



تبني مبادئ تصميم الوسائط المتعددة لماير لتحسين جودة الفيديو التعليمي للطلاب في ضوء معايير تقييم التكنولوجيا

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Doi 10.55534/1320-010-001-002

المستخلص:

أصبح استخدام مقاطع الفيديو التعليمية في التدريس شائعاً بدرجة كبيرة. وقد وُجد أن مقاطع الفيديو المصممة بفاعلية تؤدي إلى زيادة التعلم وتحفيز الطلاب. وبالرغم من ذلك، فإن الطلاب لا يستخدمون مقاطع الفيديو المنتجة فحسب، بل يُصممون بأنفسهم أيضاً مقاطع فيديو حصرية؛ لذلك، فإنه من المفيد معرفة مبادئ التصميم التي يجب أن تُتبع عند إنتاج مقاطع الفيديو للحصول على نتائج تعليمية فعّالة، وتجنب الإفراط في استخدام عناصر الوسائط المتعددة الذي يؤثر بدوره سلباً على تعلم الطلبة. وتهدف الدراسة الحالية إلى التحقق من تأثير تطبيق مبادئ (Mayer) لتصميم الوسائط المتعددة عند تصميم مقاطع الفيديو التعليمية من قبل الطلبة. حيث طُلب من خمس طالبات تصميم مقاطع فيديو تعليمية باستخدام برنامج (iMovie) قبل شرح مبادئ تصميم الوسائط المتعددة لـ Mayer من قبل الباحثة في بيئة التعلم وبعده. وتم تقييم مقاطع الفيديو التعليمية للطالبات (الاختبار القبلي / الاختبار البعدي) باستخدام معايير التقييم لتكنولوجيا التعليم للأكلي (2015). وكشفت النتائج أن درجات الطالبات تحسّنت في الاختبار البعدي ($M = 62.8$, $SD = 1.11$) مقارنةً بدرجاتهن في الاختبار القبلي ($M = 23.6$, $SD = 10.10$)، مع $t(4) = 8.56$, $p < 0.05$. ويشير هذا إلى أن تبني مبادئ تصميم الوسائط المتعددة الخاصة بـ Mayer عند تصميم الفيديوهات التعليمية قد ساعد الطالبات على تحسين جودة مقاطع الفيديو المصممة من قبلهن وتحقيق نتائج أفضل.

الكلمات المفتاحية: التصميم، الفيديو، المبادئ، الوسائط المتعددة، ماير.



Adopting the Mayer's Multimedia Design Principles to improve Students' Instructional Video Quality in the Light of Technology Evaluation Criteria

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Abstract:

The use of instructional videos in teaching is becoming more common. Effectively designed videos found to lead to greater learning and motivate students. Yet, students are not only using existing videos, but also creating exclusive ones. Therefore, it is useful to know which design principles these videos should follow to produce effective learning outcomes and avoid over usage of multimedia elements which in turn negatively affect students' learning. Thus, the current study aims to investigate the impact of integrating Mayer's Multimedia Design Principles when designing instructional videos by students. Five students were asked to create instructional videos using iMovie before and after integrating the Mayer's Multimedia Design Principles in the learning environment. Students' instructional videos were evaluated (pretests/posttest) using Al-Aklubi's (2015) educational technology evaluation criteria. The findings revealed that students' scores improved in the posttest ($M = 62.8$, $SD = 1.11$) over the pretest ($M = 23.6$, $SD = .10$), with $t(4) = 8.56$, $p < .05$. This indicates that adopting the Mayer's Multimedia Design Principles when creating the instructional video helped students to improve the quality of their videos and achieve better scores.

Keywords: design, videos, principles, multimedia, Mayer.



Introduction

The use of instructional videos is increasingly spread in higher education. Effectively designed videos have been found to facilitate greater learning compared to traditional texts such as static readings or diagrams (Castro-Alonso, Wong, Adesope, Ayres, & Paas, 2019). However, students are not just consumers of instructional videos, but also produce these videos. According to Wukowitsch and Geyer-Hayden (2019), there was a high degree of readiness, especially on the part of learners as they become participants when dealing with instructional videos rather than passive consumers. Therefore, it is necessary that students actively involve themselves in the design of instructional videos promoting theoretical and practical content. This is because it overcomes the passivity of the learners that traditional teaching methods entail.

