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Effectiveness of Augmented Reality in Developing the Reflective Thinking Skills among Secondary School Students

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Abstract

The aim of this study is to show the impact of using Augmented Reality Technique in developing Reflective Thinking Skills among Secondary School Students. To achieve this objective, the researcher used the semi-experimental approach as based on two groups (Experimental Group – Control Group). The tool of this study has been established as represented by the reflective thinking test. The sample of the study consist of (60) students who study biology in Umm Al-Qura Secondary School at Jeddah, namely, Abdullah Al-Thakafi secondary school. The sample was divided into two groups: first is the control group which consists of (30) students who use the traditional method; the second group is the experimental group which consists of (30) students who use Augmented Reality Technique during second semester (2020-2021)

The reflective thinking scale pre and post-test has been applied on the two research groups. After the completion of the research experiment, data were collected, organized, and analyzed using arithmetic averages, standard deviations, and the (T) test in order to identify the variances between the mean scores of the two research groups in the post application of the reflective thinking scale test, and ETA equation to calculate effect size. The results have shown that there are statistically significant variances at the level of significance (0.05) between the mean scores of the students of the experimental group who used augmented reality and the scores of students of the control group who used the traditional method in the posttest of reflective thinking skills related to the biology course in favor of the experimental group.

Introduction

The twenty-first century is the era of the knowledge explosion, as we are witnessing accelerated periods of scientific and technical development. And by virtue of this rapid development, it has become necessary for us to take advantage of these modern techniques. Among those techniques is the Augmented Reality Technique that is widely used today in various fields; Including the field of teaching and learning, as such technique has become a tributary of motivation and suspense to serve the educational process.

In addition, the Augmented Reality Technique is one of the modern techniques that have proven effective in the educational process, as Al-Hafezi study (2020) showed that augmented reality technique contributed to the development of structured learning skills for preparatory year students at King Abdulaziz University. Also, the study (Al-Shathri and Obeikan 2016, Al-Saaedy 2019) indicated that augmented reality technique contributes to improving education outcomes and raising the level of academic achievement of learners.

Furthermore, the augmented reality helps increase learners' control over viewing the educational content and raises their motivation towards participating in the learning process, as it combines pleasure and knowledge at the same time. It also helps the teacher to explain concepts and information more efficiently (Attar and Kansara 2015). Moreover, Al-Husseini study (2014) confirmed that the augmented reality technique is among the most exciting and advanced techniques because it is the ideal method to combine virtual reality technique with real environments. Thanks to this technique, the student can live the real world in the environment based on augmented reality through data, information, shapes and images. Also, Augmented Reality Technique is a system that enable an individual or a group of individuals to control the modification and alteration of those images and shapes in that virtual reality, which appears to us by grouping images, shapes, sounds, texts, films and sensory influences that together constitute a virtual world similar to reality in all its aspects.

Augmented Reality is a “composite view for the user that integrates the real scene that the user is looking at and the visual (virtual) scene of an image or video that was created by a computer or

a smartphone, which enhances the real scene with additional information." (Salama, Al-Balouji and the Naga 13, 2019). Augmented Reality is also defined as "a technique that produces a composite view for the user that integrates the real scene that the user is looking at with the virtual scene generated by the smart devices, enhancing the real scene with additional information, images, videos and interactive graphics". (Al-Dhaiman, 2020). While Al-Maliki and Al-Ahdal (2020, 282) define Augmented Reality as a "technique based on transforming reality into fixed and moving digital objects in the form of three dimensions, depending on a mixture of hardware and software, so that it can be used in learning geographical concepts and reflecting its true reality." In addition, (Capiro and Barroso 2016) defined the concept of Augmented Reality as "that process in which a group of technological devices such as smart phones and tablets are used, adding multiple imaginary information to material or real information."

Augmented Reality Technique has many characteristics and advantages associated with the educational process. Many previous studies mentioned the importance of adopting this technique in the educational process, and such studies include: (Al-Amarjy 2017, Dada 2009, Johnson, Yaoyune & Yuen 2011, Radu 2012). However, this importance can be highlighted through increasing the understanding of scientific content and memory retention of information as long as possible, as well as motivating the students to discover information from different directions and helping them to learn and easily perceive some contents that are difficult for them to touch, in addition to motivating learners to expand their imaginations to reach facts and concepts, as well as increasing motivation for the educated people.

