically, the results indicate that VEQ, having confirmation feedback and post-Adjunct Questions (AQs), improves comprehension compared LV. Additionally, VEQ improves self-efficacy compared to LV. Several advantages and disadvantages of the instructional design of VEQ and LV have been discussed through focus group, and the findings indicate some relative merits that should be taken into consideration for future designs of educational videos.

Effect sizes are found to be related to the usage of embedded questions and levels of self-efficacy; they are unrelated to the topic of video or participant’s gender. The effect size of embedded questions over assessment scores was 0.916 and over self-efficacy was 1.24. Participant’s gender, however, showed no significant difference in ANOVA test, hence the effect size of gender is irrelevant. The embedded questions system had an effect size measured by eta-squared of 0.13 for presentation skills topic, and eta-squared of 0.12 for battery life topic – both were large effect sizes according to the guidelines of Cohen (1977). Neither assessment nor self-efficacy differences within experimental
group (VEQ version) and within control group (LV version) were statistically significant. These statistical results lead to a conclusion that regardless of the video topic, VEQ average scores were significantly different than LV average scores.

According to the results of assessment scores, a Cohen's d of 0.916 means that there is a 74% of superiority, which is the chance that if a participant was randomly picked from the VEQ group, they would have a higher assessment score than a participant randomly picked from LV group. In this case, Cohen’s U₃ is 0.83, which illustrates that 83% of the experimental group (VEQ participants) have scored above the mean of the control group (LV participants). However, 65% of the two groups have overlapped. Moreover, in order to have one more favorable outcome in VEQ compared to LV, the study needs to treat 3.1 more participants.

**Research Question 1: The Effects of Embedded Questions and Confirmation Feedback on Comprehension**

**Review of learner control and mathemagenic activities.** Comprehension was measured by assessments. In response to the first research question, the results indicated that embedded questions in videos had a positive impact on the participants’ overall performance; VEQ participants had a significantly higher scores average than LV participants. This result represents an answer to Research Question 1 in a way that concurs with, and can be reviewed under the scope of two main concepts, they are: learner control over video, and mathemagenic activities.

**Learner control over video.** The effectiveness of learner control by using video as a medium (or tool) to study the embedded questions strategy of learning, was one of the
considerations in literature review. With VEQ and LV, the researcher was able to arrange different levels of user (i.e. learner) interaction and control. At macro-level control, the learner is able to choose whether to have VEQ or LV (Shyu & Brown, 1992; Williams, 1996); that is having videos presented with embedded questions and confirmation feedback, or not having them at all. The participants in this study were not given that type of control. At micro-level control, the learner is able to interact with embedded questions and feedback within the interactive courses (Williams, 1996; Collazo et al, 2012). The participants of this study were given that type of control. The results indicate that micro-level control, enhanced with embedded questions, can make a difference in comprehension.

Giving higher level of control to the learner can enhance learning, due to the concept of attenuation and balance between instructor and learner (Shyu & Brown, 1992; Collazo et al, 2012; Merkt & Schwan, 2014). Instructors can attenuate the degree of learner control, which is particularly the amount of control a student should have over instructional material (Williams, 1996). Instructors may use interactive videos since they are capable of containing and utilizing micro-level control. Video, as an interactive and controllable multimedia, is an educational tool that affects learner control and other mental and cognitive processes (Merrill, 1980; Vural, 2013; Merkt & Schwan, 2014; García-Rodicio, 2015; Rapt Media, 2015). And with interactivity in videos, designers and instructors can create instructional videos with more micro-level control functions, in relation to the studies of mathemagenic activities (Rothkopf, 1966; Rothkopf & Bisbicos, 1967).
Mathemagenic activities. They are the set of actions, sequences, or events that make learning happens (Rothkopf, 1966). Specifically, the study of mathemagenic activities investigates the learner's actions that are essential to the completion of pre-determined objective(s). These actions, as concluded by Rothkopf (1970), have been called: “set, attention, orienting reflex, information processing, cognition, rehearsal, and so on.” (p. 326). The mathemagenic activities term has broad boundaries within which these acts can fall. The benefit of using embedded questions and confirmation feedback in videos may be related to the increased amount of control to the learner, but it is strongly-related to the mathemagenic activity that was stimulated by the videos. The mathemagenic activities were stimulated in this study by the implementation of post Adjunct Questions (AQs). Embedded questions are those post-AQs supported by a confirmation feedback scene. Post-AQs played role in enhancing the participants’ comprehension, by integrating the position and type of AQs, and synchronizing the proper feedback after each answer. In addition, these questions appear to have:

- Acted as memory rehearsals, which supports Rothkopf (1966), Landauer & Ainslie (1975) and Glover (1989).
- Helped in improving self-efficacy by reciprocally interacting with it, which supports Bandura (1986) and Collazo et al. (2012), p. 906.
- Influenced the selection mechanism in participants, which supports Reynolds & Anderson (1982), p. 17.

Position and type of questions. Results were tackled and reviewed from the perspective of question’s attributes: position and type.
Position of embedded question. Participants took benefit from using embedded questions. One of the reasons behind that benefit is the utilization of backward and forward effects (McGraw & Grotelueschen, 1972). Typically, the literature of text comprehension (Rothkopf, 1966; Hamilton, 1985) suggests that backward effect occurs when post AQs prompt the learner to read the previous paragraph(s) again in an attempt to review and search for specific details related to the post AQ itself. The learner is then mediated, prompted to have more attention, and gets stimulated to focus on the passage(s) to come – forward effect happens.

The embedded questions used in this study were actually AQs inserted after the pertinent video segment (i.e. a video segment – post AQ stream). This study found some indications about how post AQs affected the learner’s memorization and application process. The results accordingly suggest that the same concept of backward and forward effects may have happened while interacting with embedded questions:

- Backward effect: Post AQs enable the learner to build a vivid, yet cohesive mental picture of the video segment that was previously shown (McGraw & Grotelueschen, 1972; Mayer, 2009; Valdez, 2013). Reviewing and focusing may have strengthened the mental picture in participant’s mind; they had to formulate a network of relevance to recall the required information. Corresponding and relevant images, text, music and animation support the building of another mental picture that adds to a more coherent mental process, and helps learner to better memorize the information (Paivio, 2007).
• Forward effect: Post AQs encourage learners to be more attentive to details and focus on material relevant to the question (McGraw & Grotelueschen, 1972; Valdez, 2013). Knowledge transfer takes place when the learner activates pertinent connections between their prior knowledge and the presented concepts (i.e. video material before AQ) and then generates a unique knowledge conclusion to pick an answer to the post AQ (Mayer, 2009). Choosing an answer itself, however, is a problem-solving process that could overlap between backward and forward effects (McGraw & Grotelueschen, 1972).

*Type of embedded questions.* Some participants from the focus group expressed that embedded questions were thought-provoking and overwhelming. Three out of fifteen participants found that embedded questions interrupted their thinking and distracted their attention with the presented material from the video:

I would never forget this experience because it is the first time in my life I use video with embedded questions. It was thought-consuming and overwhelming at some points.

This observation was first related to the lack of time dedicated to recap information and answer some questions, especially the application embedded questions. The use of embedded questions in this study did not support the time-on-task measurement, which could be one possible explanation for some wrong answers chosen by participants. The researcher has controlled time by giving 12 seconds to the participant to answer each embedded question. This amount of time was given to allow the participant to do 4 steps: 1) read the question, 2) read the choices, 3) do problem-solving,
and 4) pick an answer. If the dedicated time was equally-divided upon these 4 steps, then each step would have 3 seconds. The reason for dedicating specific amount of time was to control time-on-task and make it constant, and to increase the challenge/difficulty of embedded questions. The participants may have felt that there was no enough time dedicated to prepare an answer, especially in the more difficult application questions.

This feeling of thought-consumption and overwhelm, as previously stated by a participant, can be attributed to two reasons: 1) the mix of memorization and application embedded questions used in each VEQ topic, and 2) the absence of note-taking. Having a mix of memorization and application embedded questions throughout the VEQ material may have had required extra mental efforts to process the information (Mayer, 2003; Mayer & Moreno, 2003) which lead to discomposing some participants. But because of the richness in instructional material used in video, all four levels of embedded questions were applied, they were: Find a Generality (FG), Remember a Generality (RG), Remember and Instance (RI), and Use a Generality (UG) (Merrill, 1983). The interaction between type, position and level of learning in AQs have been found to be significant in learning outcome (Rickards, 1976; Andre et al, 1980; Darwazeh & Reigeluth, 1982) and it could be the reason why most participants found embedded questions useful and effective for their learning experience.

If pre-AQs (embedded questions inserted before instructional segment) were used, they may have been more effective when based on RI or RG types (Rickards, 1976; Andre et al, 1980; Darwazeh & Reigeluth, 1982). In the case of this study, post-AQs were used. They applied all types of question: FG, RG, RI, and UG. And based on the
results, improvement on learning outcome can happen when all types of questions are applied as post-AQs, not when only FG and UG are applied. The experiments of Andre et al. (1980) and Darwazeh & Reigeluth (1982) supported the use of FG or UG as post-AQs, and now this study extends the use of post-AQs by adding RI and RG types.