There are different methods enabling learners to engage in constructing the learning materials. Designing multimedia is one of the effective methods helping learners to become active builders of knowledge. Studies concluded that taking part in creating multimedia such as CDs/DVDs considerably enhances the students' interaction in various fields and the transfer of the new knowledge is enhanced as well (Bedi, Ćorić, & Samardžija, 2011). This is because students' perception of their own knowledge and skills changes through designing multimedia project activities. Additionally, designing multimedia increase learners' motivation, creativity, freedom, intelligence, and the quality of adapting to new situations (Liu, 2003).

However, it is necessary to teach student how to use multimedia elements properly. One method is to implement multimedia design principles into the learning environments. The most common theories is Mayer's Multimedia Design Principles. This theory was developed to use as a guideline for anyone who is putting together digital learning experiences to create effective multimedia learning experiences. These principles were derived from Mayer's (2005) cognitive load theory that states learning using multimedia is more likely to happen if multimedia instructional messages are designed keeping in view how the human mind works.

Thus, in the current study, Mayer's Multimedia Design Principles are used and integrated into the learning environment when designing instructional videos by students enrolling in the current study. The impact of applying these principles by students on the quality of the created videos will be assessed using Al-Aklubi (2015) technology evaluation criteria (pretest/posttest).

Literature Review

Instructional videos

Instructional videos are audiovisual media to support teaching and that teachers can show within their courses or that they can recommend as supplementary teaching material (Bruder, Grell, Rensing, & Wiemeyer, 2015). They are used to provide usefully, visualized information on a specific topic and easily trackable for learning analytics and facilitate greater learning (Murray et al., 2015; Castro-Alonso et al., 2019; & Henderson et al., 2017). Berk (2009) mentions twenty advantages of instructional video use in teaching include: grabbing students' attention, focusing students' concentration, generating interest in the class, creating a sense of anticipation, energizing students for learning exercise, drawing on students' imagination, improving attitudes toward content and learning, building a connection with other students and instructors, increasing the memory of the content, increasing understanding, fostering creativity, fostering deeper learning, providing an opportunity for freedom of expression, serving as a vehicle for



collaboration, inspiring and motivating students, setting an appropriate mood or tone, decreasing anxiety and tension on scary topics, and creating memorable visual images.

However, instructional videos must be done well to be effective for learning. Henderson et al. (2017) mention six key parameters which play a significant role in the success of instructional learning videos which are: (1) for the first draft, it is necessary to record why a video is planned and what objectives it is intended to achieve, (2) content should be creatively presented and visualized. Video recordings of persons are an excellent way to clarify facts. Distraction should be avoided, but instructional videos should also provide entertainment as this increases attention, (3) a script or video concepts must be written. Each instructional video needs a title, an introduction and a conclusion. Each video should be about 2 to 5 minutes long, (4) no videos are allowed to be published without the explicit permission of the filmed persons. Unless it is filmed at public events, when publishing on the Internet, the license terms for the use of the instructional learning videos must be clarified. Likewise, the copyrights should be clarified in advance when using external materials (pictures, music, videos), (5) concerning technology and design, teaching, and learning videos should be designed in such a way that all content is easily visible even in small end devices. Displayed texts should be readable, spoken texts understandable. Background noise should be avoided as much as possible, and (6) in addition to the appropriate platform for distribution, precise video description and the clarification of usage rights must be ensured.

Nevertheless, instructional videos with different multimedia elements need to be used with proper planning and careful consideration to have the learning contents arranged in a more meaningful manner. Wukowitsch and Geyer-Hayden (2019) argue that although the technical possibilities of any video production (especially with smartphones) are now quite easy to handle; more attention must be paid to the writing of the video concept (content, scene description, text, and duration). In addition, it is useful to know which design principles these videos should follow to avoid poor design that might affect learning outcomes. One good approach is by adopting the Mayer's Multimedia Design Principles when creating and designing multimedia elements.

