The Effect of Mobile-based Interactive Multimedia on Thinking Engagement and Cooperation

Maroua Rogti
Ecole Normale Supérieure de Laghouat, Algeria, *m.rogti@ens-lagh.dz*

Recent studies show limited research in the Algerian context on the development of learning multimedia that effectively addresses 21st century skills such as critical thinking, communication, cooperation, and creativity. However, with the continuous growth of digital multimedia and information technologies, there is an urge for utilizing 21st century skills and interacting with others through interactive multimedia tools. This study aims to investigate the effect of mobile-based interactive multimedia on developing students of English as a foreign language thinking engagement, cooperation, in higher education. A convenient sampling method was used to select one sample of students (n= 60) who received a post-treatment test. Data were analyzed through performing descriptive statistics and one sample t-test. Findings assured that mobile-based interactive multimedia has persistently shaped the education setting, and it can afford the potential to positively promote students' thinking engagement and cooperation.

INTRODUCTION

The idea of integrating technology in education has managed to improve the teaching and learning experiences, and has attracted educators for the last two decades (Khanal, 2020). Therefore, many attempts have been made in this respect for incorporating multimedia computers, internet, software, and hardware to teach the foreign language and its significant skills. In the early 1990's, the cognitive perspective of communicative language teaching was replaced by socio-cognitive perspective which emphasized the use of more authentic and meaningful language, and essentially integrating all the four skills, listening, speaking, writing, and reading with technology which led to the so-called integrative computer-assisted language learning.

Integrative multimedia emerged due to computer and internet availability, and recently due to technology changes from text and graphics to sound, animation, and video attributed to computers and PCs. These represent what we call *"hypermedia"* (Babelyuk et al., 2019). The internet and hypermedia advances allowed CALL stakeholders to integrate technology in language teaching innovatively (Tafazoli et al., 2019). Subsequently, having access to a large information resources and authentic

communication tools, students are expected to adjust with the use of technology in their language learning process which affected them pedagogically, socially, and economically (Teräs et al., 2020).

In EFL learning classroom, students' innovation, interaction, creativity, thinking engagement, cooperation, and communicative competence can be affected by various attributes (Ariani & Festiyed, 2019). In an online classroom, multimedia can support learning practices. Rahman and Ahmar (2017) stated that multimedia can provide a significant access to equity of teaching, which enables students to have high academic achievement. It is used to enhance learning activities, and develop thinking engagement and 21st century competencies.

The frame of multimedia computers can provide a dynamic environment which is not only visual or auditory, but also interactive within its learning environment (Tafazoli, 2022). Interactive multimedia environment requires interaction between learners who are involved in meaningful tasks, thing that EFL students in Algeria may lack when engaging in traditional learning environment tasks. Multimedia has been proved to be effective for learning, as it can stimulate learners' interest and enhance their learning experience. (Makruf et al., 2022). It provides a technology-based constructivist learning environment where students are able to solve problems by means of self-exploration, collaboration and active participation (Silva et al., 2023).

Regarding the background above, interactive multimedia has increased learning outcomes, interaction, and critical thinking skills. However, there was still lack of literature on learning multimedia for helping students to develop their thinking engagement. Therefore, this research aims to develop android-based interactive multimedia at higher college of Laghouat using a mobile application. Hamdani et al. (2022) emphasizes the role of using android-based application as interactive multimedia in improving critical thinking skills, as students can learn through role playing, and increase their enthusiasm to learn through game-based learning. Furthermore, this research also focuses on students' higher order thinking skills, and cooperation which serve as one of the 21st century innovative pedagogies. Therefore, the research aims to develop android-based interactive multimedia to enhance critical thinking engagement in learning settings. Ariani and Festiyed (2019) stated that students' critical thinking abilities could be improved through game-based learning. They can enjoy studying, raise their interest, and attain their goals.

Review of Literature

Incorporating multimedia and computer assisted language learning into higher education curriculum in Algeria has been considered as a relevant means to the process of learning (Babelyuk, 2019). According to Astalini et al. (2023), integrating multimedia into the EFL classroom contributed to increasing students' cognitive ability and 21st century skills, and developing their autonomy to learn (Yuan & Huang, 2020).

Hypermedia: A Conceptual Review

The word *"hypermedia"* has its origin from *"hypertext"*, a term coined by Theodor Nelson, who aimed to link texts in a nonlinear way. The idea of hypertext was joined

