Impact of Teaching a Proposed Unit on Successful Intelligence and Augmented Reality in Biology on Lateral Thinking and Science Fiction among High School Students in Al-Saih City, Saudi Arabia

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Abstract

The study examined the impact of teaching a unit based on the Theory of Successful Intelligence and Augmented Reality in Biology on developing lateral thinking and science fiction among high school students in Al-Saih City, Saudi Arabia. To verify the research experience's effect, a quasi-experimental design, the "Lateral Thinking Test," and the "Science Fiction Scale" were used. The research sample included 34 experimental and 37 control students (all high school students). The research tool used to examine both groups' lateral thinking contains 24 questions on concepts, alternatives, linkages, and ideas. Science fiction skills include alertness, flexibility, imagery, daydreaming, retreating from reality, and sustaining direction. The results demonstrated a statistically significant difference (0.05) between the average scores of the experimental and control groups for each lateral thinking skill and the lateral thinking test as a whole, in favor of the experimental group. Also, teaching a unit based on the Theory of Successful Intelligence and Applications of Augmented Reality in biology helps develop lateral thinking and science fiction. The research advocated applying the notion of Successful Intelligence and Augmented reality in high school, based on the study's results, to improve educational outcomes such as "lateral thinking" and "science fiction".

Keywords: theory of successful intelligence, augmented reality, lateral thinking, science fiction

1. Introduction

The current era is defined by successive scientific and technological advancements in the knowledge industry and its invention; consequently, the standard and criteria for countries' progress and development have grown dependent on their knowledge output and innovation.

To achieve this objective, one of the most significant challenges faced by different nations is to equip the minds of their citizens with high-level cognitive abilities and skills. These skills will enable them to keep up with rapid technological advancements, compete in solving problems, and meet societal needs. This has raised the significance of the role of educational institutions in attaining this purpose, specifically through the development of their instructional elements as a critical factor facilitating the transfer of information from the theoretical awareness stage to the application stage.

Science is one of the most important subjects that play a vital role in activating and investing the student's mental abilities (Al-Naqah and Kalaab, 2017). It is characterized by its quantity of knowledge, abstract concepts, and various skills whose teaching requires teaching methods that depend on the positive role of the student, provide them with different thinking skills and connect them to the reality of everyday life (Al-Naqah and Kalaab, 2017).

Numerous theories have been developed to explain the philosophy, mechanism, and methods of acquiring knowledge and interpreting the internal and external mental processes that affect an individual's thinking, including the "Successful Intelligence" theory, which emphasizes the importance of intelligence in determining human capabilities. One of the newer theories, "Successful Intelligence", assumes that students use their analytical, creative, and practical skills (Shuman, 2019). The successful Intelligence hypothesis is founded on information processing theory

(Ali, 2019).

Dr. R. Stenberg's work in developing the theory of "Successful Intelligence" has contributed to its widespread dissemination throughout the past three decades. Sternberg and Grigorenko feel that there are three primary axes a teacher can employ when employing the theory of successful intelligence: analytical thinking, creative thinking, and scientific thinking (Sternberg & Grigorenko, 2012). According to Munthas, the theory of "Successful Intelligence" was created to replace the traditional view of teaching (which focuses solely on students' memorization and analysis skills) and enable students to use their creative and practical skills in addition to their memorization and analysis skills (Mumthas, 2014).

Several studies have emphasized the importance of employing the theory of "Intelligence" in education, including the analysis of Al-Humaidi and Al-Kandari (2019); Al-Saadi (2019); Al-Sari and Al-Faiz (2016); Qatami (2016); Palos & Maricutoiu (2013); Prieto et al. (2015). In light of society's ongoing technological advancement and the educational community's call for the necessity to integrate technology with learning, it has become crucial to provide technical educational environments that contribute effectively to achieving learning objectives. The "augmented reality" environment is considered to be one of the modern three-dimensional technical educational environments that integrate actual reality (AR) and virtual reality (VR). The interaction between the living being and the virtual being occurs in real-time when a student performs a real task (Khalaf, 2021).