If note-taking was part of the measurement, then the performance of participants and their comprehension may have been improved, particularly because embedded questions were relevant to the previously shown sections. Perhaps the participants expected to have some papers and a pen to write their notes while watching the videos. Another explanation is that participants have limited capacity of the cognitive load (Sweller, 1988; Sweller et al, 2011), which leads to the limitation of effort allocated to note-taking, and rather allocate most of the cognitive effort to answering embedded questions. If more time was given to answer each question, then a participant would have allocated more effort to problem-solving, which could have led to a better comprehension (Prater, 1992; Vural, 2013). In which case, time-on-task should be reset to a larger constant (e.g. 8-minutes total experience instead of 6-minutes) or to be set as a variable.

In addition to note-taking, extended time, and learning level-integration, the principle of segmentation (Mayer, 2009; Clark & Mayer, 2016) could be designed and applied more properly to maintain cognitive load in participant’s mind, especially at the spots of VEQ that were found to be overwhelming and thought-consuming (Chapter 4 - Experience). For these reasons, future research may consider studying the adjustment of cognitive efforts which are allocated to note-taking and problem solving while using a
multimedia like VEQ. However, extending the time for participants to answer embedded questions can vary depending on the length, type, difficulty and position of the question.

**Confirmation feedback effect.** Having confirmation feedback after each embedded question was praised by all participants in the focus group. Providing feedback right after choosing an answer helped the participant to confirm or re-assure their information if the answer was right, and also helped in correcting, giving hints, explain errors if the answer was wrong. Both works of Hamaker (1986) and Rickards & Di Vesta (1974) conclude that inserting AQs near the instructional material and having them occur more frequently are more likely to aid as a facilitative strategy to help learners.

In this study, having embedded questions after each section in the video facilitated participants to recollect and remember the presented information. The confirmation feedback may have facilitated learning by correcting the errors or re-assuring correct answers. Confirmation feedback was presented as a short scene of 7 seconds, containing an expressive picture with a text that elaborates the wrong answer. Participants may have been challenged to review and re-think about their wrong answer(s), and also been encouraged to be more attentive on the previous section when it was repeated. In case of correct answer, the confirmation feedback was an animation of check mark with a ‘ding’ sound effect. Providing a positive feedback like this one improves the participant behavior (Andre & Thieman, 1988) and helps raising their self-efficacy (Collazo et al, 2012). However, confirmation feedback may not always facilitate concept learning, due to the fact that correct answer feedback and self-correcting feedback are limited to the way embedded question was written (Andre & Thieman,
In which case, participants of this study may have benefited from confirmation feedback by influencing their performance to better act towards a specific question, not to the whole learning material.

**Research Question 2: The Effects of Embedded Questions and Confirmation Feedback on Self-Efficacy**

The results of this study showed that self-efficacy was improved by using embedded questions and confirmation feedback. This answer to Research Question 2 clearly offers an opportunity to further investigate the psychology of learner before, while, and after interacting with VEQ and LV.

Self-efficacy was considered part of the learning experience. However, this consideration does not mean that the higher self-efficacy leads to a better comprehension. Only higher scores of assessments were taken as an indication of comprehension, due to the fact that participants may have had better feeling towards VEQ, but they have not learned much from watching and interacting with it (Boster et al, 2006, p. 58; Collazo et al, 2012, p. 905).

On the other hand, the researcher reviewed assessment scores of 7 participants from the focus group, and found that 2 of the 3 participants who expressed thought-consumption and overwhelm caused by embedded questions have actually scored high in comprehension and self-efficacy as well. Despite the negative feeling they have developed towards embedded questions at some points, they managed to accomplish a high comprehension. This can be related to their fundamental high self-efficacy characteristic (Bandura, 1977). And since self-efficacy is equivalent to confidence levels
(Seifert, 2004), then higher level of self-efficacy may have been caused by: the nature of participants as adult learners, impacts of emotional and motivational aspects, or prior knowledge.

**Adult learners.** The participants of this study were adult millennials. Both VEQ and LV versions of the videos were built, personalized, and customized to provide a suitable educational experience for adult learners, and to give them an amount of control over videos. The control contained: pause, play, stop, rewind, forward, minimize, maximize, and clickable embedded questions. Most VEQ participants of this study did not use any of the time controllers and preferred to interact only with embedded questions. The interaction of these adult learners with VEQ and LV brings attention to their characteristics that explain their educational experience.

Developing multiple types of Computer-Based Instruction (CBI) in distance learning is important (McGrath, 1992; Williams, 1996; Mayer, 2003), because more complex lessons can be explained and delivered via CBI, allowing instructors to educate learners in a more profound way. Even learners who are unable to attend classes are given the chance to distance-learn through CBI schemes. CBI has been continuously developed to reach the level of interactive multimedia learning. Interactive multimedia use pictures, words, audio and animation to represent and deliver the instructional message. This instructional message is capable of responding to the student’s actions (Mayer, 2009). Students, as suggested by Mayer (2009), can achieve deep learning by building a mental model that simulates in the instructional message.
Interactive video with embedded questions is an example of the interactive multimedia learning. With the abilities of interactive videos, instructors and researchers can collaborate to build individualized and self-paced instruction to match the adult learner’s preferences (Zimmerman, 1990; Ouwehand et al, 2015). For example, a video design can be enhanced by including multiple gestures to investigate their effectiveness on adult learners, as Ouwehand et al. (2015) showed in their study. Adult learners are self-paced, self-regulated and motivated learners (Knowles, 1990). The self-regulated learning is undergoing a deeper research to formulate greater links between customized tools (i.e. embedded questions and multi-modal tools) and a growing body of literature on multimedia in general (Zimmerman, 1990; Kim et al, 2015).

Having adult millennials, the constructivist paradigm (Knowles, 1990; Zimmerman, 1990; Jonassen et al, 1993) can also provide much-needed theoretical framework to explain the results of using embedded questions strategy in instruction, which clarifies the path of knowledge acquisition measurement of this study. Embedded questions were indicators of problem-solving process, while assessment items have captured the learning progress of the participants. Assessment scores were indicators of how much adult millennials can comprehend from embedded questions. Comprehension consists of contrasting, relating, processing and understanding the audiovisual information from the video, then preparing it for recall and use at later time (Bloom et al, 1956; Bloom et al, 2001). Adult millennials in this study are independent learners who witnessed the shift from digital immigration to digital citizenship, and it is a central
aspect of video-based learning that their learning style is mainly based on constructivism approach within online, distance learning (Keengwe et al, 2014).

A notable amount of studies (Mayer & Anderson, 1992; Mayer & Sims, 1994; Vural 2013; Merkt & Schwan, 2014) were conducted with theoretical basis that consists of the cognitive load and constructive learning, which are both contextualized for student-centered education. This study investigated and reviewed video as a medium of learning, from which came the need to partly analyze the data and relate it to constructivist approach of knowledge acquisition. But with the rapid advancement of video technology in specific, this research is mainly focused on the strategy of embedded questions as a new amendment to video-based learning. For this reason, researchers are encouraged to investigate more about constructivist approach in videos with embedded questions.

**Gaming and active learning.** Many participants praised the use of embedded questions and noted that it was an enjoyable learning experience, and described it as a ‘game’. These participants commented on VEQ experience that having multiple-choices and multiple-trials made them treat embedded questions as a game of points. They have also thought that replacing the ‘ding’ sound of correct answers with a ‘Points System’ could have raised their excitement and motivation. This observation leads the researcher to consider Gamification as an explanation to excitement. Gamification, first used for skills development purposes by Coonradt & Nelson (1985), is the term used to describe the involvement of games in education especially for children and youth (Ejsing-Duun & Karoff, 2014; Gamification in Education and Libraries, 2015). The idea of learning
something new, failing, and trying again lies at the heart of what Gamification is (Ejsing-Duun & Karoff, 2014), and it has so much to offer to enrich the learning process. Education—in general—is highly encouraged to include enjoyment through games. Video games in general are designed to activate multitasking function. The gamer can do voice chat, text chat, operate a character, manage short-term and long-term objectives, and operate interruptions and mechanisms simultaneously (Crawford, 2012). Also, in a learner-controlled setting, the involvement and achievement of learning outcomes increase (Williams, 1996; Choi & Johnson, 2005). Research have found that the challenging nature of video games ignites creative thinking and improves reasoning (Cicchino, 2015), but is that the case for adult millennials in this study?

The trend of Gamification is one of the primary forms of entertainment for millennials (Eichenbaum et al, 2014). Adult millennials are part of the gaming culture (Anguera et al, 2013) and they have self-determination (Deci & Ryan, 1985) that motivates their desire to set and modify learning pace. Anguera et al. (2013) found that playing games for an average of 12 hours per week, and over the course of a month, has improved adult gamers' multitasking abilities. In addition to the study and measurement of multitasking, the sustained attention and the working memory abilities of adults have been noticed to be improved as well (Anguera et al, 2013).

Is VEQ a type of game? Yes, it includes challenge, repetition, scoring and customized experience—these are basic elements of the video game (Crawford, 2012). Gaming mechanics in interactive videos can be a powerful tool to reshape the brain. Not only skills of adult learners can improve by gamification in interactive videos, but the
activities of pre-frontal cortex of the brain are improved too - the area associated with cognitive control (Anguera et al, 2013).