with the use of multimedia such as graphics, animation, audio and video, which represent hypermedia Lu et al. (2017). Hypermedia consists of nonlinear multimedia tools and graphics, and it involves both multimedia and hypertext. It is derived from *"hyper"* that means *"nonlinear",* and *"media"* which refers to a set of information represented in various formats. According to Zhang and Zou (2020), the integration of multimedia video, animation, graphics, sound with text, and its basic units of information *"Nodes"* and link structure, which involves the interconnection between the nodes contributed to increasing the language learning and teaching the structure of hypermedia. This can be illustrated in figure 1.
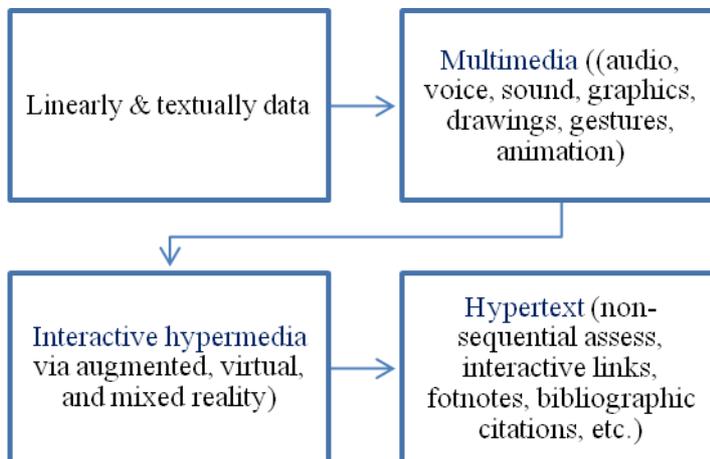

Figure 1
Hypertext and hypermedia (Cohen, 2013, p.03)

Terms like multimedia, interactive video, hypermedia, and hypertext are deeply interrelated (Kirschner et al., 2017). The first Computer-assisted Learning program was flourished in the 1950's, and technology use became more practical with designing personal computers to be used for learning (Bozkurt & Sharma, 2020). Nowadays, educators emphasize socializing learners through online communication and cooperation in their classrooms through using computer-mediated classroom discourse (Masood & Afsar, 2017).

Mobile applications and platforms are one form of interactive multimedia created for academic and educational purposes. Almost every student nowadays owns a smartphone, they can engage in mobile learning to achieve learning outcomes. According to Nikolopoulou et al. (2023), mobile devices are equipped with communication capabilities, and allow students to search for educational resources and content or for information via the web, to communicate with fellow students and tutors, to access e-class, and to download books. Chang and Hwang (2019) state that interactions mediated by technology involve synchronous interactions with individuals, and that mobility can create an interactive learning environment, it expends collaboration and communication, facilitates students' engagement, and increase their

stimulation. Bidin and Ziden (2013) realized that mobile learning encourages learner-centered environment and active involvement in the learning process.

Mobile learning involves the personalised and interactive use of computers in learning environments (Alhumaid, 2020). According to Leite (2014), ML can allow the students to construct their knowledge, it is the digital aid of adaptive, collaborative, and productive learning practices in online classrooms. There are many mobile operating systems, such as Android which is an open-source operating system. Furthermore, the Android application development is smoother than other platforms (Walker, 2011). Uzunboylu and Ozdamli (2011) indicated that mobile learning with handheld devices enables cooperative learning environments which involve interaction between peers and the teacher in the classroom. Mobile technologies have been used to promote deep learning and cooperative work in teaching classrooms, and allow students to personalize their collaborative learning progress (Zhou & Lewis, 2021; Huang et al., 2020; Each & Suppasetseree, 2021).

Interactive Multimedia and Cooperation

Interactive multimedia in learning and teaching requires the need of developing communicative and cooperative skills because of the nature of the interactivity and learner engagement in interactive multimedia (Thomas, 2018). An interactive multimedia environment requires the use of cooperative strategies to access, integrate and navigate information, also restructuring knowledge, through collaborative learning processes, project work, peer feedback, and monitoring (Parsazadeh et al., 2018). Through interactive learning environment, the students can experience integrated learning through the active interactions. Therefore, they can be self-directed learners who take full responsibilities for their learning and make independent choices (Winarti et al., 2022).

Regarding the use of CALL multimedia, Bruner (1996) states that "a well-programmed computer is especially useful for taking over tasks that, at last, can be unfit for human production" (p. 02). Occasionally, models of computer programs appeared prior to the works of constructivists: Jerome Bruner, Jean Piaget, and Lev Vygotsky. According to Constructivists, learners construct their own knowledge of the world through assimilation and experience. In addition, Mohammed and Kinyo (2020) state that Knowledge is socially produced and this cognitive constructivism promotes collaborative Learning, either with a facilitator or with other peers.

Multimedia learning Environment is typically based on Piaget's Cognitive theory and Dewey's learning principles. Piaget's theory shapes the basis of environmental and experiential theories: assimilation, accommodation, and equilibration (Piaget, 1985). It evokes that the individual's existing cognitive structures are modified based on his environment. It refers to the process of assimilation and accommodation of one's own environment. Dewey's principles yet involve three learning experiences which are situation, interaction, and continuity (Dewey, 1938). The situation represents experiences of an environment affecting the individual, while interaction involves current transactions taking place between the individual and their environments.

Constructivist theory emphasizes problem solving; thinking skills and meta-cognition, and social constructivism emphasizes the student's ability to solve complex problems in real life, practical situations (Sattin et al., 2021). According to constructivists, individuals can engage in complex tasks which require solutions to problems rather than on instructional units which involve learning particular content skills (Halpern and Dunn, 2021). Teachers' role is to provide students with the required resources and act as a guide while learners are actively engaged in interaction and thinking process as well (Tafazoli, 2022).

