

The Impact of Using the Multimedia Modality Principle to Teach Shakespearean Drama

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Abstract

The present study investigates the effect of the modality principle in multimedia learning during the teaching of drama at the English department at a Saudi university, the University of Ha'il. It compares explicitly the impact of using static pictures and narration concurrently with on-screen text for the control group with the impact of using pictures with narration only for the experimental group. A sample of 69 male English-majoring students was selected and divided into control and experimental groups. The aim was to determine which group performed better than the other with the hypothesis that audio-visual presentation of the selected content would enhance students' knowledge retention and mental skills and would lead to better learning outcomes for the experimental group. A quasi-experimental design was adopted and ANCOVA test was used to observe variation in the scores of the two groups after studying Hamlet's play. The results support the hypothesis. Students in the experimental group outperformed their counterparts in the control group. This was observed in the post-tests on the retention of knowledge and mental skills. The findings of this study provide additional evidence of the superiority of audio-visual presentation in a previously unstudied context related to the teaching of literary content.

Keywords: Computer-based multimedia, multimedia-based learning, modality principle, redundancy effect, teaching Shakespearean drama, multimedia-based instruction

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Introduction

The COVID-19 pandemic has introduced new challenges in education systems across the globe. While educational institutions endeavor to proceed with teaching the English language, they must simultaneously address the challenges associated with the COVID-19 pandemic. They also have to undertake timely and effective steps to ensure continuity and efficiency at all levels of education to mitigate these challenges.

Remote or online education was a solution to the necessary reduction in in-person education during the pandemic. According to the United Nations Educational, Scientific, and Cultural Organization (UNESCO, 2021), the design of “online courses became a necessary skillset for educators across the world” during the COVID-19 pandemic (Cavanagh & Kiersch, 2022, p. 1). Thus, educators faced an increasing demand for online programs, and many tertiary education institutions began to offer such programs.

At the tertiary education level in Saudi Arabia, Blackboard was the leading Learning Management System (LMS) platform for providing lectures during the pandemic. During the last few semesters, it has been observed that teaching English language courses followed traditional approaches with the instructor delivering the lecture and the students remaining silent. The English department at the University of Ha'il was no exception. In an attempt to improve the quality of education during the COVID pandemic, the researchers decided to implement a new teaching approach to keep students fully engaged both visually and aurally by applying what is known as the multimedia modality effect, as understood within cognitive load theory (Sweller, 1999, 2020; Clark, Nguyen, & Sweller, 2006; Allen & Seaman, 2014).

The Modality Principle (MP) asserts that using graphics and narration would lead to a more effective learning process because “two channels are used when the words are served as narration” (Çeken & Taşkın, 2022, p. 6). To avoid verbal redundancy (Moreno & Mayer, 1999; Mayer, 2014), Mayer (2001) suggests removing the on-screen text from the multimodal lesson, arguing that doing so would lead to a better learning outcome for the students. This can be attributed to the fact that the addition of on-screen text serves as a surplus load to the students' working memory and negatively affects their performance in recall and transfer. There is evidence from that literature that the removal of on-screen text can, and on many occasions does, result in better outcomes for students in different settings (e.g., Mayer, Lee & Peebles, 2014; Clark & Mayer, 2016; Colliot & Jamet, 2018; Scheiter et al., 2019). However, this effect has not been examined in the teaching of literary content. This study aims to address that research gap by investigating the impact of using static graphics and narration in addition to on-screen text in a control group and using graphics and narration only in an experimental group on the achievement and performance of literature students at the Department of English at the University of Ha'il.

Literary courses form the vast majority of those available to students majoring in English at the English department at the University of Ha'il. Therefore, it was decided to implement the multimedia modality principle in teaching one of these modules, namely a Shakespearean drama, Hamlet. The researchers designed literary content and presented the play to students using

multimedia-based instruction to study the effect of the modality principle. The present study has two objectives: to ascertain whether the redundancy effect might occur in teaching English language drama when using audio-visual and visual-only narrations and also to decide, based on statistical evidence, whether the removal of on-screen text can mitigate the load on the audio-visual channel and thus lead to better results for the experimental group.

In order to achieve these objectives, the current study seeks answers to the following research questions:

1- To what extent does the modality principle with graphics and narration only enhance students' retention of knowledge of the play Hamlet in the experimental group more so than with graphics, narration, and text in the control group?