Adult gamers learn something from playing games at their own control with less guidance from an instructor (Eichenbaum et al, 2014). For instance, Eichenbaum et al (2014) suggest that a learner produces a certain amount of neurochemicals from their brain because of the ‘rewarding process’ (p. 52). And this situation relates to the concepts of continuing motivation and self-efficacy, up to the extent that learners produce these neurochemicals as a sign of mathemagenic activity happening to expect reward(s) or positive feedback after choosing an answer. The findings of this study showed through focus group that learners can benefit from having a points system as a reward to their learning progress, which supports the remarks from Ejsing-Duun & Karoff, (2014) and Eichenbaum et al (2014). It is about time to explore more implications of the gaming factor in embedded questions. Gamification and embedded questions have a room in scientific research, and they show promising scopes of how videos can be developed for learning in the near future.

**Emotional and motivational aspects.** Each question in the assessment had an item that asked: ‘How confident are you that you chose the correct answer?’ to which the answers ranged from 20% to 100%. A participant had to choose a percentage for each answer they made in order to measure self-efficacy as a primary part of their comprehension. Many notes were gathered about the way participants have chosen their self-efficacy percentage in each question in the assessment. As noted in Chapter 4, some difficult questions affected the self-efficacy percentage of the remaining questions in the
assessment. Other participants from the experimental group expressed that they felt being under 4 tests: 2 tests while watching both VEQ videos, and 2 subsequent assessments. All of these circumstances affected these emotional and motivational aspects in each participant.

In knowledge acquisition using embedded questions, there is an important relevance between the learner’s characteristics and achievement. The aspects of this relevance can be prior knowledge, emotions and motivation, and learning strategies and abilities. As explained by Kozma (1991) and Deci & Ryan (1985), the learner’s internal knowledge structure and the external environment define the way they gain knowledge. The term ‘learning environment’ does not necessarily mean a location or a place; it is rather the educational setting that involves time, effort, and delivery method (e.g. VEQ or LV, online or face-to-face courses).

**Internal and external constraints.** The internal constraints are the learner’s characteristics that balance with a certain degree of instructional control (e.g. self-efficacy, motivation, ability and prior knowledge). The external constraints are the obstacles and/or circumstances related to the educational setting (e.g. locus of instructional control, instructional design, and types of embedded questions) (Keller, 1983; Mayer, 2003; Garcia-Rodicio, 2015). In an attempt to facilitate and improve student confidence, Keller (1983) suggested that a student could be given a certain degree of control over the instruction to enhance the feeling of self-efficacy, in addition to a proper feedback to support their motivation to learn from their mistakes or feel confident with their correct answers. These suggestions are well-applied in VEQ situation since the
multiple-choice questions are programmed to automatically provide feedback in case of wrong answers, and proceed with the presentation in case of correct answer – enhancing the learner’s self-efficacy and motivation (Deci & Ryan, 1985; Keller, 1983).

**Self-efficacy and attitude.** The attitude towards VEQ was mainly positive. Participants elaborated that embedded questions gained their confidence and self-efficacy, and that they would highly recommend using VEQ in education. Educators assure that the individual learner’s characteristics have a huge impact on how fast and effectively learning occurs. For example, there are studies that found positive effects in student’s attitude when higher learner control is used (Hurlock et al, 1974; Seymour et al, 1987; Milheim, 1989). One of the investigated attitudes was continuing motivation (Seymour et al, 1987), which indicates the likeliness a learner is internally willing to return back to a learning activity without external pressure(s). This continuing motivation is the possible explanation of why participants wanted to repeat the embedded questions experience again, and recommended using it at schools and universities.

It is concluded then, that the reason of including self-efficacy measurements is because it is an important substance of comprehension. Regardless of which learner's psychological characteristic is being studied, the research of embedded questions is aimed to produce the best learning experience in terms of persistence and making choices. There are many options and actions to take in order to treat the emotional and motivational aspects of a learner. However, the confirmation feedback is one that seems to fit well in interactive videos. The learner can choose performance-related options, answer multiple choice questions, select or click buttons that cause an instructional event,
and get feedback. These learner-performed actions should be strategically considered when designing the instructional events in instructional videos.

However, even with all these types of learner-performed actions, it is important to notice that not all learners are capable of controlling the instructional material effectively (Williams, 1996). This lack of ability to control may be treated as a gap in self-efficacy explanations; a gap that can be filled by taking prior knowledge into account.

**Prior knowledge role.** Participants thought that background knowledge had a role in performance and interest in instructional video, regardless of whether it was VEQ or LV. There are many factors that influence the way participants answer embedded questions. One of these important factors is the prior knowledge. Although prior knowledge was not measured in this study, due to the need of matching the situation of open learning from online sources, it may have had an impact on comprehension. Participants come to an experiment with prior knowledge, wide range of experiences and different ideologies. These pre-existing elements in each participant influence the way they interact, interpret, and process the information coming from VEQ and LV.

Knowing the pre-existing knowledge and skills in participants can help instructors and designers better craft instructional activities that strengthens participants’ abilities, and addresses their weaknesses to fill the gaps and serve better instructional video development. Prior knowledge of presentation skills or battery life reservation may have helped some participants by playing the role in matching the new information with pre-memorized information, and influencing the selection-mechanism to choose the right
answer(s). But there were other combinations that occurred, shown in the following figure:

![Figure 13](image)

*Figure 13.* Designed by the researcher: the role of prior knowledge in embedded questions system. Based on Thomas’ (1983) experiments 1 and 2.

According to Figure 13, the characteristics of supplemental material in videos (e.g. embedded questions and chapter index selection) can be determined by the evaluation of pre-existing skills and knowledge. For example, if the students show a solid understanding, product familiarity (Krueger, 1975), and/or comprehension of a certain concept that was planned to be covered in the course, then this concept can be dropped or presented solely without supplementary material. Alternatively, if the majority of students showed weakness in some concepts, then the characteristics of supplemental tools (e.g. video with embedded practices, 3D animation, and chapter index selection) can
be determined by the evaluation of pre-existing skills. Afterwards, these supplemental tools can be added to the course to facilitate better understanding of that concept and aid the students’ knowledge acquisition. This supplementary treatment is recommended especially when the concept is considered as an important pre-requisite of the course (Thomas, 1983). With these recommendations, an instructional video in an online course setting would be enhanced to meet the learning objectives and needs for students.

The researcher did a pre-experience assessment of video consumption to find how many hours each participant spends watching online videos on a daily basis. This assessment was in the first part of questionnaire, and it was used for identification purposes. But further studies can do a pre-test to determine prior-existing knowledge level about specific topics. Having prior knowledge does not mean that a participant possesses exceptional ability to know all about a specific topic (Thomas, 1983; De Boer et al, 2016), rather it makes it easier to learn when they already have a solid basis for the new information.

The average scores for VEQ assessment in presentation skills topic \( (M = 8.73, SD = 1.68) \) showed no significant difference from the average scores for battery life topic \( (M = 8.80, SD = 1.77) \). The same comparison was made for LV version of both topics, spotting no significant difference either: presentation skills \( (M = 7.30, SD = 2.05) \) and battery life \( (M = 7.36, SD = 2.14) \). Although the results of assessment scores revealed no significant difference between topics within both VEQ and LV versions, it was mentioned later in the focus group meeting that the battery life videos presented less common information than what was presented in presentation skills videos. This
observation can be related to prior-knowledge effect, familiarity effect, or to the popularity of the topic itself; presentation skills topic was more common and generic than battery life reservation.

**Research Question 3: The Relative Merits of VEQ and LV’s Instructional Design**

The instructional material of the videos was mainly designed based on Merrill’s (2009) model. It was observed that some technical and instructional specifications of VEQ and LV need to be strategically and instructionally considered. The videos used in this study had instructional sequences that were constructed to provide a mixture of conceptual and procedural knowledge, by telling the concepts and showing the procedure to act based on these concepts. The central objective of Tell-Show-Ask design was to avoid constant information telling, and reduce cognitive load in participants.

**Embedded questions mechanism in video: tell, show, and ask.** Telling information constantly has been characterized as ‘spray-and-pray-remember-what-I-say’ instruction (Merrill, 2009), which means that instructor (or video) presents information in a hope that learners will retain and recall it during post exams. Constant information telling was not found to be effective based on the results of LV participants when compared to VEQ participants. This Tell-Ask paradigm, without the implementation of Show-Do instruction, can be vulnerable and subject to loss of both information and portrayal.

The design of Tell-Show-Ask helped the participants in this study by motivating them and showing the relevance of what they were watching and learning. This relevance contributes to learning by: a) learning new facts, instances, concepts and/or procedures in
the context of reality, b) demonstrating skills and procedures by presenting portrayal scenes (Show), and c) rehearse memory to retain the new information, demonstration, and procedures by asking a relevant embedded question (Ask). Comprehension in this study is further enhanced by adding the instructional event of ‘Do’ at some points of the video, it occurred in UG and FG types of embedded questions. Participants interacted to these types of questions by putting more effort to mentally re-apply new information in a real-world situation.