The learning environment is characterized with the students' active involvement, as they are exposed to accomplish complex tasks which require problem solving and critical thinking skills (Tafazoli, 2022). Huang et al., (2020) argues that interactive multimedia learning environment is more convenient than e-learning environment because students can learn at their own pace, and acquire knowledge through interaction with the situation. Vygotsky (1978) emphasizes that the community plays an essential role in the process of creating meaning. These theorists suggest that critical thinking develops better in a learning context that involves peers. Occasionally, multimedia technology can enhance the learning process in a constructivist learning environment. Web-based learning, including interactive multimedia and simulation are supported by the constructivism and social constructivism approach (O'Connor, 2020).

Hypermedia learning can provide interactive communication and can create a potentially cooperative learning environment. According to Shah (2019), interactive multimedia is a good potential for collaborative work and communication. Prior to this, learners can engage in face to face and online discussion, or negotiation. Through this environment, students can also engage in project-based groups and problem-solving activities (Tafazoli, 2021). Moreover, this type of e-learning process for collaborative learning creates democratic learning environment through which students can have the opportunity to voice their opinions and hear the opinions of the others (Hodges et al., 2020).

Collaborative learning environments can engage students in active learning and create a community of inquiry (Orcutt and Dringus, 2017). As Collaboration can enable students to make progress through their zone of proximal development by the tasks they engage in (Vygotsky, 1978). According to social constructivists, students are more interested in activities which allow them to interact with others. Hypermedia can provide students with this, as they can raise complex cognitive skills, share their opinions, and comment on the arguments of others. Students can develop their higher-order thinking skills, along with reasoning, solving problems, making judgements, and drawing conclusions (Saido et al., 2015). Integrative multimedia can create a motivating and active learning environment for students and develop their 21st century skills through computer-based instruction, internet, and hypermedia (Sun et al., 2022).

Interactive multimedia can provide students with a large database by using software, hardware, and other multimedia tools to access information, by creating a learner-centered multimedia learning environment (Bouck et al., 2020). Additionally, learners

can be offered the opportunity to learn language in a more intercultural manner, by interfering with cultural situations in which they make decisions on the use of language, and make cultural interpretations of the situation by establishing a sphere of inter-culture with the other culture (Celen, 2020; Nurhafifah et al., 2020).

Students' engagement can work in parallel with communicative learning strategies in interactive multimedia learning environment, their actions and decisions, and the strategies they use to communicate and interact (Baharuddin, 2015). In effect, the metacognitive strategies involve organizing and thinking about the learning process, planning, monitoring the learning task, and evaluating the task (Halpern and Dunn, 2022). Cognitive strategies involve interacting with the material to be learned, and social and communicative strategies involve interacting with others to have self-control over assisting a learning task (Rahimi & Tafazoli, 2022).

In a study, Adeniyi, et al. (2016) examined the effects of interactive multimedia on students' pronunciation performance, the finding showed that using effective interactive multimedia teaching tools had high impact regarding the time and effort, and positively affected language skills. Learning with interactive media is more effective when learner Knowledge is activated prior to exposure to Multimedia Content such as using animation, motion images, verbal expressions. Additionally, Shahzad et al. (2021) conducted an experiment to assess the use of software development design by identifying effects of interactive multimedia environment on learning patterns of graduation students. The finding demonstrated that in controlled environments, learning was effective by using interactive multimedia, and learners became able to learn when they were given freedom to use different learning strategies which were based on the ability and cognition of learners.

The experimental study of Putri (2015) aimed to explore improving speaking ability of the eight grade students by using Interactive Multimedia. The data were collected through observation sheet and a speaking test. The findings indicated that using Interactive Multimedia could improve the students' speaking ability after the treatment, which was proved through the improvement in the mean score, in pre-test M= 3.99 and the post-test M= 5.77. Based on the findings, it has been concluded that using Interactive Multimedia is effective in improving students speaking ability.

Rajendra and Sudana (2018) conducted a quasi-experimental design with pre and posttests to investigate the effect of interactive multimedia technology on enhancing students' achievement on skills practice in mechanical technology. Findings indicated that there is a significance difference between the mean scores of students in the EG than those students in the CG. The students in the EG performed better in mechanical technology practice and in retention test than those in the CG. Their study recommended that multimedia teaching tool is effective in enhancing students' achievement on practicing skills in mechanical technology.

Shofi and Masruroh (2018) examined the effectiveness of using multimedia on improving English students' speaking fluency, using a pre-experimental study involving only one experimental group. The results of the t-test signified 8.02, and the final

calculation shows that the t-test is greater than 0.05 level. This proves that multimedia use is very effective in improving the speaking fluency of English students. This reveals that the implication of multimedia in learning speaking has been significant in improving the fluency of speaking in English. In his study, Dawood (2022) explored the correlation between students speaking competency and their interaction with multimedia tools in the learning process. The study was conducted to a sample of non-native speakers of English who were divided into treatment and control groups. The results showed that there was a significant impact of the interactive multimedia environment on developing presentation and speaking skills among the students of the treatment group, and proved that multimedia helped students perform and interact better.