Unlike the technology of "Virtual Reality," which relies on producing a three-dimensional virtual environment, the technology of "Augmented Reality" relies on adding virtual information to "Actual Reality" simultaneously (Abu Bayh, 2016). The technology of "Augmented Reality" is founded on the following theories: As knowledge is learned through communities of practice, "the social theory" considers learning as a social practice; hence, teaching outcomes include students' capacities to participate in these practices through augmented reality. According to "the associative theory," the learning process is facilitated by the student's capacity to connect and associate disparate pieces of information efficiently. In "augmented reality," learning occurs through associating actual reality and its data with virtual reality and its effects (Mansour, 2021). "The behavioral theory" is concerned with giving the student with stimuli that force him to respond and then strengthen this response, and "augmented reality" technology generates this environment with diverse effects that rely on multimedia stimuli for learning (Mansour, 2021).

Several studies have emphasized the significance of employing "augmented reality" technology in education, such as Abu Hushaish (2021); Al-Duhaiman (2020); Al-Enazi (2021); Al-Ghamdi (2021); Alkhattabi (2017); Bower et al. (2014); Techakosit and Nilsook, (2016), as this technology contributes to the student's immersion in learning and attracting his attention and interaction. This is accomplished by incorporating virtual creatures into his educational environment, such as texts, static and moving images, sounds, and three-dimensional objects, which boosts his ability to assimilate what he learns and encourages several types of thinking, including "lateral thinking."

"Lateral Thinking" is one of the forms of thinking that encourages students to consider an issue from multiple perspectives rather than in a linear fashion (Khalafallah and Nasr, 2020; Al-Shibawi, 2018). This sort of thinking necessitates those problems be approached from various angles relating to problem analysis, creativity in proposing and creating solutions, and guaranteeing their efficacy. Consequently, this type of thinking simulates the capabilities of successful intelligence. The use of "augmented reality" applications can stimulate and promote this thinking as it offers numerous educational benefits (Al-Ghamdi, 2021; Alkhattabi, 2017; Bower et al.,2014).

Edward De Bono is regarded as the originator of "lateral thinking" because De Bono (2005) explains that lateral thinking refers to how the brain functions as an organizational system when addressing a problem in lateral directions and alternatives. He defines it as "searching for solutions to problems in unconventional or illogical ways. Instead of adhering to a vertical path, lateral thinking allows for thinking from various angles, which tends to incorporate a variety of other perspectives (Saleh and Saud, 2014). The necessity of establishing "lateral thinking" in pupils has been stressed by several studies, such as the study by Khalafallah and Nasr (2020), Al-Shibawi (2018), Al-Sheikh (2014), Faizah (2017), Lamb et al. (2015).

Lateral thinking is a form of creative thinking that requires the generation of concepts, presentation of alternatives, the realization of relationships, and production of ideas. Students' application of these skills will stimulate their diverse modes of thought and extend their scientific imagination, enhancing their ability to generate novel ideas. From there, the connection between lateral thinking and science fiction becomes evident (Al-Naqah and Kalaab, 2017).

As the student's ability to imagine is related to his thinking style in terms of his ability to understand and integrate cognitive structures and processes, schedule and organize activities, communicate and imagine alternatives,

overcome obstacles, and obtain new ideas, science fiction is closely related to various types of thinking (Al-Naqah and Kalaab, 2017).

Additionally, "science fiction" is related to creativity and its foundation. There is no creativity without imagination and the production of creative ideas that flourish and mature in an ocean of imagination (Ambosaidi & Al Balushi, 2009). Thus, the imagination is a structural process in which past experiences and images stored in long-term memory are merged with current stimuli surrounding the individual and future expectations to form a novel and original concept (Ambosaidi and Al Balushi, 2009).

Several studies have stressed the significance of "science fiction" development among pupils (Al-Astal and Rajab, 2020; Sabri and Al-Rohaili, 2016; Hindawi, 2018; Abdel-Aal, 2019; Muhammad, 2019; Al-Otaibi, S. 2020, Roman, 2017). Science fiction requires the practice of several skills: awareness, flexibility, visualization, daydreaming, withdrawal from reality (Al-Astal and Rajab, 2020; Sabri and Al-Rohaili, 2016; Hindawi, 2018), and direction retention, which would expand the student's knowledge and make them more capable of generating creative solutions to scientific, accurate, and future professional and scientific problems in life (Al-Mutairi & Abdel-Aal, 2019; Muhammad, 2019; Al-Otaibi, S, 2020).