Augmented Reality is based on a set of theories that support augmented reality, including the cognitive theory, as Syed's study (2019) confirmed the existence of a close correlative relationship between the cognitive theory and Augmented Reality Technique. As when educational content is displayed in the form of a virtual model using virtual scenes, it allows for an attractive demonstration of content, the matter which leads to the learner's knowledge of himself and his abilities through the learning process and activities he performs. One of the theories on which Augmented Reality Technique is based is the Behavioral Theory, as it concerned itself with preparing the educational situation, providing the learner with stimuli that motivates him to respond, then the augmentation. On that context, Augmented Reality Technique seeks to create the educational situation by providing multiple media that work as a stimulus for the learner, so he would respond and interact with it. The associative theory also has a relationship with Augmented Reality Technique which is based on the principle that learning exists in non-human devices and tools. And Augmented Reality Technique depends on smart devices that are handled, carried or worn. (Shawahin 2019). As for the Social Theory, it is related to augmented reality, as knowledge is gained through communities of practice. Therefore, the learning outcomes involve learners' abilities to successfully engage in those practices. Also, the Augmented Reality Technique relies, in most of its applications, on learning through participation with peers. (Abdul Ghafoor 2012). In the same context, there is a correlation between the theory of self-determination and Augmented Reality Technique. Self-determination herein means the ability of an individual to decide what to do based on his awareness of his competence and his sense of his ability to act, as well as the degree of his independence and freedom in choosing and making the alternatives that he wants, and in the degree of communication, support, build relationships and bonds with those around him. (Ryan & Deci, 2000). One of the theories supporting Augmented Reality Technique is revealed by the study of Champney, Lackey, Stanney, and Quinn (2015). The study concluded that the constructivist theory plays a prominent role in promoting learning through the said technique through the learner's building of knowledge inside his mind and interpreting what the learner receives so that he can establish meanings based on his previous knowledge. In addition, learning concepts are established on the basis of inferential conclusions, and the student learns within the framework of the constructivist theory through mistakes and active learning as a prerequisite to learn, so that correct knowledge is established through experience.

Furthermore, a group of previous studies dealt with the importance of augmented reality in the educational process in general; In the study of Al-Hafezi (2020), which sought to reveal the effectiveness of employing Augmented Reality Technique in developing the skills of self-organized learning in the preparatory year courses for students of King Abdulaziz University, the study sample consisted of (52) students, and the researcher therein used the semi-experimental approach, and the data were collected using a scale tool for self-organized learning. The results of the study showed that there were statistically significant variances in favor of the experimental group which study using

Augmented Reality Technique. However, the study recommended the necessity of training faculty members on how to employ Augmented Reality Technique in various educational situations, as well as paying attention to apply Augmented Reality Technique in teaching preparatory year courses. Moreover, in the study of Al-Muqrin (2020), which aimed to identify the effectiveness of using Augmented Reality Technique in developing the visual thinking skills in the art education course for first-grade intermediate students in Riyadh, the study sample consisted of (60) female students, and the researcher adopted the semi-experimental approach, and the data were collected using the test tool. The results showed that there were statistically significant variances in favor of the experimental group in the visual thinking test. In light of the results, the researcher recommended paying attention to developing visual thinking skills in teaching art education using modern technology, including Augmented Reality Technique. Also, in the study of Al-Maliki and Al-Ahdal (2020), which sought to measure the effectiveness of teaching a unit in the social and national education curriculum based on Augmented Reality technique in order to learn geographical concepts for sixth grade students, the study sample consisted of (41) female students, and the researcher therein relied on the semi-experimental approach, and the data were collected through the test tool. The results showed that there were statistically significant variances in favor of the experimental group that studied using Augmented Reality Technique. Based on the results, the study recommended the need to work on the use of Augmented Reality Technique when teaching courses, as well as training teachers to use Augmented Reality Technique in the educational process. Al-Ghamdi's study (2020) showed the effect of using augmented reality on learning mathematics among middle school students in Al-Baha region in the Kingdom of Saudi Arabia, the semi-experimental approach was adopted, and the tool was a test that was applied to a sample of (60) female students. However, the results of the study showed a high level of achievement of the experimental group students who studied using Augmented Reality Technique. And in light of the results, the researcher recommended the necessity of organizing training courses for teachers to publish awareness regarding the importance of applying Augmented Reality Technique in teaching. Furthermore, (Akcayir & Aksayir 2016) study aimed to identify the impact of Augmented Reality applications in learning and memorizing foreign languages and vocabulary, as the researchers used the semi-experimental approach on a sample of (91) college students. And the data were collected with the test tool. The results showed that the augmented reality applications had positive effects in learning foreign language vocabulary as well as helped to increase motivation among students. It also helped them retain the learned words and improved their ability to remember them.

In this regard, the current research is different from the previous studies as it shows the effectiveness of Augmented Reality Technique in developing reflective thinking skills among secondary school students. From the researcher's point of view, the current study is one of the rare studies that combined the effectiveness of augmented reality in developing the reflective thinking skills of biology course secondary school students.

Reflective thinking is linked to modern techniques, including Augmented Reality Technique, as Al-Hafizi study (2020) pointed out that there is a correlation between Augmented Reality Technique and thinking skills in general. In this context, thinking is generally a series of mental activities that the brain performs when exposed to a stimulus that is received through one or more of the different senses. The researchers used several descriptions to distinguish one type from another of the different types of thinking (reflective, scientific, critical, creative, inventive, inductive and inferential). (Rakha 2016).