In a study by Islam (2020), the impact of audio-visual multimedia on the Bangladshi EFL students at tertiary level has been investigated. The study used a qualitative method, and the data have been collected from two different sources, from students' written response to an open-ended question and through classroom observation. Findings revealed that using multimedia technologies can be a means for improving traditional teaching practices, particularly in the EFL context.

Thinking Skills

Students can construct knowledge through having an opportunity to interact with their peers, teachers, experts from various fields, and textual and electronic databases. According to Sulaiman, et al. (2019), the incorporation of higher order thinking skills in teaching and learning is beneficial to students' real life because life has many challenges, and students can be trained to think critically and creatively prior to accomplishing tasks (Halpern & Dunn, 2021). Students can also play an active role in learning through their real-life experiences. And think critically by making judgments, reasoning, and reflection (Halpern & Dunn, 2022).

In the EFL context, the aim of teaching is to equip students with the ability to reason, reflect, infer, and make decisions independently (Shekhar & Rahnev, 2021). Occasionally, higher order thinking means doing exactly this. Critical thinking involves a problem-solving process, through which the individual can interact with others based on their prior knowledge and this leads to making judgments and inferences. The last part of critical thinking involves a decision about what to do or what to believe, critical thinking skills require a disposition to think critically and involves a subsequent decision on how to act (Ginting & Ratnawati, 2023).

According to Shekhar and Rahnev (2021), CT is a process of thought which involves making synthesis, reasoning and inferences. According to Campbel (2015), EFL students can learn effectively when they engage in meaningful tasks and solve problems, they can actively construct their own knowledge and be able to apply what they learned to new contexts. In this respect, students' perceptions of their learning environments and their academic achievements are reflected by the level of their critical thinking skills.

Interestingly, many researchers considered the enhancement of student thinking skills through the use of Multimedia computers. Using technology in the classroom can contribute to developing problem solving skills, decision making, cooperation and

higher-order thinking skills for students (Kusuma et al., 2017). Further, it is efficient to integrate technology in the classroom which can ensure students' high attitudes toward learning, and increase their higher-order thinking skills (Jiang et al., 2021). In addition, there is considerable evidence to suggest that when the classroom multimedia environment was collaborative and interactive, it creates new opportunities to ensure interaction in the teaching and learning process (Frazier et al., 2021). The cognitive dimensions of higher order thinking skills delivered by Bloom which involve analyzing, synthesis, and evaluation which are associated with conceptual knowledge, procedural knowledge, and metacognitive knowledge (Kusuma et al., 2017).

In this respect, computer-assisted communication and multimedia learning can provide opportunities for accessing remote data sources, project work, and cooperation with peers in the learning setting (Gillespie, 2020), and allows exchanging work for evaluation or for receiving interactive feedback by other students. Computer-assisted language learning can work in parallel with project-based instruction which became called integrative CALL as Gimeno-Sanz (2015) states that "it provides learners with distinctive forms of meaningful input to enrich the learning experience and with a multisensory experience like language itself" (p.4). It can enable teachers to design programs to satisfy their students' needs and enhance their learning experience.

Technology integration has proven to be effective in enhancing learners' motivation, thinking competency, and interactivity (Ross & Gage, 2006). Multimedia computers can contribute to accomplishing learning tasks through supplementary activities, and extra practice in regular EFL teaching and learning classrooms (Jafarian et al., 2012). Thus, the integration of both integrative and interactive multimedia tools proved beneficial as this allows interaction between not just EFL learners (Lee & Park, 2020), but also between EFL learners providing them with high opportunities to improve their communication and thinking skills at once (Gamage et al., 2020).

Accordingly, the study of Sandang et al. (2022) emphasizes on using interactive learning multimedia *Mejabando* and its role in improving critical and creative Thinking ability in Indonesian language learning Classroom. It aims to output android-based learning multimedia, using the model of analysis, design, development, implementation, evaluation. The findings of the analysis revealed that the average N-gain values for critical thinking skills and creative thinking skills are in the moderate effective category with 0.66 and 0.57 successively. The researcher concluded that the interactive multimedia *Mejabando* is quite effective in improving students' critical and creative thinking skills in learning Indonesian in elementary school fifth grade, and the overall mean is valid and practical in improving students' critical and creative thinking skills.

On the other hand, the purpose of the research of Jumhur (2021) was to investigate the effectiveness of critical thinking-based interactive learning multimedia for Basic Mechanical Engineering. The information design in developing the learning media was based on critical thinking aspects. The critical thinking-based interactive learning media was developed for mobile learning to be used in IOS and Android. Results of the alpha test and User Acceptance Test revealed significant findings regarding CTBILM, this prominent change in student critical thinking from the t-test on pretest and posttest is

due to critical thinking-based interactive learning multimedia.