The statements mentioned above demonstrated the significance of linking the development of "lateral thinking" and "science fiction" among science students, as this contributes to equipping them with the abilities and skills necessary to address life problems scientifically and technically by analyzing and generating ideas, appropriate solutions, and testing their efficacy. This led to the conception of the current study, which investigates the impact of teaching a unit based on the theory of successful intelligence and applications of augmented reality in biology on the development of lateral thinking and science fiction.

2. Research Problem

High school students in the Kingdom of Saudi Arabia find biology challenging to learn due to deficiencies in its teaching methods, the density of the scientific material, the existence of a gap between theory and practice, and the dry nature of the subject. It harms the level of critical thinking skills and educational outcomes. (Al-Juhani, 2017; Al-Mutairi and Abdel-Aal, 2019; Awdh and Ali, 2020)

The study by (Al-Ghamdi and Qutub, 2020; Al-Zahrani, 2021) confirmed that biology professors rely on conventional methods and do not use technological advances, such as "augmented reality" applications, which prevents students from actively participating in the learning process. This contradicts the high school biology curriculum in the Kingdom of Saudi Arabia, which tries to aid students in comprehending the material and relating it to the realities of life and other sciences. In addition, it contradicts the Saudi Vision 2030, which seeks to invest in education to ensure students have access to high-quality education opportunities. They are the focus of the educational process, requiring them to practice "science" as scientists do in problem-solving and to learn with action in mind (Ministry of Education, 2021).

Despite the importance of the development of "lateral thinking" in pupils, the researcher found that no studies had studied the teaching of biology in High School in the Kingdom of Saudi Arabia, despite a thorough search of the relevant literature. The Critical and Creative Thinking Conference (2020) hosted at the University of South Florida advised the countries whose students score poorly on international tests for "lateral thinking" due to a lack of these skills (Symulevich, 2020). Some studies conducted in the Kingdom of Saudi Arabia dealt with the development of "lateral thinking," but not in other scientific subjects such as Mathematics (Al-Sabri and Al-Ruhaili, 2016). This study confirmed a decline in lateral thinking skills among high school students and students in other educational stages, such as intermediate. The Al-Otaibi,**s** (2020) research also confirmed a fall in the science curriculum's degree of science fiction among high school pupils in the Kingdom of Saudi Arabia. All of these studies ascribe the fall in "lateral thinking" and "science fiction" to instructors' use of conventional teaching techniques.

Through interviews with female High School biology teachers, the researcher discovered that most of them use conventional methods for teaching biology, as they explain the topics through indoctrination and lecture and do not employ interactive technical methods that rely on the student's participation in learning. This mindset severely impacts the students' ability to assimilate the vast quantity of material they acquire and prevents them from applying their biology abilities to tackle the myriad difficulties they confront in real life.

The assertions mentioned above identified the problem of the present study, namely the low degree of lateral thinking and science fiction among high school biology students. The research investigated the impact of teaching a proposed unit based on the theory of successful intelligence and applications of augmented reality in biology on

developing lateral thinking and science fiction to tackle this problem.

3. Research Objectives

The present research strived to achieve the following objectives:

1) To identify the impact of teaching a proposed unit based on the "Successful Intelligence" theory and applications of "Augmented Reality" in Biology in developing lateral thinking.

2) To identify the impact of teaching a proposed unit based on the "Successful Intelligence" theory and applications of "Augmented Reality" in Biology in developing science fiction.

4. Research Hypotheses

The present research sought to verify the validity of the following two hypotheses:

1) There are no statistically significant differences at the level (0.05) between the students' average scores of both groups (the experimental and control) in the dimensional application for the test of lateral thinking.

2) There are no statistically significant differences at the level (0.05) between the students' average scores of both groups (the experimental and control) in the dimensional application for the science fiction scale.