Reflective Thinking is defined as "a set of skills that a student possesses based on visual vision of topics, ideas and problems for analysis, interpretation and detection of fallacies in order to reach proposed results and solutions, which are measured by the degree obtained by the student on the scale prepared for this purpose." (Al-Atwi. 1109, 2020), while Fares (447, 2020) defines Reflective Thinking as a "mental process that the students perform with the intention of contemplation and scrutiny of consideration through the content presented to them to determine the reasons that support a particular situation and to reach conclusions that enable them to control the educational environment, to encourage them to propose and put forward new ideas." In this regard, Reflective Thinking is a form of mental processing that is applied to gain a better understanding of complicated ideas, and is assigned to reprocess knowledge, evaluation, decision making and work planning. (Ghanizadeh 2017, 108)

Reflective Thinking is highlighted as an educational necessity through the benefits that result therefrom. In this context, the study of Haddady (2017) showed the importance of reflective thinking in helping learners to practice Deep Reflective Thinking, and confirmed its contribution to the exploration of new teaching methods and approaches. As through reflective thinking, learners shall have access to

multiple ideas about a topic, and they shall also enjoy the ability to personally evaluate their work. Reflective Thinking shall also enhance learners' opinions by helping them find solutions for problems and deeply analyze issues. Reflective Thinking helps the teacher achieve a better understanding of how the game is played on one hand, and to diversify the teaching methods on the other hand, while contributing to improving teaching methods, and practicing the duties of the teacher with high professionalism.

One of the studies that showed the importance of the reflective thinking in the educational process is (Guangormez & Duruk 2016), as it sought to develop reflective thinking skills among elementary students in science and technology through scenario-based learning. It also studies the relationship between reflective thinking skills and academic success. In this study, data were collected using a test tool and the scale of science and technology subjects as well as the reflective thinking scale. The study sample consisted of (90) students. The results of the study showed the effectiveness of scenario-based learning in developing reflective thinking skills with a positive relationship between the development of students' reflective thinking skills and their academic success. In the same context, (Sivac 2017) study was concerned with measuring the level of reflective thinking among teachers prior to their service as well as problem-solving ability. The study was applied to a sample of (38) female teachers. Data were collected using the reflective thinking scale and the problem-solving scale. However, the results showed a moderate and above the positive relationship between reflective thinking and problem-solving skills of pre-service teachers.

The issue of the current research is to support the Kingdom's Vision 2030 in integrating technique with education to advance the educational process and to improve educational outcomes in order to create a generation capable of achieving the best aspirations and results. In addition, many previous studies revealed the importance of Augmented Reality Technique for the benefit of the educational process. Whereas, the study of Kasnawi (2020) found out the effectiveness of Augmented Reality Technique in teaching science courses in the secondary school. Moreover, the results of the study (Subiyanto, Markamah & Murnomo 2018) revealed that the use of Augmented Reality Technique using smart phones makes the educational process fun and interesting for learners because this technique contains multiple and various media that contribute to information linking in order to achieve educational goals. The study of (Sirakaya, Kilic Cakmak 2018) showed that the use of Augmented Reality Technique in education leads to an increase in the academic achievement of learners, and the research problem includes the lack of students' interaction with the course topics (Biology 2) through the researcher's notes on his work. Accordingly, the researcher highlights the importance of applying Augmented Reality Technique in our educational environments.

In light of the above, the research problem can be formulated and summed up in the main question:
"What is the effectiveness of Augmented Reality in developing the reflective thinking skills among secondary school students?"

From this main question, the following sub-questions are derived:

- What are the Reflective Thinking Skills that should be available to secondary school students?
- What is the form of Augmented Reality to be used in developing the Reflective Thinking Skills among secondary students?
- What is the effectiveness of the proposed design in developing the Reflective Thinking Skills among secondary school students?

In order to answer the third question and obtain answers to the research problem, the hypothesis was formulated as follows: There are statistically significant variances at the significance level (0.05) between the mean scores of students of the experimental group that used Augmented Reality and the scores of the students of the control group that used the traditional method of post-testing the reflective thinking skills associated with the biology course in favor of the experimental group.

1- Methodology

2-1 Design

The experimental design was relied on, and it is based on the (Pre and post) design for both research groups (experimental - control). The first group is experimental and was taught by using the independent variable which is the application of augmented reality on students' mobile devices, and the dependent variable is the development of Reflective Thinking Skills at levels (reflection and observation - detection of fallacies - access to conclusions - Giving persuasive explanations - Developing recommended solutions). The second group is a control group, and it was taught by using the independent variable of teaching in the usual way such as presentations (PowerPoint). The

dependent variable is the students' performance in the test designed to measure Reflective Thinking Skills.