Putting emphasis on the study of Abdulah et al. (2021), which explores interactive multimedia and problem-based learning. The aim of the study is to assess its effectiveness on increasing critical thinking skills. This research uses a Research and Development approach, and the data was obtained through the media validation sheet instrument, while data analysis used the independent t-test. The results show that interactive multimedia based on problem-based learning proved to be significant to improve critical thinking skills in students. Djamas et al. (2018) emphasized on evaluating interactive multimedia learning tools which are fit with games in Linear Motion and Newton's Laws, and its effect on improving critical thinking skills. The study involved testing 30 students' critical thinking skills after using interactive multimedia learning tools. Therefore, the results show that interactive multimedia tools are effective and practical.

After reviewing the literature, it is apparent that most research examined the effects of interactive multimedia on improving the language skills, communication, and speaking competence, and very few investigations have examined the effects of mobile-based interactive multimedia on cognitive skills and cooperation among Algerian EFL learners. In this respect, the present study diagnoses the role of integrating mobile-based interactive multimedia in EFL contexts, and it uncovers the level of students' thinking engagement and cooperation through interactive multimedia use. The study also tempted to investigate the effect of mobile-based interactive multimedia on learners' attitudes. To meet these objectives, the following research questions were put forward:

- Does mobile-based interactive multimedia have a significant impact on EFL students' thinking engagement and cooperation?

- Do EFL students hold positive attitudes towards using mobile-based interactive multimedia in the EFL classroom?

The following hypotheses are stated respectively:

H0: Mobile-based Interactive multimedia has no statistically significant impact on increasing the level of students' thinking engagement and cooperation in the classroom.

H0: EFL students do not hold positive attitudes towards using mobile-based interactive multimedia in the EFL classroom

METHOD

The researcher used a quasi-experiment type of the One-Group Posttest-Only Design (X O1) to conduct the present study. According to Maciejewski (2020), "quasi-experiment is a retrospective study of a single treatment cohort and a non-equivalent comparator cohort" (p.40). Quasi-experiments aim to examine causality between an intervention and an outcome. In this study design, an intervention (X) is implemented and a post-test survey (O1) is taken. To run the present study, the researcher used four instruments: the test of Metacognitive Knowledge adopted from Händel et al. (2013) to test homogeneity, the Online Student Engagement Scale (OSE) adopted from Dixson (2015)

to test thinking engagement, cooperative learning scale of Fernandez-Rio et al. (2017) to test cooperation, and attitudes towards online learning (AOL) scale of Jiang et al. (2022) for testing attitudes of students as the post-tests by reviewing the related literature on mobile-based interactive multimedia. The scales of the survey were also carried out to measure the participants' responses after the treatment.

A total of 60 EFL students were selected through a convenient sampling method, after being homogenized by taking the test of Metacognitive Knowledge. They were selected and assigned to a treatment group (n=60). The survey was administered to ENSL students at the department of English who have received the treatment, which lasted for five sessions. The scales of the survey were five-point likert-type scales ranging from Strongly Disagree (1) to Strongly Agree (4). The data collection started in the spring of 2022. The participants included just female students because this gender is usually the dominant at college. They aged from 19 to 21 years old and were learning English as a foreign language. The participants expressed verbally their consent to participate in the study, as the researcher ensured that their responses during the study would remain confidential.

The five sessions' treatment involved using an online application, named Interactive Whiteboard application, which is an android-based application. The students were asked to download the Android application. A storyboard was created, and the process of interactive multimedia was identified through a plan which started from the beginning of interactive multimedia until the end by the teacher. Then, a storyboard was designed for giving a visualization of the interactive multimedia tool. This interactive multimedia consists of lessons, images, documents, videos, recording, links, and games.

The classroom created was named Writing skills class, and was created for second year EFL students. The teacher who is the researcher herself, has familiarized the students with lessons about writing an argumentative essay, the form and effectiveness of the thesis statement, and the outline of the essay.
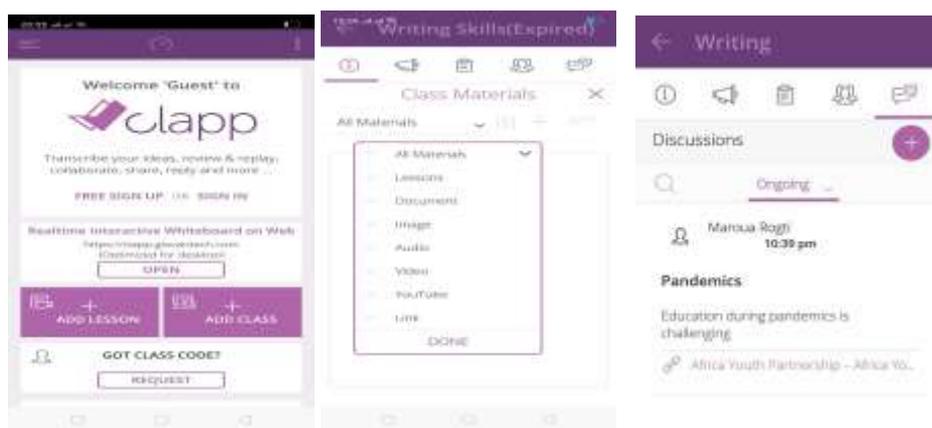