5. Research Significance

The significance of the research is taken from the following:

1) To bring to the attention of those "responsible for developing the biology curriculum for high school" the importance of incorporating the theory of "successful intelligence" and "applications of augmented reality" into the biology curriculum, as it is crucial to the development of lateral thinking and science fiction in high school students.

2) The study offered a unit based on the notion of effective intelligence and applications of augmented reality in biology. This unit's teacher's manual can assist biology teachers in teaching the high school biology curriculum.

3) The researcher presented a test of lateral thinking and a science fiction scale that biology teachers in the first year of high school can use to assess their students' level of lateral thinking and science fiction.

6. Limitations of the Research

The research is limited to the following:

- **Subjective Limitations:** A proposed unit on "Bacteria and Viruses" in the curriculum of biology for the first grade in High School based on the theory of successful intelligence and applications of augmented reality in biology to develop lateral thinking and science fiction in the students (female) of high school in Al-Saih city in the Kingdom of Saudi Arabia. #
- **Human Limitations:** A random sample of students from first grade in High School.
- **Spatial Limitations:** Two schools among the many schools located in Al-Kharj Governorate in the Kingdom of Saudi Arabia.
- **Time Limitations**: This **study** was implemented during the first semester of the Academic Year 2021-22.

7. Terminologies of the Research

The research includes the following terminologies:

7.1 The Theory of "Successful Intelligence"

Sternberg and Grigorenko (2012) defined "successful intelligence" as an integrated system of talents necessary for life success through the use of analytical, creative, and practical skills within the sociocultural context of the learner. Therefore, the intelligent learner can identify his strengths to capitalize on and his flaws to fix and compensate for. (p. 265). The theory of procedurally successful intelligence is defined as one of the modern theories that are based on the brilliance of high school students and employ their analytical, creative, and practical abilities in the study of biology to foster their development of lateral thought and science fiction.

7.2 Technologies of "Augmented Reality"

The phrase "augmented reality" is defined by Al-Muqrin (2020) as "the technology that allows the simultaneous blending of digital content from software and computer items with the real world" (p. 281). The procedural "augmented reality" technologies are defined as modern three-dimensional technical applications that use the visual, auditory, and kinesthetic effects in presenting biology topics to high school students. It is to motivate them to address these topics from multiple perspectives and come up with ideas, alternatives, and creative solutions based on their science fiction and their understanding of the relationships between different concepts in biology.

7.3 Lateral Thinking

De Bono (1990) described lateral thinking as "a set of particular procedures or processes that are applied systematically to generate new ideas and concepts, i.e., through a systematic method, specialized tools or strategies are employed to increase creativity" (p. 12). Procedure-wise, lateral thinking is defined as one of the thinking patterns that require high school students to approach biology problems by considering them from multiple perspectives, recognizing their numerous facets, generating new alternative concepts, and employing them all to find more than one creative solution to those problems.

7.4 Science Fiction

Science fiction is defined by Robin (2001) as "the individual's ability to predict the future in light of scientifically ordered changes in natural events" (p. 58). Science fiction is operationally defined as the capacity of high school pupils to forecast the future occurrence of scientific phenomena in biology by utilizing their expansive imagination and creative reasoning.

8. Research Methodology

The research relied on an experimental approach with a Quasi-Experimental Design based on the application (pre-post) for two groups (experimental - control). The Semi-experimental method is defined as the method that is based mainly on the study of human phenomena as they are in nature without human intervention, or it is defined as the study of the relationship between two variables as they are in reality without controlling the variables which is the design known as the pre- or post-application of two groups, one experimental and the other a control group (Al-Assaf, 2016).