The table below indicates the Semi-Experimental Design of Research:

Table 1: The Semi-Experimental Design of Research

Group	Pre-Application	Independent Variable	Dependent Variable	Post-Application
Experimental	Reflective Thinking Skills Scale	Augmented Reality Technique	Reflective Thinking Skills	Reflective Thinking Skills Scale
Control	Reflective Thinking Skills Scale	Augmented Reality Technique	Reflective Thinking Skills	Reflective Thinking Skills Scale

2-2 Sample

The research sample consisted of (60) students from the course (Biology 2) at Abdullah Al-Thaqafi Secondary School affiliated to the General Administration of Education in Jeddah, where they were divided into two groups: first is the control group which consists of (30) students who use the traditional method; the second group is the experimental group which consists of (30) students who use Augmented Reality Technique during second semester (2020-2021) 2- Search Tool

3-2 Research Tool

The current research relied on the research tool represented in the Reflective Thinking Skills Test. The skills of reflective thinking focused on (Reflection and observation - detection of fallacies – giving persuasive explanations – access to conclusions - developing recommended solutions) and the scale consists of (30) single objective tests; (Multiple choice quadrant.) To verify the scale, the researcher evaluated the validity of the reflective thinking skills scale using the validity of the arbitrators and the validity of the Content (Lawshe Content Validity Ratio CVR), as the scale was displayed in its initial form on a number of (10) of the university's faculty members who are specialized in educational techniques, as well as supervisors and teachers of biology in general education, in order to ascertain the validity and authenticity of the Reflective Thinking Skills. The researcher also evaluated the validity of the content by using Lawshe equation in order to estimate the content validity percentage (CVR)) (Content Validity Ratio)) for each singular of the Reflective Thinking Skills Scale.

Also, the researcher estimated the stability of the Reflective Thinking Skills Scale by using internal consistency. In this context, the following tables indicate Pearson's correlation coefficients between paragraphs and scale dimensions, and between the dimensions and the scale as a whole.

Table 2: Correlation Coefficients between scale and dimensions N= (60)

Singular	Pearson's correlation coefficient	Singular	Pearson's correlation coefficient	Singular	Pearson's correlation coefficient
1	0.406**	11	0.360 **	21	0.443 **
2	0.560 **	12	0.473 **	22	0.429 **
3	0.440 **	13	0.239	23	0.583 **
4	0.540 **	14	0.498 **	24	0.092
5	0.432 **	15	0.420 **	25	0.532 **
6	0.545 **	16	0.503 **	26	0.590 **
7	0.540 **	17	0.476 **	27	0.460 **
8	0.534 **	18	0.411 **	28	0.325 **
9	0.374 **	19	0.561 **	29	0.339 **
10	0.259 **	20	0.463 **	30	0.422 **

The previous table indicates the correlation coefficients at the significance level (0.01) **, (0.05) * between each singular and the dimension it belongs to except for singular No. (13) and No. (24)

Table 3: Correlation Coefficients between scale dimensions and the Scale as a Whole N= (60)

SN	Dimensions	Correlation Coefficient
1	**Visual Vision**	**0.264 ***
2	**Detection of Fallacies**	**0.527 ****
3	**Access to Conclusions**	**0.679 ****

4	**Giving Persuasive Explanations**	**0.321 ***
5	**Developing Recommended Solutions**	**0.636 ****

As explicit in the previous table, there are significant correlation coefficients at the significance level (0.01) (0.05) between each dimension of the scale and the scale as a whole. By calculating the reflective thinking skills scale using Alpha Cronbach method and the following table shows the value of the stability coefficient by "Alpha Cronbach" method.

Table 4: Value of the Stability Coefficient by "Alpha Cronbach" Method N = 60

Stability Coefficient of the Scale as a Whole	**0.293 ***

It is clear from the previous table that the scale stability coefficient was (0.293), which is significant at the level of significance (0.05). The researcher also estimated the stability of the reflective thinking skills scale using the re-application method, after applying the scale to the exploratory sample of (10) students with a time interval of two weeks. The following table shows the scale stability coefficient by the re-application method.

Table 5: Stability Coefficient of the Reflective Thinking Skills Scale by Re-Application Method (N =60)

Stability Coefficient of the Scale as a Whole	**0.146 ***

It is clear from the previous table that the re-application stability coefficient for the scale as a whole was (0.146 *), which is a statistically significant coefficient of stability at the significance level (0.05).

4-2 Procedures

An analytical survey of the previous studies related to the research topic was conducted with the aim of preparing the theoretical framework, formulating hypotheses and linking the results. In addition to the analysis of the scientific content of Biology 2 course in order to develop the appropriate scenario that achieves the development of reflective thinking skills among secondary school students. Also, a research tool was established in a form of reflective thinking skills scale test. The educational design of the augmented reality environment was prepared along with its production. Also, official approvals were taken from King Abdulaziz University addressed to the Department of Education in Jeddah. And accordingly, it was approved to implement the research in the secondary school of Professor Abdullah Al-Thaqafi on the research sample. Meeting with the subject teacher and explaining the nature of the research and the methods of its implementation. However, an answer was given on all inquiries and questions, and the teacher was also informed of the need to hold a meeting with the students of the study sample through Madrasty platform and explain how to implement the experiment, in addition to conducting an exploratory experiment in order to calculate the time taken to answer to the scale, as well as to calculate the validity and stability of the scale and the validity of the educational design for the augmented reality and its applicability. Selection of the study sample was from among the students of the fourth level in the secondary school of Professor Abdullah Al-Thaqafi in Jeddah. And they were chosen on purpose. The study sample consisted of (60) students, who were divided into two groups: The first is experimental: their number is (30) students who study using Augmented Reality Technique. The second is control: their number is (30) students who study using the usual traditional method.