Figure 2
Interactive whiteboard application

In this application, the users read the material, as they are asked to think, synthesize, and analyze before learning a new aspect. For example, they have to analyze and synthesise the nature of pandemics, then they learn about the role and effect of pandemics in education. After that, they can draw conclusions about it. According to Ennis (2011), critical thinkers can be able to question, analyze, judge the credibility of a source, and make judgments, clarify and support their opinions appropriately, and to imaginatively integrate the logic of an opinion with reactivity to others. Moreover, students can also develop their higher order thinking skills, such as analysis, through interaction. Thakur and Al Mahrooqi (2015) state that critical thinking skills develop through cognitive ability, and are basically needed for evaluating the thinking process that results in a meaningful learning experience.
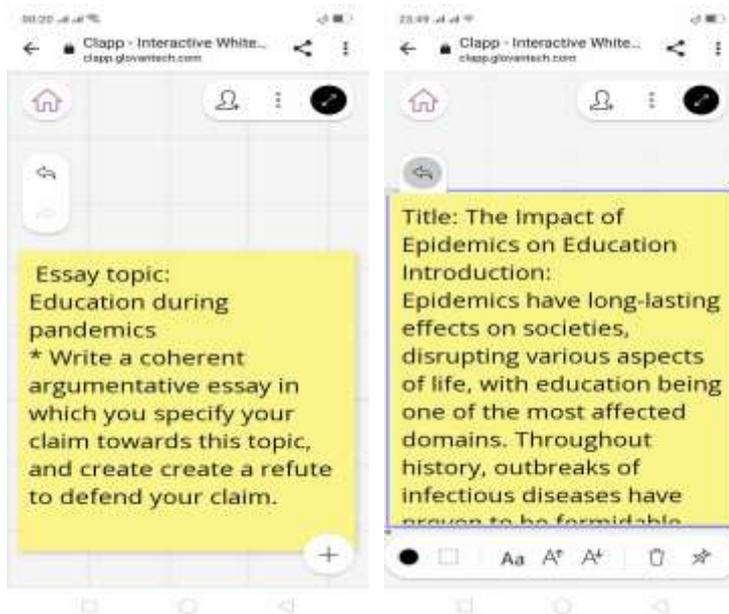

Figure 3

Example of a student's answer on the Interactive whiteboard

This interactive multimedia is also equipped with games and quizzes to achieve students' high thinking engagement and understanding of what has been taught. In this interactive whiteboard application, the students have been familiarized with different quizzes and games associated with it.

FINDINGS AND DISCUSSION

The total reliability of the questionnaire was estimated by Cronbach's Alpha which equals ($\alpha= 0.82$). It signifies that there is a high level of internal consistency between the items of the scales, and proves that the scales are extremely accurate. After that, the

researcher used correlation matrix to test correlations between dependent variables, and to screen the items of the scales. As correlations between 0.3 and 0.9 should not be eliminated, the correlations between dependent variables ranged between −0.3 and 0.7 in all utilized scales, indicating that there were no multicollinearity effects in the data. The third test was the prerequisite test which consisted of the normality test to test the post-test scores of the students' thinking engagement and cooperation using the Kolmogorov-Smirnov and Shapiro Wilk tests.

It consisted of thinking engagement and cooperation data, and the students' attitudes prior to the post-test. The t-test was also used to test the level of thinking engagement indicators collected from the students' responses and performances during the online classroom. The normality scores of thinking engagement and cooperation, and attitudes for both pre-test and post-test for the sample, relying on Kolmogorov-Smirnov and Shapiro Wilk analysis are presented in table 1.

Table 1
Result of Tests of Normality for thinking engagement, attitudes, and cooperation

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Cooperation in Interactive Multimedia	,153	60	,001	,935	60	,021
Attitudes towards Interactive Multimedia	,192	60	,000	,921	60	,001
Students Level of thinking Engagement	,248	60	,000	,554	60	,000
a. Lilliefors Significance Correction						

The normality Kolmogorov- Smirnov tests of the students' thinking engagement in the post-test was 0.248. The sig value is below 0.05, (0.000≤ 0.05), cooperation statistic= 0,153 with sig= 0.001 which is below 0.05, and attitudes towards interactive multimedia statistic is 0.192 with sig (0.000≤ 0.05). This signifies that the post-test score was normally dispensed. In addition, the Shapiro-Wilk tests of variance were below the alpha level of 0.05. The normality score of students' cooperation was 0.02, thinking engagement statistic was 0.000, and attitudes towards interactive multimedia score was 0.001.

After checking out and meeting the required assumptions, the researcher could run the t-test. As reported in Table 2, M (3.2017) and SD (0.2054) for the sample group were calculated in turn on the cooperation post-test. In addition, M (3.1867) and SD (0.2375) and M (3.2817) and SD (0.4114) were calculated respectively on the attitudes, and thinking engagement post-tests.