2- To what extent does the modality principle with graphics and narration only enhance students' retention of mental skills about the play Hamlet in the experimental group more so than with graphics, narration, and text in the control group?

Literature Review

The Cognitive Load Theory (CLT) (Sweller, 1999) and the cognitive theory of multimedia learning (Mayer, 2001, 2021) paved the way to improved learning. Clark et al. (2006) further developed the CLT, referring to the potential of this theory to affect both short-term and long-term memories. They assert that short-term memory is limited in capacity and duration, and to ensure retention in short-term memory, the instructional design process should eliminate irrelevant content. They refer to three types of cognitive loads: (1) intrinsic, concerning the content itself; (2) extraneous, referring to the improper principles of instructional design; and (3) effective, including the instructional variables that enhance learning. The CLT identifies three effects that reduce the extraneous cognitive elements: redundancy, modality, and split attention.

Baddeley (2000) assumes that working memory has three distinct capacities: the visual-spatial capacity that deals with mental images, the phonological capacity that deals with verbal information, and the central executive capacity which functions as a coordinating processor. Mayer (2001, 2021) developed the cognitive theory of multimedia learning based on the principles of Sweller's CLT and Baddeley's working memory model. The cognitive theory of multimedia learning is based on three assumptions: the dual-channel assumption, the limited-capacity assumption, and the active processing assumption. The dual-channel assumption suggests that the learning process consists of two paths for the processing of information. The first path represents the auditory-verbal channel. The second represents the visual-pictorial channel. The limited-capacity assumption indicates the existence of a limit on the amount of information that one channel can process simultaneously. The active processing assumption argues that learners are not passive recipients of language and that teachers should engage them during teaching and retention. Mayer's model comprises several stages, namely: using words in verbal memory, using images in visual memory, processing words within a mental model, processing images in a visual mental model, and finally integrating the verbal content, the visual content, and the prior knowledge.

Regarding multimedia learning, Sweller (1999) and Clark and Mayer (2016) argue that pictures or animations should be narrated rather than presented through text. Sweller (1999) calls this the modality principle. The three conditions to achieve multimedia learning using the MP are removing the redundancy effect, avoiding the split-attention factor, and using spoken text rather than visual. Clark et al. (2006) assert that a better learning experience may result from using graphics and narration compared to graphics and narration with text (Colliot & Jamet, 2018; Scheiter et al., 2019). This is because the pictorial channel will be overloaded when pictures and text are presented together. The on-screen text can negatively affect the working memory which leads to an impairment in the learning process. It has long been argued that “instructional material should be designed in a way as to not overload the channels” (Krüger & Bodemer, 2022, p. 2).

Knoop-van Campen, Segers, and Verhoeven (2018) conducted a study on the modality and redundancy effects of multimedia learning in children with dyslexia to explore the advantages of learning from written and spoken text with pictures. They show that children with dyslexia spent more time learning when using text than learning through audio and graphics. The study concludes that it is more beneficial to use auditory learning. Similar results in favor of auditory presentation have been reported in the literature (e.g., Sweller, 1999; Mayer, 2001, 2005, 2009, 2014; Ginns, 2005; Ayers & Sweller, 2005; Clark et al., 2006; Harskamp, Mayer, & Suhre, 2007; Schmidt-Weigand, Kohnert, & Glowalla, 2010; Köhl, Scheiter, Gerjets, & Edelman, 2011; Tabbers, Martens, & Van Merriënboer, 2001, 2004; Scheiter, Schüler, Gerjets, Huk, & Hesse, 2014; Mayer et al., 2014; Eitel, 2016; Mutlu-Bayraktar, Cosgun, & Altan, 2019; Castro-Alonso & Sweller, 2020; and for a comprehensive review see van den Broek et al., 2014).

The computer-based multimedia presentation has been extensively investigated in the literature. For example, Savoji, Hassanabadi, and Fasihipour (2011) presented 80 eighth-grade female students with a computer-based multimodal presentation comprising 16 slides on lightning formation. The goal was to examine the role of dual coding and interactivity level in promoting scientific understanding in a multimedia learning environment. Surprisingly, they found that the narrative group in their study spent less learning time and exhibited more mental effort in processing information than the on-screen text group. Similar findings have been reported in the literature by Singh, Marcus, and Ayres (2012), Incecay and Kocoğlu (2016), and Lee and Mayer (2018).