Pre-application of the scale; To ensure the homogeneity of the experimental and control groups in the level of Reflective Thinking Skills; As shown in the following table:

Table 6: The T-test shows the variances between the control and experimental groups in the pre-measurement on the Reflective Thinking Skills Scale

Scale Dimensions	Group	Mean	Deviation	Degree of Freedom	T	Sig Value	Significance
Visual Vision	Experimental	1.833	1.440	29	0.166	0.869	Not Significant
	Control	1.766	1.250				
Detection of Fallacies	Experimental	2.400	1.302		0.233	0.825	Not Significant
	Control	2.333	1.124				
Access to Conclusions	Experimental	2.733	1.142		1.848	0.075	Not Significant
	Control	2.667	1.142				
Giving Persuasive Explanations	Experimental	1.900	1.155		0.107	0.916	Not Significant
	Control	1.933	1.201				

Developing Recommended Solutions	Experimental	1.766	1.040		1.055	0.300	Not Significant
	Control	2.066	1.387				
The Scale as a Whole	Experimental	10.666	3.209		0.495	0.624	Not Significant
	Control	10.300	2.743				

As shown in the previous table, it is clear that there are no variances between the means of the experimental and control groups with regard to the Pre-measurement on the dimensions of the Reflective Thinking Skills Scale, and this indicates the homogeneity of the two samples on the scale.

Table 7: Shows the significances of the Colmograph and Shperwellic test to verify the moderate distribution over the Reflective Thinking Skills for the Experimental Group

Dimensions of Reflective Thinking Skills Scale	Colmograph Test Df 60		Shperwellic Test Df 60	
Visual Vision	Z	0.192	Z	0.910
	Sig	0.000	Sig	0.000
Detection of Fallacies	Z	0.169	Z	0.936
	Sig	0.000	Sig	0.004
Access to Conclusions	Z	0.161	Z	0.935
	Sig	0.001	Sig	0.003
Giving Persuasive Explanations	Z	0.185	Z	0.918
	Sig	0.000	Sig	0.001
Developing Recommended Solutions	Z	0.205	Z	0.918
	Sig	0.000	Sig	0.001
The Scale as a Whole	Z	0.119	Z	0.958
	Sig	0.034	Sig	0.029

Furthermore, the previous table shows the non-moderation of the distribution, and parametric statistics T-test were used in order to verify the validity of the hypotheses due to the accuracy of the parametric statistics and the use of means and deviations. Whereas, the variables are relative, and such statistical procedure is the most appropriate, the experiment application was determined to be for two weeks. The researcher hired one of the teachers of Biology 2 to do this experiment under the supervision and follow-up of the researcher. Apply the process to the sample members according to the experimental design of the research. Application of the post measurement to the experimental and control groups to measure search results. Correcting and monitoring the student's answers automatically through Madrasty platform programs and conducting statistical analysis and extracting the results. Statistical treatment of the current study was carried out using Program (spss) and the following statistical methods were adopted: Pearson's correlation coefficient to determine the validity of the internal consistency of the paragraphs and dimensions of the scale. As well as the factorial validity to verify the scale factors and their saturation with factors. And also, the Facronbach coefficient to calculate the stability of the test. Split half has also been used to calculate the stability of the test. Arithmetic means and deviations were used to compare means of groups. The T-test for correlated and independent samples was also performed to detect variances between the two groups. And finally, the eta square was used to calculate the size of the effect of the independent variable on the dependent variable.

2-5 Instructional Design

The researcher relied on the general model of instructional design (ADDIE) in teaching the experimental group due to its ease, simplicity, clarity of steps, flexibility and logic sequence. The general model of instructional design (ADDIE Model) consists of five phases indicated as follows:

1- Analysis
2- Design

3- Development
4- Implementation
5- Evaluation

Figure 1: Basic Phases of the General Model of Instructional Design (ADDIE) (Azmy, 2015)

Analysis:

It is the basic phase for the other phases in the instructional design, which includes the analysis of the problem and the assessment of needs in light of the challenges facing the student in recognizing concepts and acquiring skills in some secondary school courses and that can be overcome by employing Augmented Reality Technique in the educational process. It also includes an analysis of the objective of the Augmented Reality Technique in developing the Reflective Thinking Skills of secondary school students through presentation of the course in an interesting and attractive manner. It allows students to actively participate among themselves. Furthermore, the analysis phase includes the analysis of learners' educational and social characteristics, the analysis of the educational content as well as the analysis of learning objectives analysis.