Video content was presented in this study as information and portrayal. If the video contents were mainly based on information telling, they would have been generally exposed to multiple interpretations by the participants, which could lead to an inaccurate new knowledge. Portrayal is a more specific application of the information. When both components of video material (information and portrayal) are used, they facilitate effective learning (Merrill, 2009). Participants interacted with information and portrayal in 4 different instructional events: Tell, Show, Ask and Do. Information can be ‘Told’ in multiple ways (e.g. speech, text, graphics, and animation). ‘Show’ represents portrayals of specific examples of information, and they can also be demonstrated in multiple ways: audio, visuals, movement and timing (Mayer & Anderson, 1992; Goodman & McGrath, 2002). The instructional event ‘Ask’ requires the learner to remember a general information. However, ‘Ask’ fails in making the learner able to perform a new task or solve a new-situation problem (Merrill, 2009). Therefore, the instructional event ‘Do’ asks the learner to mentally apply the newly-gained knowledge to a specific situation and assess a new portrayal. Solving a new-situation problem is what ‘Do’ represented in this
study. Participants were asked to solve specific situations via UG and FG embedded questions.

Figure 14 summarizes the basis on which the embedded questions were composed, and the corresponding interaction of participants with these questions. The top part of the figure illustrates multiple types of knowledge covered by embedded questions (FG, UG, RI, and RG), and these multiple types were used and applied in embedded questions in the form of: kinds-of concept, how-to perform a certain procedure, and what-happens if a condition is met and a consequence is happened. Appendix L provides a full categorization chart of all embedded questions used in this study with their types.
Figure 14. Participants’ Interaction with Embedded Questions. Analysis based on Merrill’s (1983) CDT and Merrill (2002).

**Embedded questions impacts: cognitive load.** Some participants in the focus group have mentioned that the use of embedded questions has raised their anxiety and feeling of being overwhelmed with information. Embedded questions were expected to minimize the cognitive load for all participants due to the utilization of Segmentation Principle (Mayer, 2009; Clark & Mayer, 2016), which indicates that learners understand
better when multimedia material is partitioned and presented in smaller segments, rather than a continuous, unstoppable presentation. A possible explanation of embedded questions’ negative effect on memorization and information recall, is that participants have limited capacity of cognitive load (Mayer & Moreno, 2003; Sweller et al, 2011), which leads to the limitation of effort allocated to watching several segments and focusing on their contents. Most of their cognitive efforts were possibly allocated to answering embedded questions, taking into consideration that they may have been anxious, reluctant, or captivated to the impression of being under a difficult test.

Most participants, on other hand, have found embedded questions very helpful in recalling information at later time due to the segmentation of presented material (i.e. lower cognitive load) and to the relevance to the general way of teaching at Middle Eastern schools:

When we used to study, it was mostly memorization of the information regardless of whether we understand the reading or not. That was mostly the case back in our schools in the Middle East region. With VEQ, recalling the information and cognitively applying it to new examples was a sort of a training system for the memory.

Teaching at Middle Eastern schools is heavily-based on memorization of the information, and sometimes indoctrination (Ioana & Cracsner, 2016). Therefore, an average student in that region tends to memorize information in order to pass the exam. Once the exam is finished, the student may forget most of what they have memorized. The use of multiple adjunct questions is identical to memory rehearsal (Rothkopf, 1966)
which, in addition to segmentation, is a possible reason that explains why most participants felt that embedded questions were helpful in memorization and information recall.

Overall, the scores of VEQ and LV assessments represent an outcome of information processing that happened overtly and covertly (Grabowski, 2004; Chi & Wylie, 2014). This outcome reveals a conclusion about how learning happens: the elements of learning in this study consists of memory rehearsing, outcome expectation, concept and procedure understanding, self-efficacy and interactivity. What unites these elements is the fact that they all represent two domains of educational learning, they are: cognitive domain and affective domain (Bloom et al, 2001). Cognitive domain is the learner’s ability to perform active processing, rehearse memory, relate to new information, gain knowledge, and recall information at future time. The affective domain relates to different characteristics of the learner, such as self-confidence, self-efficacy, rewarding and attitude (Bloom et al, 1956; Bloom et al, 2001).

Comprehension, using embedded questions, may have happened due to memory rehearsing, notifying, relating, applying and/or interactivity. They were all possible functions. These functions, however, go through an incorporated system of information processing, and this system starts with encoding audio-visual information, then storing this type of information for either a brief or extended period of time, and finally retrieve it at -later- appropriate time or reactivate it for current application(s) (Merrill, 2002; Mayer & Moreno, 2003).
Recommendations for Future Research

In this section, the researcher presents what further research should be conducted in embedded questions. Here is a list of recommendations that should be strategically considered for multimedia designers, instructors, and researchers in video-based learning using embedded questions system:

- This study took place in a workshop room, not in a classroom setting. And the researcher randomly sampled the participants by selecting them from graduate students’ population. Future research can expand the sample by studying youth and children interactions with embedded questions, and base the measurement on different settings: fully online, blended, face-to-face, or classroom. The benefit from this expansion is to extend the literature of embedded questions to include various ages, not only adult millennials.

- Not all areas of knowledge identified in the CDT model (Merrill, 1983) and Bloom’s Taxonomy (Bloom et al, 2001) were investigated by the usage of embedded questions. The purpose of this study was to respond to inquiries concerning the use of embedded questions specifically in conceptual and procedural knowledge. Researchers are encouraged to investigate other types of knowledge, and how can embedded questions improve learning within these types. The benefit is to highlight the limitations and delimitations of embedded questions when used for other integrations and types of knowledge, such as factual and meta-cognitive knowledge.
• Using embedded questions with confirmation feedback may have revealed different results in comprehension if assessment test was given after a relatively-long delay (a day or two). Having an assessment immediately taken after VEQ and LV experience was possibly an advantage to the participant, because the new information was still vivid in their short-term memory. Researchers are encouraged to take this advantage away, make the test more challenging, replicate this study and re-assess the effectiveness of embedded questions in videos.

• Cognitive load was not a variable to test in this study, thus future research should consider studying the adjustment of cognitive efforts which are allocated to problem solving while using interactive videos. Studying the impact of embedded questions on cognitive load would enhance the understanding of psychological and mental processes, and illustrate more insights about what happens when learners perform problem-solving, as suggested by Kim et al. (2015). Studying cognitive load can further determine the convenient time amount that needs to be given for each embedded question, and adjust the time-on-task accordingly.

• Include a pre-test: replicating the pre-experience assessment in this study with a prior-knowledge assessment would benefit in investigating the effectiveness of embedded questions system on new, or less common topics. In addition, prior-knowledge assessment can reveal more insights about the type of courses that may need supplementary material as VEQ.

• Cover more topics: it is suggested that videos may cover and present different topics (e.g. History, Chemistry, Physics) that are targeted for students at different
levels (high school, undergraduate or graduate). Covering more topics should enhance the instructional design of VEQ in a way that enables educators to blend it within their course contents. In this regard, a sequence of experiments on embedded questions can benefit in establishing a meta-data of topics that VEQ model is capable of teaching.

- One of the participants indicated that he has a B-12 deficiency, which causes a casual memory loss or weakness (Growdon, 2015). It is suggested that this study can be extended to a medical application for B-12 deficiency and short-term memory treatment. The only difference in next medical studies for this treatment is to design the research with a different sampling technique, and choose participants who have this kind of deficiency to find if the continuous usage of VEQ can truly help treating and maintaining short-term memory.

- With the compatibility and features of HTML5 web applications, educators and programmers can collaborate to build a real-time analytical system that captures the viewing pattern and problem-solving process of each participant. Such system would benefit research by building a real-time data of multiple-trials, clicks, mouse movement and the number of correct and incorrect answers to each embedded questions, thus extending the ability to conduct deeper analysis of behavioral patterns towards embedded practices in multimedia.

- Refer to Table 2 (Appendix K) for detailed technical suggestions and recommendations regarding the design of interactive video material.
Conclusion

Videos with basic control buttons can hardly be considered as a sole source of learning. Huai (2000) first inserted that the learning style and short-term memory are connected. But this insertion is subject to further investigation when multimedia learning is involved. And even with a variety of video viewing behaviors, as investigated by De Boer et al. (2010) and De Boer et al. (2016), there is no firm connection between the learner characteristics (e.g. self-efficacy, prior knowledge and the capacity of short term memory) and the video viewing behavior. This means that despite the nature and mechanism of video, learners will always watch it with different viewing patterns based on their own preferences (Huai, 2000; De Boer et al, 2010).

The researcher would argue that there are four things that happen in the learner's mind when he/she watches and tries to learn something from an instructional video (i.e. process the information). These possibilities are tentative, and they are proposed to be thoroughly investigated, studied and analyzed by future research:

1. The learner thinks they know the topic, which leads to paying less attention, lack of following every detail, or dedicating less time to watch (Mazzoni & Cornoldi, 1993). The feeling of knowing something is a key determinant of studying; higher self-efficacy (Bandura, 1977).
2. The learner does not recognize that what is being presented differs from what they already know from text books or lectures (Thomas, 1983; Yonelinas, 2002; De Boer et al, 2016). Integrating with prior knowledge is essential here.
3. The learner does not learn, but they felt excited to watch an aesthetic visual simulation of some concept (Boster et al, 2006, p. 58; Beyth-Marom et al, 2005).