Although multimedia design principles are easy to implement and result in improved short-term retention among students, empirical research is still needed to determine how these principles affect transfer and construct of knowledge (Issa et al., 2011). Therefore, the current study is investigating impact of adopting the Mayer's Multimedia Design Principles on students' instructional videos quality and performance using Al-Aklubi (2015) technology evaluation criteria.

Cognitive Load Theory

Cognitive load theory CLT is a psychological theory that had emerged from the work of Sweller in the late 1980s aims to provide instructional techniques that fit within the characteristics of working memory (Sweller, 1988). The theory explains the effects of the design of learning materials on what happens in the human brain when learning takes place emphasizing that the working memory capacity has limitations when dealing with novel information.

According to Van Merriënboer et al. (2006) there are three types of cognitive loads which processed in working memory include: intrinsic; related to the inherent nature of the learning material, extraneous; is the load generated by suboptimal instructional procedures, and germane; is the load imposed by cognitive processes that contribute to learning by facilitating the development of cognitive schemata.



Mayer's Multimedia Design Principles

Mayer's Multimedia Design Principles for designing effective multimedia presentations are based on cognitive theory of multimedia learning. According to Mayer (2005) cognitive theory of multimedia learning is derived from the theory of cognitive load theory. It provides a well-researched account of how people learn from words and pictures, and states that meaningful learning using multimedia is more likely to happen if multimedia instructional messages are designed keeping in view how the human mind works. This theory is based upon three fundamental assumptions, which are: dual channels, limited capacity, and active processing (Mayer, 2005).

The dual-channel theory of multimedia learning suggests that there are two distinct channels in the human information processing system, of which one processes information presented in a visual or pictorial format and the other processes information presented in an auditory or verbal format. Each channel has predetermined limited capacity to process incoming information (Mayer, 2005). Sensory memory is exposed to an unlimited amount of incoming information presented as verbal and pictorial stimuli, but only a limited number of the incoming stimuli can be processed through either channel at any given time. The selected information progresses through the system to reach the working memory area in the nervous system where the information is organized into distinct cognitive representations. Limited capacity means that humans have limited capacity of processing the information through each channel, at a time, the assumption being consistent with the cognitive load theory. Active processing refers to the fact that humans active learning happens by constructing a coherent mental representation of experiences, and by integrating incoming information with the prior knowledge – making mental model (Mayer, 2005).

Mayer's Multimedia Design Principles have broadly been categorized into three generic principles: curtail extraneous processing; manage essential processing, and nurture generative processing (Issa et al., 2011). According to Mayer (2009), extraneous processing is a type of cognitive processing that does not support the learning objective, often caused by poor instructional design, like picture on one slide and its explanation on another slide of presentation. This processing must be reduced to have less cognitive load. Essential processing is the process of representing the essential material to the working memory, through the process of selecting and organizing. This cognitive processing must be managed. Generative processing involves the process of making sense from the presented material through integrating and organizing. This needs learner's motivation and engagement too; thus, generative processing needs to be nurtured (Mayer, 2005).

Mayer's Multimedia Design Principles are as follows: (1) multimedia Principle: Students learn better from words and pictures than from words alone, (2) spatial contiguity principle: Students learn better when corresponding words and pictures are displayed near on the screen, (3) temporal contiguity principle: students learn better when corresponding words and pictures are presented simultaneously rather than successively, (4) coherence principle: students learn better when extraneous words, pictures and sounds are excluded rather than included, (5) modality principle: students learn better from animation and narration than from animation and on-screen text, (6) redundancy principle: students learn better from animation and narration than from animation, narration, and on-screen text, and (7) individual differences principle: low-knowledge



learners or high-spatial learners will enjoy stronger design effects, as shown in Appendix B.

Adopting Mayer's Multimedia Design Principles when creating instructional videos by students

Technology has tremendous impacts on education in general and particularly in learning. Using technology in the learning environments has been approved to improve students' learning and increase their motivation. The use of multimedia elements in the teaching materials is able to attract students' attention, achieve better retention rate and then improving students' performances (Li & Tsekian, 2013).