Design

At this phase, the procedural objectives were determined, and the scientific content was designed, as well as the educational tasks design (the roles of the teacher and the learner). This phase also included the design of learning strategies and also designing the evaluation. And finally, designing the scenario based on the steps of activating the augmented reality through the use of Madrasty platform and how to deal with it by the teacher and the student according to the following plan:

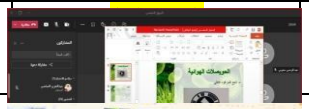
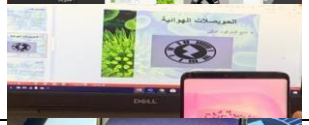
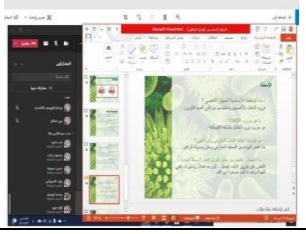
SN	Platform Content	Description	Implementor
1		The main screen of Madrasty platform, through which the lessons are displayed.	The teacher
2		The teacher presented the lesson using Augmented Reality Technique by sending a barcode image on the platform.	The teacher
3		The student displays his mobile phone on the computer screen after he opens an application (Zappar) to read the augmented reality.	The student
4		The student listens to the presentation containing video and 3D images after reading the augmented reality.	The student
5		The teacher presents some questions to the students after they finished watching the content for the purpose of feedback.	The teacher and the student

Figure 2: Content Design of the Electronic Design

Development:
Access to (savefrom.net) in order to download the 3D video clips from Youtube.

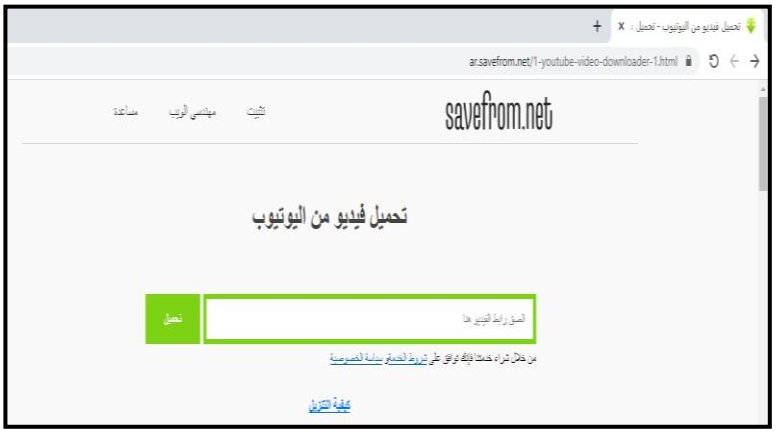
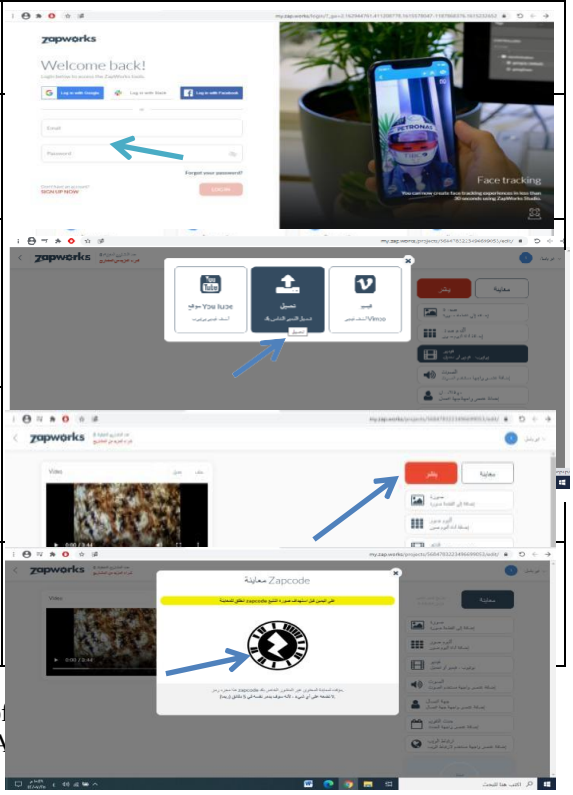


Figure (3): Software Interface (launch screen) (save from.net)
In addition to the file management software so as to modify some remarks on the video such as deletion of the intro or the ending which do not serve the educational process.

Also, (INSHOT) Program was used to adjust and write on photos.

Implementation:
The implementation phase went through several steps as follows:
Creating an account in (ZapWorks) according to the sequence indicated in the following table:

Table 8: How to Create an Account in (ZapWorks)

Indication	Image
Access to (ZaoWorks) and create a new account	
Selection of a new project by clicking on Projects icon	
The sort of file to be downloaded (Video or image) is selected. The sort of addition is selected as well.	
After finishing download, each Barcode image shall be published separately with the digital object related thereto.	
In the final phase after publishing, the barcode related to the reading of the augmented reality appears through Zappar Application.	