Table 2
Descriptive statistics for thinking engagement, attitudes, and cooperation post-tests

	N	Mean	Std. Deviation	Std. Error Mean
Cooperation in Interactive Multimedia	60	3,2017	,20543	,02652
Attitudes towards Interactive Multimedia	60	3,1867	,23755	,03067
The Students' Thinking Engagement in the Classroom	60	3,2817	,14148	,05312

To see if there was a statistically significant difference between the obtained means, one sample t-test was run. As shown in table 3, the dependent variables, cooperation (0.00 < 0.05) and thinking engagement (0.00 < 0.05), had both a significant value which indicates that there was a significant impact of interactive multimedia on cooperation, attitudes, and thinking engagement in the group sample.

Table 3
Results of one-sample t-test of the thinking engagement, attitudes, and cooperation post-tests

Dependent Variables	Test Value = 0				95% Confidence Interval of the Difference	
	T	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Cooperation in Interactive Multimedia	120,724	59	,000	3,20167	3,1486	3,2547
Attitudes towards Interactive Multimedia	103,911	59	,000	3,18667	2,1253	3,2480
Thinking Engagement in the Classroom	61,776	59	,000	3,28167	3,1754	3,3880

Therefore, the null hypothesis is rejected and the hypothesis which indicates that interactive multimedia significantly affects EFL students' cooperation and thinking engagement in the online classroom is approved. On the other hand, to address the second question, we can see that the T-value for students' attitudes towards interactive multimedia is 103,911, df = 59, and Sig is 0.000, which is less than 0.05. Therefore, it was reported that the students had positive attitudes toward interactive multimedia to increase their level of thinking engagement through higher order thinking skills.

Table 4
Results of Test between subjects Effects for the post-test

Source	Type III Sum of Squares	Df	Mean Square	F	Sig
Corrected model	1,016[a]	8	,127	4,395	,393
Intercept	325,515	1	325,515	11263,962	,000
Attitude	1,016	8	,127		,393
Error	1,474	51	,029		
Total	617,530	60			
Corrected total	2,490	59			
Corrected model	1,565[a]	9	,174	1,032	,428
Intercept	280,010	1	280,010	1661,848	,000
cooperation	1,565	9	,174	1,032	,428
Error	8,425	50	,168		
Total	656,150	60			
Corrected total	9,990	59			
Corrected model	1,237[a]	9	,137	3,285	,003
Intercept	229,425	1	229,425	5482,659	,000
thinking	1,237	9	,137	3,285	,003
Error	2,092	50	,042		
Total	612,620	60			
Corrected total	3,329	59			

The test between subjects' effects in Table 4 shows which variable is affected the most by mobile-based interactive multimedia regarding EFL learners' cooperation and thinking engagement. Based on statistical data in this table, the second null hypothesis is also rejected, and it is proved that both thinking engagement and cooperation are highly impacted by the use of interactive multimedia, because sig-value< α, α=0.05, sig=0.000. Therefore, it is concluded that there is a statistically significant impact of interactive multimedia on thinking engagement and cooperation. According to Abdullah et al. (2021), students can achieve high level of interactivity through multimedia projects, be self-directed learners, and learn to think critically, and to practice problem-solving and decision-making.

Considering the findings of the impact of mobile-based interactive multimedia on thinking engagement and cooperation regarding, and how the research variables and tests were applied. The first null hypothesis of the study was rejected and we approved that mobile-based interactive multimedia has statistically significant impact on the both thinking engagement and cooperation. We also rejected the second null hypothesis and approved that students hold positive attitudes towards using interactive multimedia in the classroom. Therefore, the researcher concluded that EFL learners can achieve high level of thinking engagement and cooperation when they are highly involved in interactive multimedia.

It was also revealed in the analysis that sig=0.000, considering the assumption that α=0.005, sig<0.05. Therefore, interactive quizzes have a significant impact on both thinking engagement and cooperation by developing students' critical thinking skills, and by satisfying their needs through the subject matter. According to Ozdamli and Cavus (2011), quizzes or interactive games may be used as a supplementary tool of acquiring knowledge through language content. Suyatna (2018) emphasized that critical thinking skills must be taught and integrated into curriculum contents in order for students to engage in constructivist and deep learning.

By increasing one variable, we can expect that the other one increases too. On the other hand, most of the participants assume that they do not really focus on what the teacher is explaining in classroom, affirming that they emphasize more on the conversations and debates while using the application, as they become active recipients of their lesson. These responses were homogenous accordingly with the std= 0,560 which confirms their assumption. On another question, students have been asked whether they would get into trouble for interacting when using the interactive whiteboard application, and the majority state they would not with M= 3.257 and std= 0.443. This typically signifies that teachers do encourage discussions to promote the level of interactivity and cooperation while using interactive multimedia-based lesson. The work of Shahzad et al. (2021) proves the idea that learning through interactive multimedia can increase the level of students' creativity, interaction, and innovation.

Accordingly, the first research question examined whether mobile-based interactive multimedia significantly affects learners' thinking engagement and cooperation in the EFL classroom. The findings ensured that compared to the post-test findings of the sample group, the thinking engagement and cooperation of the students augmented at

the end of the experiment. In effect, the multimedia in the Android application, such as images, videos, lessons, recording, and graphics, enabled an accessible learning content, and was consistent with the materials of online learning. This finding can be in line with Sandang et al. (2022) who argued that critical thinking should be related with curriculum contents. Larson and Miller (2011) explained that the students should be enabled to construct knowledge through interaction as well as though interpretation, analysis, and evaluation which all can be integrated with the use of technology.