Savojiet al. (2011) also found that low-interactivity groups outperformed high-interactivity groups on tests for retention and transfer. They attribute this finding to the need to lower behavioral activity during learning. Their main argument is that enabling learners to control the pace of instructions and narration can have a positive impact on information processing and the ability to recall. They conclude that while learners have an active role in their learning, at some stage, intervention is necessary. Understanding individual differences between learners and the interaction between type of modality and presentation mode is significant. It can have a considerable impact not only on instruction design but, importantly, on post-tests.

Mayer et al. (2014) examined different issues related to learning academic content in the ESL context. They specifically conducted two sets of experiments on students at the University of California to test the effectiveness of different instructional methods for helping non-native speakers of English learn new content that is presented in English. Computer-based multimedia presentations in English were applied in the two experiments. In the first experiment, a representational redundant effect video was added to a slow-paced 16-minute narration on wildlife in Antarctica. The authors assumed that adding the video would help clarify word meanings without adding extraneous cognitive load and therefore result in an improvement in performance in comprehension tests.

In the second experiment, redundant effect captions were added to a fast-paced, 9-minute narrated video lecture on chemical reactions. Adding the redundant captions was perceived as an attempt to enable learners to “parse the incoming auditory stream” (Mayer et al., 2014, p. 653) with the possible outcome of adding extraneous cognitive load which results from split visual attention. The authors found that participants in the first group benefited from having videos to support the narrated lesson. Adding the on-screen captions to the videos in the second group, however, did not result in learning improvements in terms of retention or transfer tests. One possible explanation is that the split-attention effect could have come about from the addition of printed words to the graphics, as was found to be the case in previous studies (e.g., Clark et al., 2006; Harskamp et al., 2007; Kühn et al., 2011; Tabbers et al., 2001, 2004; Ayers & Sweller, 2014). Overall, the two groups did not differ significantly in self-reported enjoyment of the lesson or perceived difficulty of the presented tasks. They did, however, differ in the effort they put into understanding the lesson, where subtitles enabled less effort to be expended. Remarkably, this reduction in reported effort due to the use of subtitles did not translate into improvements in comprehension.

A recent study on nuclear power supports the need to consider the interaction effects between presentation modes (spoken or written) and multimedia types (animation and simulation) using a two-by-two factorial experiment (Liu, Lin, Hsu, Hsu, & Paas, 2021). The participants were assigned to four experimental groups: Simulation with Spoken Text (SST), Simulation with Written Text (SWT), Animation with Spoken Text (AST), and Animation with Written Text (AWT). The major finding is that participants learned more from AST and SWT. One possible explanation for the efficacy of AST is that using dual modality presentation can mitigate the overload of the limited working memory system. This overload is likely to occur when texts are presented visually (Liu et al., 2021). In contrast, SWT contains different learning activities (e.g., observation and manipulation). As a result, more time is needed for learners to re-read the procedures of manipulation. With simulations, SWT is better because “the task of manipulation exacerbates the negative effects of the transient nature of spoken text on learning” (Liu et al., 2021, p. 314).

The superiority of audio-visual narrations with pictures over visual-only narrations with texts was also questioned by van den Broek et al. (2014). In their study, a group of 84 university

students studied audio-visual or visual-only multimedia presentations. The students then answered oral and written retention and transfer questions within one day. The primary objective was to examine text modality in learner-paced multimedia presentations and how its effects change over time. Another aim was to investigate how these effects relate to study behavior during learning and how the modality of the final performance measure influences them. Overall, no performance difference was found between the two groups immediately after learning. However, after one day, the visual-only group scored significantly higher on three out of four outcome measures. The authors attribute this finding to the reversed modality effect which is related to the negative effect of audio-visual presentations. In summary, the result of the study stands in sharp contrast to common multimedia design recommendations. The authors suggest that on-screen text should be included in learner-paced presentations. They also argue that it is essential to consider how active learners respond to multimodal input and how the modality of texts limits or fosters proper study behaviors. They conclude with a call to consider the long-term effects after learning and argue that it is by no means sufficient to evaluate decisions on multimedia design immediately after learning due to the possible change of effects over time.

The literature on the MP do not cover specific topics that are significant for ESL students studying English literature. The current study, therefore, aims to address this research gap and explore the effect of the MP on the learning of students studying Shakespeare's Hamlet at the Department of English of the University of Ha'il.