Although multimedia elements are powerful to be integrated in the learning environments, the overused of such tools would negatively affect the learning outcomes. Li and Tsekian (2013) argued that we should not be overjoyed with the usage of multimedia elements because they could be overused in various applications, so the learning process could not be taken place efficiently. Thus, to maximize the effectiveness of adopting these tools in the learning environments, implementing the Mayer's Multimedia Design Principles is a good approach to avoid the inappropriate usage of technology tools. One of the teaching multimedia tools which should take into consideration multimedia principles are instructional videos. Instructional videos involve different multimedia elements such as text, sound, clips, graphics, and animation.

Currently, students are not only consuming these videos, but also creating and designing such instructional tools. Although most of the studies investigated implementing the Mayer's Multimedia Design Principles by instructors when designing the teaching materials and environments (Mahajan et al., 2020), fewer studies examined teaching these principles for students to apply them when those learners become the creators and the designers of the learning tools. According to (Mahajan et al., 2020), Mayer's cognitive principle of multimedia learning and principles of instructional designs need to be practically implemented to make lectures interesting, interactive, and effective. Therefore, it is not enough to adopt these principles by instructors, but students should also learn multimedia design principles and how to implement them when creating and designing multimedia elements for learning.

Several studies demonstrated the effectiveness of adopting the Mayer's Multimedia Design Principles in the context of education when designing multimedia elements. A study by Bedi et al. (2013) investigated the impact of using Mayer's Multimedia Design Principles when students create multimedia CD/DVDs when working in a Project-Based learning activities. The findings reflected that students were given not only an opportunity of honing their practical knowledge of programming, graphic designing and designing multimedia elements but as well an opportunity of enhancing their skills of problem-solving, planning the projects, team working, critical thinking, interpretation and visualization. In addition, designing the CD/DVDs encourages learning by means of researching or working projects during the school year.

Another study by Issa et al. (2011) used a pre-test/ post-test control group design, in which the traditional learning group received a lecture on shock using traditionally designed slides and the modified-design group received the same lecture using slides modified in accord with Mayer's principles of multimedia design. The study concluded that adapting PowerPoint slides of lectures according to multimedia principles is likely to translate in to improved short-term retention among medical students.



Additional study by Wukowitsch & Geyer-Hayden (2019) demonstrated that the inclusion of students in designing videos proves to be highly motivating due to their identification with the protagonists. The interviewed practitioners and teachers agree that videos produced by peers in the peer group better convey the desired content in the course of knowledge transfer. The findings also reflected that simple production - preferably involving the pupils - is preferable to elaborately designed instructional learning videos. Moreover, it showed a high degree of readiness, especially on the part of learners, not only to deal with instructional videos as passive consumers but also as participants themselves. Therefore, they suggested that these results should motivate students to actively involve themselves in the design of instructional videos promoting theoretical and practical content. However, the study showed that although the technical possibilities of any video production (especially with smartphones) are now quite easy to handle by students; more attention must be paid to the writing of the video concept (content, scene description, text, and duration).

At the same time, Li & Tsekian (2013) conducted a Pre-test/ Post-test using the Mayer's Design Principles in designing the online learning materials. The findings showed improvement students' performances and help to achieve better balance and combination of multimedia elements. The results demonstrated that the proper usage of multimedia elements applying the Mayer's principles would help in improving students' performance in the teaching and learning process and also it managed to motivate students in learning. In addition, students were successfully motivated in the web learning environment and gave encouraging comments about the web learning environment as well as on the learning module.

However, as the previous studies prove the effectiveness of adopting the Mayer's Multimedia Design Principles when designing the teaching and learning materials, the current study is investigating the impacts of adopting these principles on the students' performance as the creators of the instructional videos. In other words, it answers the question: Is adopting the Mayer's Multimedia Design Principles improving the students' instructional video quality and performance in the light of technology evaluation criteria?

Technology Evaluation Criteria

Al-Aklubi Educational Technology Evaluation Criteria was developed in 2015 to evaluate multimedia and provide a list of educational and technical standards for those interested in media production. The criteria consist of two parts; one is educational, and the other is technology criteria. The researcher focuses and uses the technology criteria in the current study which will cover the Mayer's Multimedia Design Principles. The criteria domains are: the written text, images, the pronounced language, sound effects, animation, animated images, interactivity, and interface. These criteria have been used by several studies to evaluate multimedia elements.

Research Question

The research question comprises one main question: Is adopting the Mayer's Multimedia Design Principles improving the students' instructional video quality in the light of Al-Aklubi educational technology evaluation criteria?