The stage of creating the account follows the stage of
teacher's and learners' mobile devices and through A

The researcher also implemented the application on an exploratory sample of (50) students to ensure the effectiveness of the application and the ease of displaying the augmented scientific content, as well as to open all the included links. After verifying the effectiveness of the application in reading augmented reality, the teacher implemented the experiment on the experimental group. A barcode image of augmented reality was displayed by sharing the teacher's screen with his students via Madrsaty platform according to Figure No. 7, bearing in mind that the time of displaying the barcode is compatible with the less

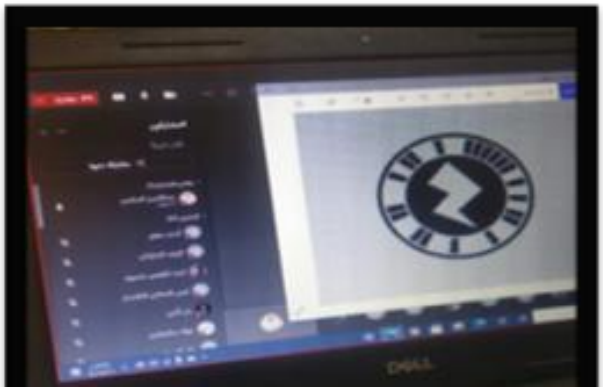


Figure 7- Barcode Display Image for Students Through the Teacher's Screen Sharing

The application (Zappar) is opened by the student who directs the mobile camera on the barcode through Madrasty platform in order to watch the scientific content downloaded on his mobile device once the barcode is scanned.

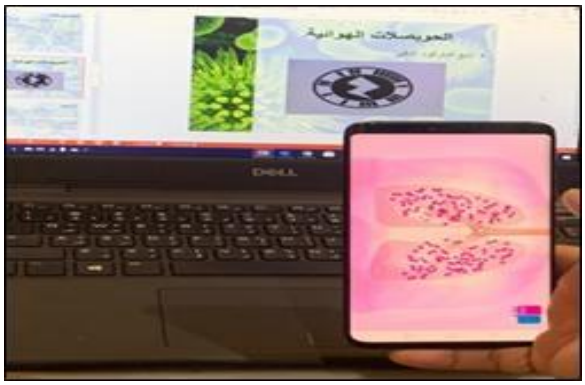


Figure (8) The Appearance of the Barcode to the Students through Madrasty platform

(Implementation(

After completing the preparation of the digital content via Augmented Reality Technique, the design was presented to a group of specialists in educational supervision of biology, in order to determine its validity and its relevance in achieving the objectives that were established, in light of technical and educational standards, in addition to the extent of suitability for the students of the study sample and getting to know their proposals in terms of addition or modification. The validity of the design and its readiness for application on the students of the study sample, as well as its ability to achieve the said objectives are confirmed.

8: Results

The following is a review of the research results and the validation of the research hypothesis which states: There are statistically significant variances at the significance level (0.05) between the mean scores of the experimental group students that uses augmented reality and the scores of the students of the control group that uses the traditional method of post-testing the Reflective Thinking Skills associated with the biology course in favor of the experimental group. The hypothesis was validated by using parametric statistics (t-test). For the two independent samples. The following tables show the results:

Table 9- The t-test shows the variances between the means of the experimental group on the two pre and post measurements and the effect size.

Scale Dimensions	Group	Mean	Deviation	Degree of Freedom	T	Sig Value	Significance	Size Effect of ETA square
Visual Vision	Post-Experimental	1.833	1.440	29	9.815	0.000	Significant	0.392
	Post-Experimental	3.700	0.749					
Detection of Fallacies	Pre-Experimental	2.400	1.302		2.379	0.024	Significant	0.592
	Post-Experimental	2.966	1.449					
Access to Conclusions	Pre-Experimental	2.900	1.268		5.214	0.000	Significant	0.513
	Post-Experimental	3.900	1.028					
Giving Persuasive Explanations	Pre- Experimental	1.766	1.135		10.14	0.000	Significant	0.338
	Post-Experimental	3.633	0.614					
Developing Recommended Solutions	Pre-Experimental	1.766	1.040		9.000	0.000	Significant	0.338
	Post-Experimental	3.533	1.040					
The Scale as a Whole	Pre-Experimental	10.66	3.209		16.95	0.000	Significant	0.657
	Post-Experimental	17.76	2.773					

Table 10: The T-test shows the variances between the means of the experimental and control groups on the post-measurement

Scale Dimensions	Group	Mean	Standard Deviation	Degree of Freedom	T	Sig Value	Significance
Visual Vision	Experimental	3.700	0.749	29	3.751	0.001	Significant
	Control	2.766	1.072				
Detection of Fallacies	Experimental	2.966	1.449		0.691	0.495	Not Significant
	Control	2.766	1.194				
Access to Conclusions	Experimental	3.900	1.028		4.066	0.000	Significant
	Control	2.833	0.874				
Giving Persuasive Explanations	Experimental	3.633	0.6149		4.447	0.000	Significant
	Control	2.600	10.037				
Developing Recommended Solutions	Experimental	3.566	1.040		3.542	0.000	Significant
	Control	2.733	0.980				
The Scale as a Whole	Experimental	17.766	2.775		6.204	0.000	Significant
	Control	13.700	2.365				

By extrapolating the results of Table (10), it becomes clear that the students of the experimental group that studies using Augmented Reality Technique have high reflective thinking skills compared to the control group that studies using the traditional method in the post-measurement of the scale, where the mean scores of the experimental group in the post- measurement is (17.766) with a standard deviation of (2.775), while the mean score of the control group in the post- measurement is (13.700) with a standard deviation (2.365): the calculated (T) value is (6.204) which is a statistically significant value at the level (0.05). Thus, the statistical significance is directed in favor of the group with the highest mean, which is the experimental group that studied using augmented reality. Accordingly, the statistical hypothesis is accepted.