Methods

The present study uses quantitative measures to describe differences in the results obtained from multimedia-based instruction in the teaching of Shakespearean drama for the selected groups. The students were assigned randomly to two groups. The students in the first group (the control group) were presented with static pictures, narration, and on-screen text while studying the Shakespearean play Hamlet. The students in the second group (the experimental group) received graphics and narration of the play - but no text. This study adopts a quasi-experimental design to analyze the data obtained. The data were analyzed using the ANCOVA test to provide statistical evidence for the variation between the results obtained from the control and experimental groups. Due to sample size restrictions, the results discussed in the following section are representative of the selected sample only. More tests must be applied to a larger sample for evidence to be conclusive and applicable to EFL students in various contexts. However, the findings of the current study are a valuable resource to guide the future design of multimedia input in the given context.

Research Design

A quasi-experimental design was adopted in this research. Two groups were chosen randomly to avoid selection bias. The independent variable is the systematic multimedia lessons. The dependent variable is based on two potential gains: gain in knowledge and gain in mental skills for the two groups. The quasi-experimental design in this research is intended to establish a

cause-and-effect relationship between the independent and dependent variables. The MP of multimedia learning was adopted in the design and development of the instructional content (Mayer, 2001, 2021; Clark et al., 2006).

Participants

Two groups of students were chosen randomly from a cohort of 400 students from the Department of English at the University of Ha'il in the second semester of the academic year 2020-2021. All the students were enrolled in a Bachelor's degree in English language and literature. The 69 students were divided into two groups: control and experimental. The control group included 34 male students, and the experimental group included 35 male students (Table one). All students were of similar age and educational background. They were scheduled in these groups to study Shakespearean drama.

Table 1. *Sample description*

	Frequency	Percent
Experimental	35	50.7
Control	34	49.3
Total	69	100.0

Research Instruments

The researchers designed and developed a systematic multimedia program of the Shakespearean play Hamlet. Three education technology experts from the College of Education evaluated the software. An achievement test was administered before and after the study period. The test included 20 multiple-choice questions. The questions were designed by the researchers to measure both knowledge and mental skills about the play. The test was validated by the instructor who has been teaching this course for the last ten years at the English department. A pilot study of 20 students was administered before the administration of the program.

The instrument included questions on knowledge such as "What is the theme in Hamlet's play?" It also tested mental skills by asking questions such as "What would have happened if the queen had not drunk from the poisonous cup?"

Research Procedures

The experiment was conducted in the second semester of the academic year 2020-2021 via the Blackboard platform. The experiment took place over one month. A lecture strategy of instruction was applied in two 3-hour sessions per week. A pilot study from the population of the study was conducted on a group of 20 students. A reliability coefficient of .84 was verified through a test-retest approach. The reliability coefficient is appropriate for this study (Cohen, Manion, & Morrison, 2005). As mentioned above, the control group (34 students) was taught based on the multimedia-designed chapters that relied on graphics with audio and text. The experimental group

(35 students) studied the systematically designed chapters of the play Hamlet with audio, graphics, and animation only. After the experiment, both groups sat for the post-test.

The Procedure of the Systematic Multimedia Program

Two versions of the systematic program were designed by the researchers specifically for the play Hamlet. The design of the two versions followed the principle of the modality effect. The first version explained the chapters of the play to the control group through audio, text, graphics, and animation. The second version explained the chapters of the play to the experimental group through audio and animation only. Both contents were instructed through the Blackboard platform in the second semester of 2020-2021. Both groups sat for a pre-test and a post-test. The tests included 20 multiple-choice questions. Ten questions measured the students' knowledge of the play and the other ten measured their mental skills. Figure one introduces the first page of the program which was designed for the Shakespearean play called Hamlet. Figure two shows the knowledge of the first scene of the play through graphics, narration, and text. Figure three presents part of the mental skills portion just with pictures and narration only. Figure four illustrates an example of the evaluation questions at the end of the play (see Appendix A).

Results

The study aimed to investigate the effectiveness of the modality principle on students' knowledge and mental skills of their subject of learning, the play Hamlet. An ANCOVA test was used to examine differences between the mean scores obtained by the two groups after studying the play. The independent variable in this study was the multimedia instructional program, and the dependent variable was the achievement test divided into two parts, knowledge (10 questions) and mental skills (10 questions). The significance level was set at ($p \leq 0.05$).