Methodology

This study adopted a quasi-experimental research design with one group (experimental). The population comprises five students enrolled in the course; "Educational TV Programs", majoring in kindergarten during the semester of Spring 2021



as the COVID-19 pandemic still spreads in the world and most educational institutions continue using the e-learning via Blackboard as the main learning platform. Participants exposed to pretest/posttest (Al-Aklubi Educational Technology criteria) before and after implementing the treatment (Mayer's Multimedia Design Principles)

Instrument

The instrument in the current study is Al-Aklubi's (2015) educational technology criteria used to evaluate the students' instructional videos consists of two parts; educational and technology criteria with three scales of the degree of applying the criteria by the students; 2= large, 1= medium, and 0= not applied (see appendix A). Each part consists of several domains. To the current study, the technology criteria were used to evaluate the students' instructional videos. They consist of eight domains containing 45 criteria which are: the written text, images, the pronounced language, sound effects, animation, animated images, interactivity, and interface (see Appendix A).

Procedures

At the beginning, the researcher explains the iMovie features for four weeks and asks the students to create and design an instructional video for children in specific topics they decided to choose. A pre-test (educational technology criteria by Al-Aklubi, 2015) was used to evaluate the students' instructional videos. After that, The Mayer's Multimedia Design Principles were integrated and explained by the researcher for few following weeks. Then, the students were asked to re-create the same instructional videos which they have created considering the Mayer's principles. Their instructional videos were evaluated (post-test) using the same educational technology criteria (Al-Aklubi, 2015) and their scores were recorded.

Data Analysis

The Statistical Package for Social Science (SPSS) software version 20 was used to analyze the data in this study. All analyses were conducted using $p \leq .05$ as a level of statistical significance. A paired sample t test ; also called the dependent sample t test is used to compare the means of the same item in two different conditions.

Results

The findings of the current study show major differences in students' scores for post-test ($M = 62.8$, $SD = 10.4$) over pre-test ($M = 29.6$, $SD = 13.6$), $t(4) = 6.22$ $p < .05$.

Students score higher in the post-test after implementing the Mayer's Multimedia Design Principles when they create their instructional videos, as shown in Table 1 and Table 2.

Table 1
Paired Samples Tests

Paired Samples Test									
		Paired Differences							
		Mean	Std. Deviation	Std. Error	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
Pair					Lower	Upper			
1	post - pre	33.20000	11.94571	5.34228	18.36744	48.03256	6.215	4	0.003



Table 2

Means and Standards Deviation for Each Condition

		Paired Samples Statistics			
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	post	62.8000	5	10.44988	4.67333
	per	29.6000	5	13.55729	6.06300

Discussion

The current study examined whether integrating the Mayer's Multimedia Design Principles when creating instructional videos by students improve their performance. The results revealed improvement in the students' performance and videos quality when recreating instructional videos after implementing the Mayer's principles as their videos were evaluated using Al-Aklubi Technology Evaluation Criteria (2015). These findings are consistent with most of the previous studies (Wukowitsch & Geyer-Hayden, 2019; Li & Tsekian, 2013; and Issa et al., 2011), which investigated impacts of applying the Mayer's Multimedia Design Principles when designing and creating instructional materials and multimedia elements. Before implementing the Mayer's principles, students were using extraneous words and pictures in some slides. Also, some of them used printed text instead of words and narration, used words alone instead of presenting pictures and words, and used formal dry style when presenting words. Following the Mayer's principles, students were able to exclude overloaded multimedia that they implement in their predesigned videos and focus on essential materials. When using images, they improved them and insure their clarity and ease of use. The participants also linked the images to the objectives and the content, included external frame, and avoided details that distract the learners. In addition, the participants used clear animation, linked the graphics to the content and objectives, and sync them to the sound. Moreover, they were focusing more on graphics and animation than text and having at least three elements in one frame. The significant improvement of the participants' performance after implementing the Mayer's principles reflected the effectiveness of such principles. Yet, still more studies in need to examine the effectiveness of Mayer's principles and their impacts in learning transforming.