4. The learner gets more confident in the ideas they know before (Mayer, 2009; Heick, 2015), or gets self-determined to learn new ideas (Deci & Ryan, 1985). Hence, enhancing existing knowledge with new information.

In order to design and create effective videos for learning, this cycle of four prospects needs to be completed by adding more interactivity in the video and more control to the learner. As previously mentioned, a video is more interactive when it pauses and shows a question -on an overlaying screen- related to the topic, and waits for the learner’s input to click on an answer. Video provides confirmation feedback then continues to play if the answer is right or plays the consequence of the wrong answer. A learner can benefit from the higher level of control over video when they are able to try different answers, watch the consequences of wrong answers, and follow the video path when the right answer is chosen. With embedded questions and confirmation feedback, a learner can:

- Raise self-efficacy and build more confidence,
- Enhance existing knowledge with new information,
- Rehearse memory,
- And achieve better learning outcome (higher assessment score).

Due to the difficulty of designing interactive videos, it may take a huge amount of effort and time. Despite that HTML5-based platforms for video programming are now made to be very user-friendly, the composition and editing of video require some
advanced skills which are not found in many teachers. Educational video has been studied as an instructional medium for embedded questions because: a) it diversifies education and illustrates concepts very well, b) it is commonly and widely using time controllers only, which may not be enough for highly-interactive experience, and c) there has been a significant growth of video popularity among adult users for entertainment and educational purposes. Fundamentally speaking, no design is perfect. The current version of VEQ will undergo many developments to cover more topics, add multimodal inputs, refine its educational efficiency, and improve the technical and instructional features of it.

Summary

This chapter offered a meaning to the results and findings of this study. The objective of this chapter was to analyze and discuss the quantitative results and qualitative findings, taking into account that the method used was a sequential explanatory method. By this method, a rich data has been obtained, thus the researcher was able to effectively test the hypothesis and provide proper explanations to each point covered in the literature review.

Research questions were stated, answered, and analyzed to formulate a complete understanding of concepts mentioned in previous chapters, covering: learner control on embedded questions, mathemagenic activities, position and type of questions, adult millennials and their active learning, emotional and motivational aspects, attitude and self-efficacy, the role of prior-knowledge, cognitive load effects, and the relative merits of VEQ and LV’s instructional design. The analysis put the results and findings into
proper context of the literature review’s theoretical framework, and summarized the overall study with the appropriate elements that comprise a conclusion.
References


Google Forms (2015). Create and analyze surveys for free. Retrieved from: 

https://www.google.com/forms/about/


http://support.videoblocks.com/customer/portal/topics/610636-licensing-faq-s/articles


Appendix A: Questionnaire Links

Questionnaire 1: Battery Life Experiment

https://docs.google.com/forms/d/1VyDXs6q8mO2O3rmB3xJBKVXSYfuwseGOAdTVd
wDtntA/viewform?usp=send_form

Questionnaire 2: Presentation Skills Experiment

https://docs.google.com/forms/d/1nq5iXqEcXU_bkneHQtdsga9mgZbtGCDz9h4-
vEQkjiyw/viewform?usp=send_form
Appendix B: Consent Form

Ohio University Adult Consent Form with Signature

Title: Embedded Questions in Interactive Videos

Researcher: Adiy Tweissi

You are being asked to participate in research. For you to be able to decide whether you want to participate in this project, you should understand what the project is about, as well as the possible risks and benefits in order to make an informed decision. This process is known as informed consent. This form describes the purpose, procedures, possible benefits, and risks. It also explains how your personal information will be used and protected. Once you have read this form and your questions about the study are answered, you will be asked to sign it. This will allow your participation in this study. You should receive a copy of this document to take with you.

**Explanation of Study**

This study is being done because of the need to expand scientific research in interactive videos for educational purposes. Interactive videos are considered one of the new developments in educational technology, and is being studied to be used for instructional and educational purposes at schools, universities, and online learning websites. In specific, there is a strategy called embedded questions, by which a user is provided more tools to control and interact with the time and display of the video.

If you agree to participate, you will be asked to sign this form, answer some basic questions about your background, watch a version of interactive video, and finally take a test that is related to the topic of the video you just watched.

You should not participate in this study if you do not feel comfortable in watching videos and/or taking tests and/or being recorded. Your participation in the study will take no more than
25 minutes. No further discomforts or risks are anticipated. This study is important to science and society because it provides more scientific advancement to the visual literacy field, as one of the skills in the 21st century, and contributes to global education. Individually, you may benefit from learning about a new interactive tool developed to expand the potential of video technology, not only in education, but in marketing and media as well.

You may not benefit financially by participating in this study. No compensation is provided. Your study information will be kept confidential by the researcher. All recorded videos will be completely deleted at the end of this study. Additionally, while every effort will be made to keep your study-related information confidential, there may be circumstances where this information must be shared with:

* Federal agencies, for example the Office of Human Research Protections, whose responsibility is to protect human subjects in research;
* Representatives of Ohio University (OU), including the Institutional Review Board, a committee that oversees the research at OU;

If you have any questions regarding this study, please contact the investigator Adiy Tweissi, +962 795131100, at373211@ohio.edu or the advisor Dr. David Moore, 740.597.1322, moored3@ohio.edu

If you have any questions regarding your rights as a research participant, please contact Dr. Chris Hayhow, Director of Research Compliance, Ohio University, (740)593-0664 or hayhow@ohio.edu.
By signing below, you are agreeing that:

- you have read this consent form (or it has been read to you) and have been given the opportunity to ask questions and have them answered;
- you have been informed of potential risks and they have been explained to your satisfaction;
- you understand Ohio University has no funds set aside for any injuries you might receive as a result of participating in this study;
- you are 18 years of age or older;
- your participation in this research is completely voluntary;
- you may leave the study at any time; if you decide to stop participating in the study, there will be no penalty to you and you will not lose any benefits to which you are otherwise entitled.

Signature_________________________________________ Date________________

Printed Name________________________________________

Version Date: [01/15/2016]
Appendix C: Video Links

*Interactive Videos*

Clip 1 – LV instructional video about reserving the laptop’s battery life. Duration: 5:15. Language: Arabic

https://www.youtube.com/watch?v=M-7btffHB8dc


https://www.youtube.com/watch?v=ibz11XOuhvM


http://cdn1.raptmedia.com/projects/GU2TqKa6/play


https://play.raptmedia.com/projects/7YqA3dum/play
### Appendix D: Video Story Boards

**Video Story Board: Battery Life**

<table>
<thead>
<tr>
<th>Scene Actions</th>
<th>Script – Voice Over Reading</th>
<th>Technical Notes</th>
</tr>
</thead>
</table>
| United Eye Productions network reveals, then a black, rotating laptop shows up. Music starts. | There is a universal issue in laptop systems, this issue is the battery life and efficiency. Here are some techniques that will help you in dealing with, and extending the life of your laptop’s battery. Did you know that a battery can live longer than its original life span? | LV: linear presentation. No change.  
VEQ: stop to ask question number 1: “When should you re-charge your battery?”  
Answers: at 1%, 20 – 30%, or at 50% |
| The same black laptop model stops rotating, then a battery icon fades in with a text “20% - 30%”. | First of all, when the battery is low, you should not wait until it becomes at 0% or extremely low level. The best range in which you should re-charge the battery is when it comes in between 20% to 30%. | LV: linear presentation. No change.  
VEQ: stop to ask question number 2: “How can data be assembled to save power?”  
Answers: by deleting all files, doing backup, or perform disk defragment. |
<table>
<thead>
<tr>
<th>Task</th>
<th>Instructions</th>
<th>Notes</th>
</tr>
</thead>
</table>
| A disk model shows up with a closed side, and an open side to highlight the inner circuit. Disk defragment icon fades in the low-left corner of the screen. | Also, consider doing a function called Disk Defragment. This function is a very useful application of power saving. | LV: linear presentation. No change.  
VEQ: stop to ask question number 3: “Where is Disk Defragment located?”  
Answers: main hard disk drive, start menu, or control panel. |
| The desktop screen shows up with Windows Task Manager dialogue box. Then the computer mouse moves to click on “Processes” tab. | You may also hold the keys CTRL + ALT + Delete, then choose “Windows Task Manager” to go into the Processes tab. In this tab, you will find some un-necessary processes that work behind the scene. These specific processes need to be terminated to save power as well. | LV: linear presentation. No change.  
VEQ: stop to ask question number 4: “What should you delete to save more power?”  
Answers: running applications, processes, or screen light. |
| A sequence of batteries starts moving from right to left side of the screen. | As for the charging process, re-charge the battery until it reaches 100%.       | LV: linear presentation. No change. |
| Plate of electronic circuit and dice rotates, then a close-up shot of the yellow circuits. | Avoid leaving the laptop in charge for long period of time. Leaving the laptop on continues D/C for a long time may cause damage to the inner circuits. | LV: linear presentation. No change.  
VEQ: stop to ask question number 6: “What would happen if you continuously keep charging the battery?”  
Answers: Circuit damage, D/C shortage, or it doesn’t matter. |
| An open laptop with random game on its screen. Then a closed laptop shows on a table, with a text that says “40%”. | Some people prefer to work on the laptop leaving it connected to D/C current all the time, but they remove the battery completely. This is possible, but don not remove the battery unless it’s charged | LV: showing still images and notes to consider in reserving battery life.  
VEQ: stop to ask question number 7: “Can you work on a laptop without battery?” |
for at least 40%. Consider using Hibernate function instead of Sleep Mode too, this helps in deep reservation. Answers: Yes for a short time, Yes with a charger, Yes after having the battery reach 40% and leave laptop linked to charger.