A pilot study (20 students) was administered to determine the difficulty index and discrimination index (see Table two in Appendix B). The reliability coefficient was verified and found to be .84 for both knowledge and mental skills (Table three).

Table 3. *Reliability. Kuder Richardson - 20*

	KR-20
Knowledge	0.75
Mental Skills	0.78
All items	0.84

A pre-test was conducted before the experiment on the two groups to verify the equality between groups. Tables four and five show no statistically significant differences at $\alpha = 0.05$ between the two groups in the students' knowledge retention of the play and their mental skills.

Table 4. Equality between groups regarding the retention of knowledge

	GROUP	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Retention of knowledge	Experimental	35	8.91	1.292	5.373	67	.000
	Control	34	7.09	1.525			

Table 5. Equality between groups regarding mental skills

	GROUP	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Retention of mental skills	Experimental	35	8.51	1.337	5.114	67	.000
	Control	34	6.50	1.895			

Discussion

To answer the first research question (see Introduction), means, standard deviations and estimated marginal means of students' retention of knowledge according to group variables were computed as presented in Table six.

Table 6. Means, Standard Deviations and estimated marginal means of students' retention of knowledge of Hamlet's play according to group variable

Method	Pre		Post		Estimated Marginal Means	Std. Error
	Mean	Std. Deviation	Mean	Std. Deviation		
Experimental	5.83	1.654	8.91	1.292	8.899	.241
Control	5.35	1.555	7.09	1.525	7.104	.245
Total	5.59	1.612	8.01	1.676	8.001	.171

There is a slight variation in the means of the students' retention of knowledge of the play according to the group variable. The mean knowledge score in the control group is $X = 7.09$ with s.d.of1.52, while the mean for the experimental group is 8.91 with s.d.of1.3. One-way ANCOVA was used to examine whether there were statistically significant differences in the means (Table seven). Table seven displays statistically significant differences at $\alpha = 0.05$ in the post-test due to group variables favoring the experimental group.

Table 7. One-way ANCOVA results of the students' retention of knowledge of the play Hamlet according to group variable (Experimental, Control)

Source	Sum of Squares	df	Mean Square	F	Sig.
Pre-test (covariate)	.756	1	.756	.376	.542
Group	54.316	1	54.316	27.010	.000
Error	132.722	66	2.011		
Corrected Total	190.986	68			

To answer the second research question of the study (see Introduction), means, standard deviations and estimated marginal means of students’ retention of mental skills according to the group variables were computed. They are presented in Tables eight and nine.

Table 8. Means, Standard Deviations and estimated marginal means of students’ retention of mental skills in the play Hamlet, according to group variable

Method	Pre		post		Estimated Marginal Means	Std. Error
	Mean	Std. Deviation	Mean	Std. Deviation		
Experimental	5.46	1.686	8.51	1.337	8.514	.279
Control	5.18	1.445	6.50	1.895	6.501	.283
Total	5.32	1.567	7.52	1.914	7.507	.198

Table eight displays a slight variance in the means of the retention of mental skills in the play according to group Variable. The Mean score of mental skills in the control group is $X = 6.50$ with s.d. 1.89, while the Mean for the experimental group is 8.51 with s.d. of 1.34. One-way ANCOVA revealed statistically significant differences at $\alpha = 0.05$ in the post-test due to group variables in favor of the experimental group (Table nine).

Table 9. One-way ANCOVA results of the students’ retention of mental skills in Hamlet play according to group variable (Experimental, Control)

Source	Sum of Squares	df	Mean Square	F	Sig.
Pre-test (covariate)	.004	1	.004	.001	.971
Method	69.315	1	69.315	25.523	.000
Error	179.239	66	2.716		
Corrected Total	249.217	68			

The results indicate that the modality effect seemed to favor graphics with narration only. Participants in the experimental group outperformed the control group. This is apparent in the students’ results in both groups between the pre-test and the post-test. The findings of the ANCOVA test $F = (1.68) = 27$ at $p = .000$. As $p < 0.05$, demonstrate significant differences between the two groups concerning knowledge displayed by the experimental group. This significant result might be due to the use of the multimedia instructional program that excluded texts and relied on the program with graphics and narration only. This program assisted students in recalling knowledge of Hamlet’s play. This finding is in line with the findings reported by Moreno and Mayer (1999), Mayer (2001), Allen and Seaman (2014), and Mayer et al. (2014).