3-4: Discuss the Results

Based on the result reached, and which proved the effectiveness of Augmented Reality Technique in developing Reflective Thinking Skills among secondary school students, and hence the results of the current research agree with several previous studies that were referred to in the research that proved the effectiveness of Augmented Reality Technique in developing diverse thinking skills, as the current study agrees with previous studies that focused on developing achievement, motivation, the level of technological acceptance, problem solving, self-organized learning skills, educational websites design and such. This is consistent with the cognitive theory, as Al-Shami (2016) emphasized as one of the sources of knowledge and learning strategies, especially the augmented reality, in terms of understanding, attention, memory, reception, and information processing, as increasing the learner's awareness is connected to the acquired knowledge and the method of acquiring it in a way that enhances the activity of the learner, as this activity, experience, or training acquired by to the learner causes a positive change in his behavior.

In this context, the researcher believes that this change can be acquired through the adoption of Augmented Reality Technique. As this technique contributes to increasing the motivation to learn, arousing attention, improving the educational performance of students, and increasing the level of reflective thinking, as proved by the current study.

On the other hand, the constructivist theory agrees with the results of the study because of its prominent role in promoting learning based on the establishment of knowledge inside the learner's mind which receives explanations that enable the same to create meaning on the basis of the knowledge obtained. In addition, learning of concepts mainly relies on deductive conclusions, as the student learns within the framework of the constructivist theory through mistakes and active learning as a condition for learning, so that the valid knowledge is to be established through experience. In Augmented Reality Technique, the topics is presented with the use of multimedia that allows to build concepts through observation and personal activities within an interactive environment that enables the learner to interact with 3D shapes and information that has been augmented with reality. In the same context, the behavioral theory supports the results of the research, where the technique seeks in general, and Augmented Reality Technique in particular, to create the educational situation and provide the learner with the stimuli that would drive him to respond and then to achieve augmentation. Augmented Reality Technique also seeks to create the educational situation through providing multiple media that act as a stimulus for the learner, so he would respond to and interact with them. (Shawahin, 2019). Referring to the social theory that looks at learning as a social practice, where knowledge is to be gained from communities of practice, the learning outcomes therefore involve the learners' abilities to participate in these practices successfully, and Augmented Reality Technique depends in most of its applications on learning through participation with peers. (Abdul Ghafoor, 2012). Also, the theory of self-determination is linked to motives and supports the results of the research, as it includes three main elements including independence, efficiency and linkage. However, self-determination herein means the ability of an individual to decide what to do based on his awareness of his competence and his sense of the ability to act, as well as the degree of his independence and freedom in choosing and making the alternatives that he wants, and in the degree of communication, support, build relationships and bonds with those around him. (Ryan & Deci, 2000).

9: Recommendations and Suggestions

In light of the results of the current study that teaching using Augmented Reality Technique contributes to the development of Reflective Thinking Skills, the researcher recommends generalizing the use of Augmented Reality Technique in education in general, and in biology in particular, in addition to reorganizing the content of biology curricula so that it focuses through its content on acquiring different thinking skills in general, and Reflective Thinking Skills in particular, as well as the need for educational institutions to adopt projects to disseminate Augmented Reality Technique.

With the need to pay attention to the production of educational programs in order to develop the ability to provide learners with Reflective Thinking Skills, with interest in applying Augmented Reality Technique programs and training teachers to employ them in teaching, as well as recommending more research on the impact of Augmented Reality Technique in teaching various subjects, and establishing workshops for male and female teachers with an aim to train them on how to use modern technology in teaching, and working on equipping schools with educational halls equipped with all devices and software that enable the teacher to use Augmented Reality Technique in teaching while linking it to the Internet according to the educational standards aimed at achieving positive outcomes, with interest in designing educational books enhanced by Augmented Reality Technique according to modern learning theories. The study also recommended a set of proposed research as a study on the impact of Augmented Reality Technique in developing various skills, such as critical thinking skills, visual thinking skills, scientific thinking and problem-solving skills, as well as studying the impact of Augmented Reality Technique in teaching other subjects such as physics, chemistry and geology, in addition to a study to demonstrate the effectiveness of Augmented Reality Technique in e-learning in light of the Corona pandemic. It also recommended to conduct an evaluation study about the appropriateness of the content of current biology curricula for Augmented Reality Technique.

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