Conclusion

Instructional videos have been increasingly used in higher education. Integrating the Mayer's Multimedia Design Principles when creating instructional videos by instructors and students is crucial to avoid over usage of the multimedia elements and overload of the memory. Yet, there is still fewer studies examining adoption of the Mayer's Principles by the students as designers of the learning materials. In the current study, the students were asked to create instructional videos using iMovie before and after integrating and explaining the Mayer's multimedia design principles in the learning environment. Students' instructional videos were evaluated (pre-tests/post-test) using Al-Aklubi (2015) educational technology evaluation criteria. After the pre-test and before the post-test, The Mayer's Multimedia Design Principles were integrated and explained by the researcher for few weeks as a treatment variable. The findings from the study provided statistical evidence that implementing the Mayer's Multimedia Principles Design when creating instructional videos improved the students' performance and videos quality. Therefore,



concluding that instructors should integrate these principles into the teaching environments to help students properly utilize multimedia elements and improve their performance. However, the results of the current study indicate that more studies are needed to examine how these principles affect transfer of learning.

Acknowledgment

The authors are thankful to the Deanship of Scientific Research at Najran University for funding this work under the General Research Funding program grant code (NU/NRP/SEHRC/11/1).



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Appendix A

Al-Aklubi (2015) Educational Technology Criteria

Technology Criteria		Highly applied 2	On Average 1	Not Applied 0
1-Written text	1- In Arabic language; the text is at the top of the screen from the right side, and in English language; the text at the top of left 2- The words count on the screen do not exceed 30 words 3- the screen should not exceed six lines of text 4- Using font 18 or 16 when writing the main and the subtitle 23-font color contrasts with the background color			
2-Images	5-In the Arabic language is located in the left of the text, while in English language is located in the right of the text 6- Clarity and ease of the image 7-The image is linked to the objectives and the content 8- The image contains external frame 9- The image does not contain details that distract the learners			
3-The pronounced language	10- Matching the pronunciation to the written text 11-Clarity of voice and linguistic integrity of pronunciation 12- Using the language to provide feedback 13- Using the language to give instructions			
4-Sound effects	14- Containing sound effects 15- Sound effects is lower than the sound of the spoken language			



- | | |
|-------------------|--|
| 5-Animation | 16- Clarity of animation
17- Graphics are linked to the content and objectives
18-Graphics sync with sound
19- Animation sync with character's movement
20- Graphics display speed is from 16 to 39 |
| 6-Animated images | 21- Clarity of displayed image
22- Image is synchronized with the sound
23- The duration of the animated image is not more than 3 minutes
24- Display speed 1/24 |
| 7-Interactivity | 25- Determining the control pattern of the program on the part of the learner
26- provide the elements of attraction and excitement in the software
27- Providing the icons of PREVIOUS, NEXT, and HOME to move among screens
28-Providing EXIT icon in all screens
29-Containing YES or NO exit confirmation message
30-The ability to control the sound and display the clips |
| 8-Interface | 31- Ease of use
32- Focusing more on graphics and animation than text
33- Having at least three elements in one frame
34-Having the control icons at the bottom of the frame (NEXT-PREVIOUS-MENUE-HOME-EXIT-HELP)
35- The place of control icons is steady in all frames
36-The audio includes visual media
37-Having SKIP icon
38-Effectiveness of websites links
39- Easy access to other screens from the home screen
40-The main screen contains a list of sub contents |



41- Formatting attention
attractive elements (color,
images, graphics, and effects)

Appendix B

Mayer's Multimedia Design Principles of Designing Effective Instructional Multimedia Materials

Eliminate external distracters	
Coherence principle	Exclude extraneous words, pictures, and sounds
Signaling principle	Highlight essential material
Redundancy principle	Do not add on-screen text to narrated animation
Spatial contiguity	Place printed words next to corresponding graphs
Temporal contiguity	Place corresponding narration and animation at the same time
Encourage learners to establish 'mental frames' for the material	
Segmenting principle	Present animation in learner-paced segments
Modality principle	Present words as narration instead of printed text
Pre-training principle	Prepare/read ahead of time
Facilitate integration of new material with prior established knowledge	
Multimedia principle	Present words and pictures rather than words alone
Personalization principle	Employ conversational style instead of formal dry style to present words