Clark et al. (2006) and Clark and Mayer (2016) stated that a more effective learning experience could be achieved through graphics and narration, more so than graphics and narration with text. They argue that the pictorial channel would be overloaded when pictures and text were presented together. Similar findings were reported by Colliot and Jamet (2018), Scheiter et al. (2019), Mayer et al. (2014), and Knoop-van Campenet al. (2018) who assert that it is more beneficial to use auditory learning. Ayers and Sweller (2014) also argue that adding the on-screen captions to the videos in the second group did not result in learning improvements which also conforms to the findings of this study. The present study provides additional evidence to the

previous arguments. It could be argued that adding the on-screen text in the case of the control group overloaded the students' audio-visual channel thus resulting in lower performance in tests on retention of knowledge.

With regard to the findings related to the second question that measured retention of mental skills, it has been reported that the ANCOVA test showed that $F = (1.68) = 25$ at $p = .000$. As $p < 0.05$, there are significant differences between the two groups with regard to mental skills, with the experimental group showing better skills. This result conforms with the findings by Liu et al. (2021) that reveal a significant impact due to the use of animation and graphics with spoken text. Likewise, animation was included in the events of the play where Hamlet performed the killing of the king by his brother. The result also conforms with the studies by Eitel (2016), Knoop-van Campenet al. (2018), and Clark et al. (2006) that support the use of auditory learning. Similar results in favor of auditory presentation have been reported in the literature (e.g., Sweller 1999; Mayer 2001, 2005, 2009; Ginns, 2005; Ayers & Sweller, 2005; Harskamp et al., 2007; Kühl et al., 2011; Tabbers et al., 2001, 2004; Scheiter et al., 2014; Mayer et al. 2014; Mutlu-Bayraktar et al., 2019; Castro-Alonso & Sweller 2020).

However, the results of the current study are inconsistent with some previous studies (e.g., Savoji et al., 2011; Singh et al., 2012). For example, Savoji et al. (2011) examined the role of dual coding and interactivity level and found that students exert more mental effort to process information than their counterparts from the on-screen text group. Another study conducted by Ayers and Sweller (2014) found that adding on-screen captions to videos does not result in learning improvements. The study by van den Broek et al. (2014) stands in between, suggesting the superiority of the visual-only group and that on-screen text should be included in learner-paced presentations. In the present study, the findings support the first argument that audio-visual presentation has more benefits than visual-only presentations. It could be argued that using animation has contributed to the superiority of audio-visual presentation, eliminating the need to present the accompanying text or captions.

Recommendations and Implications

This research focused on the effect of the modality principle on students studying Shakespearean drama in the English department at the University of Ha'il. Two versions of the multimedia program were designed, developed, and experimented using the Blackboard platform. The version with pictures and narration helped students achieve significantly better results than the program that included graphics, narration, and texts. The MP revealed a high possibility of enabling the students to retain knowledge and sharpen mental skills in the course of study of Shakespearean drama.

In light of the findings of this research, it is recommended that multimedia-based instruction is adopted in teaching linguistics and applied linguistics classes to help students excel in their academic work. Moreover, with the urgent and increasing need to teach courses using online platforms, further studies and investigation are required to evaluate the merits of various

instructional techniques that can be adopted for adaptable teaching environments, such as during the COVID-19 pandemic lockdowns. These techniques, however, should not only focus on issues related to learning and the transfer of knowledge and mental skills. One of the limitations of the literature on the cognitive theory of multimedia learning is that it focuses on instructional techniques and, on many occasions, ignores the role of students in the learning process (Cavanagh & Kiersch, 2022). In other words, students' engagement and satisfaction are important because they are likely to impact learning. Taking the role of students into account while designing new content can improve the quality of online classes not only in terms of communication among students but also among faculty members (Ginting et al., 2022). Further research is needed on the role of students' engagement and satisfaction and how the two combined may influence learning and the overall achievement in retention of knowledge and mental skills tests. Overall, using new concepts and instructional strategies with education technologies and multimedia is highly recommended because it could help students under different circumstances excel in a competitive labor market.