<table>
<thead>
<tr>
<th>The same laptop on the table continues to show, then two hands will hold it, flip it, unlock the battery placement, and put the battery separately.</th>
<th>After removing the battery, place it in a relatively low temperature area not exceeding 24 c. A low temperature as refrigerator is not recommended, nor the areas exposed to direct sunlight.</th>
<th>LV: showing still images and notes to consider in reserving battery life. VEQ: stop to ask question number 8: “After removing the battery, where should you place it?” Answers: in an area with up to 24c temperature, in the refrigerator, in a place with sun light.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two hands re-attach the battery to the laptop, then flip laptop to show the side where fan access is. Fingers point on the fan access holes. An</td>
<td>Finally, in regards to the laptop-battery connection, make sure that the fan access holes are always clean. You can use cleaning wipes and ear picks to clean them up, so</td>
<td>LV: linear presentation. No change. VEQ: stop to ask question number 9: “How and where should you put the laptop during usage”</td>
</tr>
</tbody>
</table>
arrow of fades in to show the direction of air flow.

that more fresh air can flow inside the laptop body to prevent high heat.

Answers: on your lap, on a separate surface (like a book), or on bed.

A stock picture of girl using laptop on the bed. Then a stick picture of a boy covered on bed and using a laptop.

Red pointers show up to indicate the location of fan access holes.

By the way, putting a laptop on the bed like many people do, is a silent killer. Because it prevents the fan from getting enough air, which causes heart and damage to the battery and inner circuit over time.

LV: linear presentation. No change.

VEQ: stop to ask question number 10: “Which of the following habits are correct?”

Answers: putting the battery in refrigerator, always work on laptop without battery, re-charge until 100%.

Zooming in to a laptop on a white base. Music ends.

Screen ends with contact information.

End of voice over.

LV: linear presentation. No change.

VEQ: linear presentation. No change.

Resources List:


PC Magazine: http://www.pcmag.com/article2/0,2817,2458636,00.asp

### Appendix D: Video Story Boards “Continued”

**Video Story Board: Presentation Skills**

<table>
<thead>
<tr>
<th>Scene Actions</th>
<th>Script – Voice Over Reading “Translated to English”</th>
<th>Technical Notes LV and VEQ</th>
</tr>
</thead>
</table>
| United Eye Productions network reveals, then a sequence of public speeches show up. Music starts. | So how do you surpass anxiety and suspicion from being in front of a relatively large number of audience? Whether you do a public speech for entertainment, education or work, you need to learn few tips to do it well.                                                                 | LV: linear presentation. No change.  
VEQ: linear presentation. No change.                                                                 |
| An assortment of A4 papers fades in, then showing a caption of audience looking at the viewing side. A man’s model shows up on top of the audience and continues to show on another photo of audience from different side. | There is a good technique to start with, which is to print a photo of audience on an A4 paper for example. It is preferred that the photo shows audience while they are looking straight at you. You may hang this photo on a surface and start speaking to the virtual audience. | LV: linear presentation. No change.  
VEQ: stop to ask question number 1: “How can you start practicing?”  
Answers: by talking to virtual audience, taking a deep breath, or memorize all information from the presentation material. |
<table>
<thead>
<tr>
<th>Image Description</th>
<th>Detailed Description</th>
<th>Questions and Answers</th>
</tr>
</thead>
</table>
| A stock photo of a man getting prepared in front of a mirror. | Also, consider doing the same thing by practicing in front of a mirror; you may stand in front of it and start talking. | LV: linear presentation. No change.  
VEQ: stop to ask question number 2: “Where else can you practice?”  
Answers: in the kitchen, in the bathroom, or in front of mirror. |
| Two hands holding a camera (black HD camcorder).  
Flipping the camera with two hands, opening the screen, closing it, and finally closing the lens. | With the same technique of practicing, you can also use a camera to talk to. Believe it or not, camera can be even more distracting than the real audience. | LV: linear presentation. No change.  
VEQ: stop to ask question number 3: “Why should you use a camera for practicing?”  
Answers: because it’s cheap, because it’s HD clear, or because it’s distracting. |
| Close up and wide angle shots of an empty stage. Then a time lapse of chairs being sorted on the stage. A man shows up walking on the stage to face empty chairs. | There is a very helpful way to get used to the atmosphere of presentations. Try to arrange a visit to the stage a day or 2 days before your presentation, because this will help you in | LV: linear presentation. No change.  
VEQ: stop to ask question number 4: “What can you benefit from visiting the stage at early time?” |
| Close-up shot of a mouth, microphone, and sound waves show up one after another. A young person wearing headphones sitting on a couch and getting hit by blue liquid. A man wearing | gaining confidence, getting used to the environment and reducing the anxiety. | LV: no change. VEQ: stop to ask question number 6: “If you face stammering problems, what can you do to enhance continuous speech?” |
| A number of people (males and females) sitting on chairs and looking at the camera. | If you cannot go to the stage earlier, then you may ask for help from your friends or family members. Ask them to sit in front of you as audience, and start practicing with them. | LV: show a sequence of facts and notes. VEQ: stop to ask question number 5: “What are the preparations mentioned until now?” Answers: visit stage-audience photo-kitchen-camera, camera-friends-clothing, or audience photo-mirror-camera-stage visit. |
| Headphone and setting up the microphone. | Talking out loud. Repeat this kind of speech and compare it to your performance without music, until you reach a level when you can continuously speech without cuts. | Answers: put some loud music and start talking loudly, use headphones connected to your phone with music and read an article, or be in a complete silence. |
| Zooming out: a woman on stage talking to audience. Scene freezes. | One of the complimentary things to do while presenting, is to look straight at the audience. | LV: showing still images and notes to consider in reserving presentations. VEQ: stop to ask question number 7: “Where to look?” Answers: circular view around the audience, cover one side of the audience, or look into the eyes of one specific person. |
| Woman continues to present while being shot in side angle. Arrows start to show where she is looking; one arrow to the right, arrow to the top, arrow to the left, and | Make sure to look at the audience in a circular way. You may turn your head at each side of the stage so that every person would feel that you’re sharing information | LV: linear presentation. No change. VEQ: stop and ask question number 8 “What else can you use for practicing?” Answers: camera, ruler, papers. |
finally arrow to the bottom side.  

<table>
<thead>
<tr>
<th>Scene</th>
<th>Description</th>
<th>Question</th>
<th>Answers</th>
</tr>
</thead>
</table>
| A scene of presenter standing on stage while holding a flower – offering it to the audience. Camera tilt-shift to show whole view of the stage. | Audiences have different kinds of people, but most of them come to your presentation knowing no body – just like you. They are new to you and you are new to them. | LV: linear presentation. No change.  
VEQ: stop to ask question number 9: “So how do you start?” | Answers: as audience to stand up, begin showing the slides, or do ice-breaking. |
| Time lapse scene of audience moving around the stage. | You are the one responsible to do the ice-breaking, which is to break this unfamiliarity between you and the audience using jokes, exciting introduction, or an engaging story. | LV: linear presentation. No change.  
VEQ: stop to ask question number 10: “One of the audience has just asked you a hard question, what would you answer?” | Answers: avoid it, say “I don’t know”, or make it up. |
| Time lapse scene of audience leaving the stage. Music | With these tips, you may now begin practicing for your next presentation. | LV: linear presentation. No change. |
ends. Credits and contact information appear. Cut.

presentation and be well-prepared. End of voice over.

VEQ: linear presentation. No change.

**Resources List:**

University of Kent – Careers and Employment Services, Tips on Making Presentations:

http://www.kent.ac.uk/careers/presentationskills.htm

Skills You Need: http://www.skillsyouneed.com/presentation-skills.html

Comprehensive Public Training Program (CPTP), State of Louisiana – Effective Presentation:

Appendix E: Focus Group Questions

Semi-structured Interview

Experience:

Q1. How often do you use video to help you in studying?

Q2. Were you able to control the video properly?

Q3. (Possible follow up question) what technical issues did you face while interacting with the video?

Q4. As a graduate student, what are your perceptions of using LV/VEQ videos?

Q5. How would you rate the whole experience using embedded questions system?

Self-Efficacy:

Q6. Were you confident that you could answer all questions correctly in the assessment?

Q7. Can you express your feeling towards using LV or VEQ videos and how did they develop or affect your motivation to continue the task?
Q8. (Possible follow-up question) do you think that VEQ version helped you in answering the assessment questions? Do you think LV version helped you in answering the assessment questions?