Based on the findings, we may assume that this positive change may be due to the use of mobile-based interactive multimedia in the classroom. We may say that the positive impact of the interactive multimedia use through the computer, mobile, and social platforms might have enabled the students to increase their level of thinking and cooperation. This can be supported by the idea of Ikonnikova et al. (2022) that mobile applications should include all the curriculum of the program, and the learning materials in a form of graphics such as images, videos, and recordings, so that the students can study effectively the material in the learning application. Ozdamli and Cavus (2011) emphasized that the graphics, video, and multimedia components could support mobile learning applications. In accordance with the findings, it is plausible to argue that the participants might have shaped the positive attitudes of students toward interactive multimedia. According to Hamimi and Sari (2018), interaction is the major characteristic of mobile learning applications which enables the students to interact with media.

The results of the post-test showed that the higher mean of scale items was M= 3, 65. Most participants agreed that they can ask questions for additional clarification, and give arguments with evidence and challenging ideas, suggesting that cooperation and interaction were emphasised through students' active performance in class. The homogeneity of the answers strengthens this claim with the std= 0,650. Most participants also argued that they can use their prior knowledge in responding appropriately, and debating among themselves to reflect on what they have learned and what they are learning as new material.

Considering the role of interactive multimedia integration in EFL learning, students claimed that they can develop their thinking skills through evaluation, analysis and cooperation. Eventually, this will necessarily increase their problem-solving skills in accomplishing project work tasks. The potential basis for these findings might be due to the fact that interactive multimedia mainly deals with increasing the cognitive development of students which is already related with their social development and social skills. Therefore, mobile-based interactive multimedia applications shall be effective in an interactive classroom environment; this is affirmed in many studies by Syawaludin et al. (2019) Sandang et al. (2022), Islam (2020), Jumhur (2021), Djamas et al. (2018), and Abdulah et al. (2021). This may be because language performance reflects the social nature of teaching and learning, and the cognitive development of the learner is deeply associated with cooperation and activity in an interactive multimedia learning environment, as Vygotsky (1978) emphasized in his theory on social interaction.

CONCLUSION

This study has investigated the impact of promoting thinking engagement and cooperation through using mobile-based interactive multimedia in Algerian EFL classroom. It has offered valuable data about the efficiency of implementing particular teaching and learning tools in accomplishing complex language tasks such as computer software, media blender, video blender, and mobile applications. This can allow students to experience language learning through active interactions, and subsequently they can be self-directed learners. The significance of the practical effects between the research variables highly supported and impacted the findings of the study. Considering the research questions of the study, the findings demonstrated that the participants perceived mobile-based interactive multimedia through mobile application in their EFL classroom as highly effective and practical. The overall analysis of the quantitative data proved that the majority of the students are holding positive attitudes towards the efficiency of multimedia use in an interactive learning environment.

Some implications may be introduced for educators in light of the findings of the study. First, the findings of this study may be a benefit for ministry of higher education to put more emphasis on in-depth learning which emphasises on interactive multimedia computers and mobile learning. They should provide the required means for this issue and train educators to run interactive online classrooms. In addition, institutions of higher education may like to equip their faculties with new technological devices such as computers in order to enable EFL students to take advantage of online classrooms. As achieving critical thinking ability requires teachers' high intervention and competence, with the use of multimedia computers in an interactive learning environment, students can be encouraged to be self-directed by making judgments, questioning assumptions, reflecting, thinking critically, debating, and exchanging arguments. Therefore, engaging students with hypermedia can stimulate their critical thinking competency, and can help them engage through meaningful debates which will typically increase self-directed learning.

Therefore, the findings of the study also tempted to be highly reliable and consistent compared to other research findings in the field which prove valid impact of interactive multimedia use in Algerian higher education. The study has spared the agenda for future investigations in further areas in education such as assessment and evaluation of higher order thinking skills of students and learner autonomy. A major stand in the growth of higher order thinking ability is the learner-centered approach. Occasionally, Gunawan (2019) views that assessing the level of students' thinking skills and abilities should work in parallel with the curriculum which involves thinking skills instruction, as the assessment of higher order thinking skills requires cooperation, collaboration, and social activity.

Prior to this, the constructivist approach offers teachers the ability to do exactly this. Teachers can develop HOTS ability through problem-based learning activities and project work which can help students construct new knowledge based on their already acquired knowledge and their prior life experiences. Teachers today should act as guides

for students, and allow them to solve complex problems instead of passively receiving direct answers without using their higher order thinking skills. Thus, students will actively be involved in their learning process and achieve its high learning outcomes. On the other hand, interactive multimedia can allow various possibilities of developing HOTS in the EFL classroom. Teachers should be aware about higher order thinking pedagogies, and be equipped with technological knowledge in order to effectively teach higher order thinking skills in the online EFL classroom.

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