Conclusion

The present study hypothesized that an audio-visual presentation would lead to better learning outcomes for students. The central aim was to compare the impact of using static pictures and narration concurrently with on-screen text for the control group with the impact of using pictures with narration only for the experimental group. The results support the hypothesis. The results demonstrate the superiority of the application of audio-visual representation over visual-only representation. This is manifested in the students' achievements in post-tests on the retention of knowledge and mental skills. This study provides additional evidence that visual presentation in the form of on-screen text or captions can add a surplus load to the auditory channel and the working memory which results in adverse effects on the learning process.

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Appendices

Appendix A

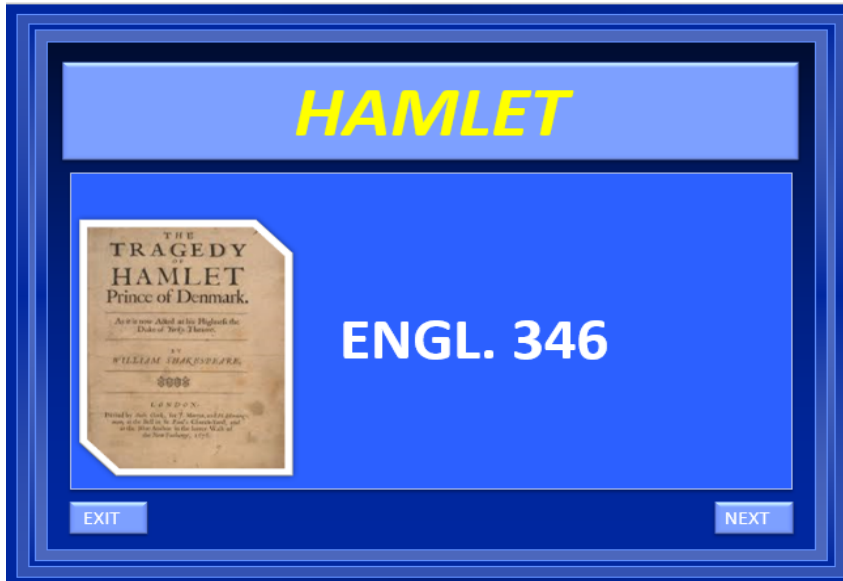


Figure 1. Home screen



Figure 2. Introduction (knowledge)



Figure 3. Mental skill

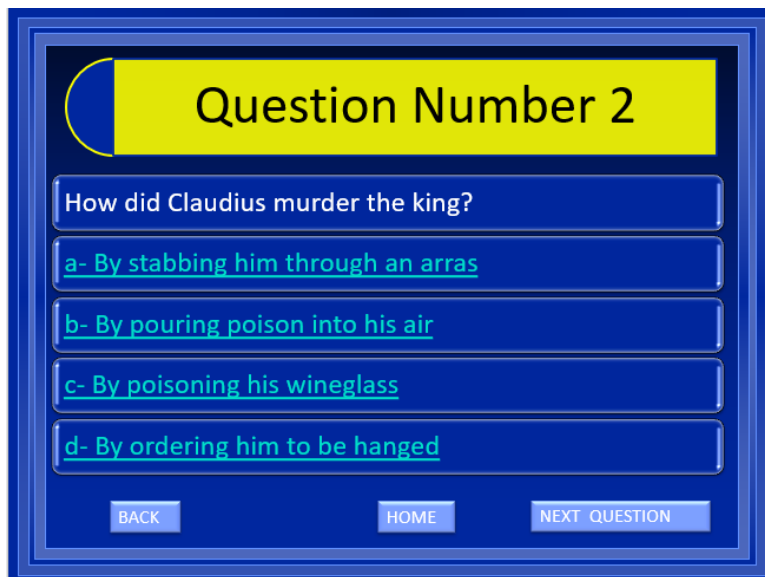


Figure 4. Evaluation

Appendix B

Table 2. Discrimination index and difficulty index

	Discrimination index	Difficulty Index
1	.48*	0.25
2	.47*	0.35
3	.46*	0.35
4	.70**	0.35

5	.55*	0.35
6	.53*	0.40
7	.58**	0.40
8	.64**	0.40
9	.49*	0.45
10	.43*	0.45
11	.47*	0.45
12	.63**	0.45
13	.46*	0.45
14	.56**	0.45
15	.29*	0.45
16	.47*	0.50
17	.62**	0.50
18	.66**	0.50
19	.65**	0.55
20	.70**	0.55

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).