هل تعتقد أن النسخة الأخرى مفيدة إن أمكنك إجابة على أسئلتك؟ وإذا لم تكن كهذه النسخة الأخرى من الأسئلة؟

**Instructional Design and Cognitive Load:**

Q9. Would you prefer a video that tells and shows you something constantly, or a video that tells, shows and asks you a question to follow up with concepts?

هل تفضل مشاهدة فيديو يشرح وي векаشيكم بالمحتوى دون استراحة؟ أم أن التوجيه في استفسارك ومن ثم السؤال الذي ينطبق كجزء من الفيديو؟

Q10. What are the advantages and disadvantages of constant showing versus showing with questions?

ما هي إيجابيات وسلبيات كل من العرض المتواصل والعرض المتعدد السؤال؟

Q11. How did you feel after watching VEQ version? How did you feel after watching LV version?

كيف شعرت بعد مشاهدة نسخة VEQ؟ كيف شعرت بعد مشاهدة النسخة العادية؟

Q12. Could you differentiate between your experience with VEQ and LV – all in all, which one did you prefer?

لمساعدتك، كيف يظهر لك الفيديو الVEQ والنسخة العادية لجميع الأسئلة الأخرى؟
Appendix F: AETG Research Room Approval

A scanned copy of Arab Education & Training Group support and approval to use their facility.

The Arabian Education and Training Group

Letter of Support

To whom it may concern,

The Arab Education and Training Group (AETG) agrees to provide support and location for the research titled: The Effects of Embedded Questions Strategy in Video among Graduate Students at a Middle Eastern University.

AETG is informed that a study to be conducted by researcher: Mr. Adiy Tweissi, as a partial fulfillment of the requirements for the degree Doctor of Philosophy from Ohio University. Mr. Tweissi will use the AETG facility and devices like computers, camcorders, and printers necessary to conduct his experiment with the participants. Upon his request, he was granted this acceptance letter.

Dr. Basem Saraireh, CEO

bsaraireh@yahoo.com   + 962 796999938
Date: 02/24/2016
Appendix G: Letter of Contact

The following is the body of email message and publication to distribute among prospective participants – Arabic and English:

A research to be conducted by a PhD candidate from Ohio University - USA, as part of his graduate studies pursue. The study is titled: “The Effects of Embedded Questions Strategy in Video among Graduate Students at a Middle Eastern University”. His study is going to take place at the workshop room of Arab Education and Training Group (AETG), located in Baraka Building, Unit 402, Amman, Jordan. The study is titled: Embedded Questions Strategy Effects in Interactive Videos Among Graduate Students.

The study is intended to broaden the scientific research about instructional videos, and investigate the effectiveness of embedded questions strategy on interactive videos as they are being continuously developed to meet more educational expectations. If you are interested in joining this study and being a participant, please contact the researcher directly at:

Mr. Adiy Tweissi - Cell Phone: +962 795131100 - Email: at373211@ohio.edu
Appendix H: Screenshots of Questionnaires

Battery Life Video:
Please answer the following questions.

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the most suitable place to put the battery in after replacement?</td>
<td>On a window exposed to sun light, On a table where no direct sun light exists, Inside a closed, cold area</td>
</tr>
<tr>
<td>How confident are you that you chose the correct answer? (Pick one of the values below)</td>
<td>□</td>
</tr>
<tr>
<td>How do you end the unnecessary processes?</td>
<td>CTRL + ALT + Delete - End Applications, Start Menu - Accessories - Disk Defragment, CTRL + ALT + Delete - End Processes</td>
</tr>
<tr>
<td>How confident are you that you chose the correct answer? (Pick one of the values below)</td>
<td>□</td>
</tr>
<tr>
<td>Which level is recommended to re-charge the battery when it’s reached?</td>
<td>60%, 70% - 40%, 30% - 20%</td>
</tr>
<tr>
<td>How confident are you that you chose the correct answer? (Pick one of the values below)</td>
<td>□</td>
</tr>
<tr>
<td>What is the side effect of connecting the laptop to a D/C current continuously for a long time?</td>
<td>Corruption of inner-circuit, Heat generation, High temperatures, Slow performance and high temperature, Nothing will happen</td>
</tr>
<tr>
<td>How confident are you that you chose the correct answer? (Pick one of the values below)</td>
<td>□</td>
</tr>
</tbody>
</table>
Up to what extent should you re-charge the battery?

It doesn't matter

at least 50%

100% 

How confident are you that you chose the correct answer? (Pick one of the values below)

How can you work on your laptop without the battery?

Remove the battery when it's completely out of power

Remove the battery and turn on the laptop without electricity or D/C

Remove the battery only when it's charged for at least 40% and then work on laptop with D/C

How confident are you that you chose the correct answer? (Pick one of the values below)

Which of the following habits are considered correct?

Charge until 100% and recharge when it's 25% to 25%

Put the laptop on a book and let it charge for 3 days

Put the laptop in a closed, cold area and never charge it until it's completely out of power

How confident are you that you chose the correct answer? (Pick one of the values below)

On what kind of surface it is recommended to put the laptop?

On your lap for a long time

On a table

On a blanket

How confident are you that you chose the correct answer? (Pick one of the values below)

How can you re-assemble your data in order to save more power?
How confident are you that you chose the correct answer? (Pick one of the values below)

On what kind of surface it is recommended to put the laptop?
- On your lap for a long time
- On a table
- On a blanket

How confident are you that you chose the correct answer? (Pick one of the values below)

How can you re-assemble your data in order to save more power?
- Disk Defragment
- Cut the main hard disk files and paste them again in new locations
- Application Defragment

How confident are you that you chose the correct answer? (Pick one of the values below)

What do you think is the most reliable temperature for best battery performance?
- c 22
- c 40
- c 2

How confident are you that you chose the correct answer? (Pick one of the values below)
Presentation Skills Video:

Questionnaire - Presentation Skills

* Required

**Age**

[Input Field]

**Profession**

[Input Field]

**Subject of Study**

[Input Field]

**What do you check on internet?**

- YouTube
- Twitter
- Vimeo
- Daily Motion
- Rapt Media
- Facebook
- Instagram
- Other

**If you watch videos on a daily basis, approximately how many hours do you spend watching videos?**

- Less than 1 hour
- Hours 3 - 1
- Hours 6 - 4
- More than 6 hours

[Continue]
Please answer the following questions.

You have 10 minutes to complete your answer.

When you print a photo of audience to practice, what would be the best position for them?

- Audience who look directly at you
- Audience from side angle
- Audience from top view

How confident are you that you chose the correct answer? (Pick one of the values below)

Which of the following tools can you use for practicing?

- Printed slides to be memorized
- Small note papers only
- Small note papers and practice in front of mirror

How confident are you that you chose the correct answer? (Pick one of the values below)

If someone asked you a difficult question that you have no specific answer for, how would you react?

- That's a good question, I think we can reach an answer to it by deeper discussions and studies in the future
- This is a hard question and I'm not obligated to answer it here
- Give a tricky in-direct answer

How confident are you that you chose the correct answer? (Pick one of the values below)

For what can you use a camera?

- Practicing
- To solve mistakes and surpass anxiety
- Both answers above are correct

How confident are you that you chose the correct answer? (Pick one of the values below)
How do you start communicating with audience?

- Asking the audience to introduce themselves one by one
- Show the first slide and start explaining it
- A short exciting story to introduce yourself

How confident are you that you chose the correct answer? (Pick one of the values below)

How can you improve the continuity and clarity of your speech?

- Reading a whole book silently with soft music
- Reading out your slides clearly with headphones on to separate your hearing
- Reading an article without music

How confident are you that you chose the correct answer? (Pick one of the values below)

When is it recommended to go to the stage/room of presentation?

- Before few days
- An hour before presentation to settle things up and prepare
- Both answers above are correct

How confident are you that you chose the correct answer? (Pick one of the values below)

What should you wear for the public speech?

- Sport wear and shorts
- Formal or smart casual
- Pajamas
- Hand over a robe

How confident are you that you chose the correct answer? (Pick one of the values below)

At whom would you look while presenting?

- To a central point within audience seats
At whom would you look while presenting?

- to a central point within audience seats (0)
- Focus on two persons at two different sides (0)
- Circulate your sight around multiple angles (0)

How confident are you that you chose the correct answer? (Pick one of the values below)

- (0)

Where can you practice for presentation?

- Closed, silent, low-light room (0)
- With a group of your friends in a large room (0)
- Alone while your eyes are closed (0)

How confident are you that you chose the correct answer? (Pick one of the values below)

- (0)
Appendix I: IRB Approval

The IRB forms have been successfully submitted and approved.

<table>
<thead>
<tr>
<th>Project Number</th>
<th>16-E-140</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Status</td>
<td>APPROVED</td>
</tr>
<tr>
<td>Committee</td>
<td>Office of Research Compliance</td>
</tr>
<tr>
<td>Compliance Contact</td>
<td>Shelly Rex (<a href="mailto:rex@ohio.edu">rex@ohio.edu</a>)</td>
</tr>
<tr>
<td>Primary Investigator</td>
<td>Adly Tweissi</td>
</tr>
<tr>
<td>Project Title</td>
<td>The Effects of Embedded Questions Strategy in Video among Graduate Students at a Middle Eastern University</td>
</tr>
<tr>
<td>Level of Review</td>
<td>EXEMPT</td>
</tr>
</tbody>
</table>

The Ohio University Office of Research Compliance reviewed and approved by exempt review the above referenced research. The Office of Research Compliance was able to provide exempt approval under 45 CFR 46.101(b) because the research meets the applicability criteria and one or more categories of research eligible for exempt review, as indicated below.

<table>
<thead>
<tr>
<th>IRB Approval</th>
<th>04/11/2016 08:54:44 AM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review Category</td>
<td>1,2</td>
</tr>
</tbody>
</table>

If applicable, informed consent (and HIPAA research authorization) must be obtained from subjects or their legally authorized representatives and documented prior to research involvement. In addition, FERPA, PPRA, and other authorizations must be obtained, if needed. The IRB-approved consent form and process must be used. Any changes in the research (e.g., recruitment procedures, advertisements, enrollment numbers, etc.) or informed consent process must be approved by the IRB before they are implemented (except where necessary to eliminate apparent immediate hazards to subjects).

It is the responsibility of all investigators and research staff to promptly report to the Office of Research Compliance / IRB any serious, unexpected and related adverse and potential unanticipated problems involving risks to subjects or others.
Appendix J: Transcript Sample

A scanned sample of the focus group’s transcript.

P (Ha): You can put marks on the text book to follow up with certain points, but you cannot highlight or put yellow marks on a video. This gives a better way to follow the details than a video in some cases.

P (Je): It depends on the topic itself. If it was literature, novel, or art then I’d rather read it because I want form and create characters and events of the story in my imagination. Take movies for example, they usually do not succeed in adapting a novel. But if it was something technical or scientific, then video will succeed in delivering the information.

P (Om): When I used to watch videos for manufacturing and steel industry, I realized through visualization how these machines work. So I guess they improved my perception and visualization by mimicking and depicting the process itself. They were a mix of live action and animation videos.

P (Ka): In literature it’s better to be books. But some movies or videos did a very good job in bringing the story to life. I think it depends on people. All people can imagine, but not all people all visual, some prefer to read over watching.

To previous participants: Did you find it easy/hard to control the VEQ and LV videos?

P (Kh + Je + Om + Fa): It was easy to find out what’s happening after getting into the first question. The first embedded question in both VEQ videos was prompt and somewhat unexpected. But once you answer the question and proceed to the next one, you would realize what is going on and how the video actually works.

P (Ma + Da + Sa): For the LV videos, it was obvious how to control them. They were playing on YouTube platform, and YouTube is very common and easy to use. But VEQ shown on a different platform, which was not common. Somehow I felt like wanting to know more about where I am, what was the website name? Getting familiar with the main platform may have reduced the anxiety a little bit in the beginning. But eventually, when VEQ proceeds you’d realize how user-friendly it is.

P (Sh): Embedded questions are distracting to me. When I watch a video I’d like to watch it completely in one shot without any interruptions. Embedded questions interrupt my thinking and linking with the presented material from the video, and even they guide me to think and focus about specific details and make me forget about/miss some others.

P (Fa): It would be great to have a video with indexed sections. You can click on any section to get to the point you are searching for. It is better to have clickable chapter titles rather than being interrupted by questions. But these embedded questions may be very useful if you want to conduct an exam and have student memorize certain points from the text book.

KEY: [ ] Experience - Indicates learner control and possible technical issues.
[ ] Self-Efficacy - Emotional observations and effects on motivation.
[ ] Instructional Design and Cognitive Load - Embedded Questions pros and cons.
[ ] Suggestions and Recommendations.
[ ] Researcher Talking.
Appendix K: Instructional and Technical Recommendations

Detailed technical suggestions and recommendations regarding the design of interactive video material and using embedded questions.

Table 2.

Participants’ Noting Suggestions and Recommendations

<table>
<thead>
<tr>
<th>Participants Agreed</th>
<th>Notes</th>
<th>Explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Participants</td>
<td>Script Writing</td>
<td>Writing the video script in a way that matches the needs of students and fills the gaps in their knowledge background, based on a formative evaluation.</td>
</tr>
<tr>
<td>8 out of 15</td>
<td>Indexing</td>
<td>Indexed sections. Students can click on any section to get to the point they are searching for through clickable chapter titles.</td>
</tr>
<tr>
<td>10 out of 15</td>
<td>Separation</td>
<td>A lecture video that lasts 20 – 30 minutes would be a better application for embedded questions.</td>
</tr>
<tr>
<td>11 out of 15</td>
<td>Feedback</td>
<td>Giving a straight feedback to answer, then going back directly to the same question rather than watching the last scene again.</td>
</tr>
</tbody>
</table>
Another option: alternative choice on the corner of the screen to the student whether they want to repeat the last scene or not.

Replace the ‘ding’ sound of correct answers with a points system. Reduce the volume of wrong answer’s sound effect – match it with the rest of sound levels.

Guiding instructions on how to use VEQ in the beginning of the video. Design it in a way that teaches itself to the student using, for instance, introductory questions: ‘you will see many of these questions while watching the video, in order to keep proceeding, pick the correct answer based on the context of the video topic. If your answer to a certain question was wrong, don’t worry. You will be given another chance. Are you ready?’ If the learner chooses ‘Yes’ then a feedback scene shows a ‘Like’ button with a sentence that says ‘Let’s Go!’ If the answer was ‘No’ then take them into a short explanatory scene that gives more details of
how this VEQ works, and finally go back to
the same introductory question: ‘Are you
ready?’

Conclusion and IQ questions are
recommended in addition to the
memorization and application questions.

Question Type

Also the multi-modal input can help in
composing different types of embedded
questions, such as text writing, fill in the
blank, voice input, and drawing.

Using separation scenes between embedded
questions and extending the video time (e.g.
fade out screens and time-lapse), students
need be able to find some spots in which
they can write notes.

Note-taking

To make sure the video presents a factual
and trustful material, designers and
developers are encouraged to support the
information by adding resources and
references in the video as part of the ending
credits.

All participants

Authenticity
**Appendix L: Embedded Questions Chart**

*Categorization Chart of Embedded Questions used in VEQ*

<table>
<thead>
<tr>
<th>FG: Battery Life</th>
<th>Presentation Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>What would happen if you continuously keep charging the battery?</td>
<td>Which one of these you can also use to practice for presentation: mirror, camera, or poster?</td>
</tr>
<tr>
<td>What should you delete to save more power?</td>
<td>If you face stammering problems, what can you do to enhance continuous speech?</td>
</tr>
<tr>
<td>Can you work on a laptop without battery?</td>
<td>Where else can you practice?</td>
</tr>
<tr>
<td>RG: Battery Life</td>
<td>Presentation Skills</td>
</tr>
<tr>
<td>When should you re-charge your battery?</td>
<td>What can you benefit from visiting the stage at early time?</td>
</tr>
<tr>
<td>Up to what extent should you re-charge the battery?</td>
<td>Why should you use a camera for practicing?</td>
</tr>
<tr>
<td></td>
<td>What are the preparations mentioned until now?</td>
</tr>
<tr>
<td>RI:</td>
<td>What is the name of PC menu in which you can find the Disk Defragment function?</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Which of the following habits are correct?</td>
</tr>
<tr>
<td>UG:</td>
<td>How and where should you put the laptop during usage?</td>
</tr>
<tr>
<td></td>
<td>After removing the battery, where should you place it?</td>
</tr>
<tr>
<td></td>
<td>How can data be assembled to save power?</td>
</tr>
</tbody>
</table>
Appendix M: Correlations within Groups based on Gender

An Additional Factorial ANOVA to Highlight Deeper Results

In order to investigate the correlation between gender and comprehension, an additional factorial analysis of variance (ANOVA) test was compiled. The factorial ANOVA specifically tested the significance across two samples from both control and experimental groups; these samples were: male participants and female participants. As shown on Table 3, the researcher attempted to investigate additional details about whether further differences occurred in comprehension results based on gender.

Table 3.

Summary of Factorial ANOVA

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Source</td>
</tr>
<tr>
<td>Corrected Model</td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
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<tr>
<td>Gender</td>
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</tr>
<tr>
<td>Video_Type</td>
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<tr>
<td>Gender *</td>
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</tr>
<tr>
<td>Error</td>
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</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td></td>
</tr>
</tbody>
</table>

*p > 0.05
In terms of average score, there was no significant effect for embedded questions among participants based on gender, $F(1, 56) = 0.180, p = .796, \eta^2 = .001$. In terms of self-efficacy, there was no significant interaction based on gender, $F(1, 56) = 0.485, p = .489, \eta^2 = .009$.

However, the plot results on Figure 15 showed that both male and female participants achieved significantly higher scores in VEQ videos. On the other hand, the plot also indicated that male participants had significantly lower self-efficacy than females in LV version of the videos. Both plots highlighted the interaction of gender and video type, and the effect of this interaction on average score and self-efficacy.

*Figure 15*. Caption of mean plots from SPSS program: showing the difference in scores and self-efficacy between video types and genders.