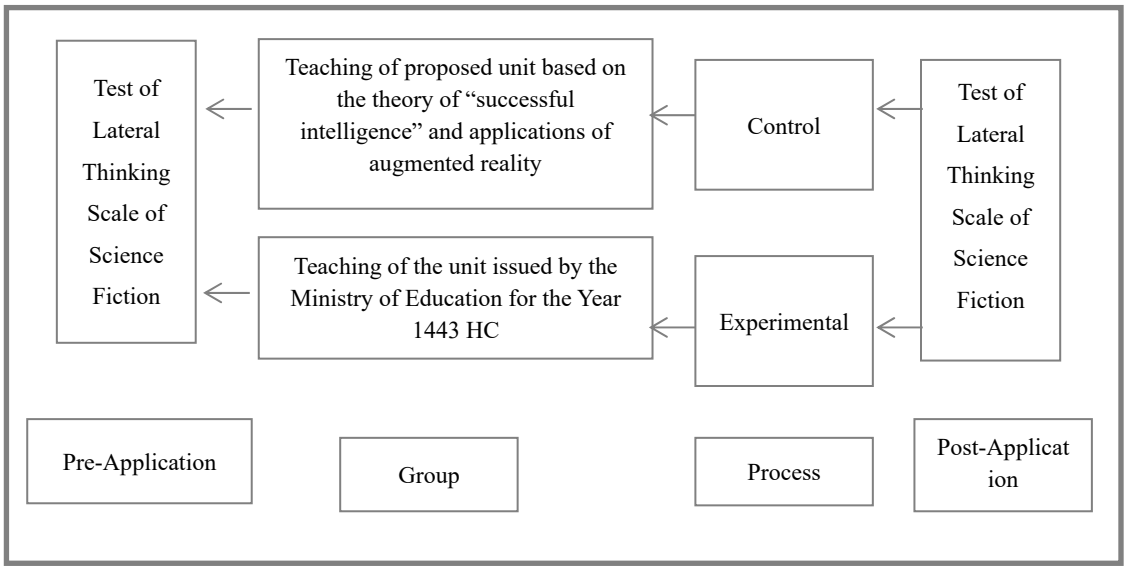

Figure 1. The Experimental Design of the Research

8.1 The Population of the Research

This study's population comprises all first-year female High School General Education students in Al-Kharj Governorate during 2021-22. There were 1200 pupils in all.

8.2 Research Sample

Two schools were chosen so that one of them can represent the "experimental group," which consists of 34 students (females) who were studying the biology subject during the application period, and the "control group," which consists of 37 students who were dissecting the biology subject during the application period.

8.3 Research Materials and Tools

The research materials and tools comprised of the following:

First: The Proposed Unit is based on the theory of "successful intelligence" and "applications of augmented reality" in biology. It was prepared as per the following:

1) Selection of the Educational Content: The unit "Bacteria and Viruses" was selected due to its applicability to the period in which the research will be implemented. Its topics were reformulated, and some activities corresponding to the types of intelligence in the theory of successful intelligence and augmented reality were added so that the research objectives in developing lateral thinking and science fiction among first-year high school students could be met.

2) Analysis of the Content of the Unit "Bacteria and Viruses" in the first-year high school biology course: The purpose of the study was to discover and reformulate the unit's subjects, concepts, generalizations, and facts under the research objectives. This is accomplished by modifying and dividing it, establishing a timetable for its instruction, and reformulating its objectives, activities, and evaluation methods following the theory of "successful intelligence" and the "applications of augmented reality" in its instruction, as well as by encouraging the development of lateral thinking and science fiction among students. The unit was evaluated using the following criteria:

- Determining the unit's category and analysis The unit's category of analysis contained concepts, generalizations, and facts. In addition, the unit of analysis is reflected in each paragraph's instructional material, which includes concepts, generalizations, and facts.#
- Verification of Stability of Analysis: The procedural unit was evaluated twice, with the first analysis performed by the researcher and the second by one of the first-year high school biology teachers at the researcher's request. Using the Holist equation and the results of the two studies, the stability of the analysis was obtained by determining the percentage of agreement between the two analyses.

Table 1 shows the stability of the results of content analysis

Table 1. Results of the Calculation of Stability of Content Analysis for the Unit "Bacteria and Viruses" in the Course of Biology for First Grade in High School

Elements of Content Analysis	Analysis of Researcher	Analysis of Teacher	Points of Agreement	Stability Coefficients
Concepts	13	13	13	1
Generalizations	26	20	20	0.87
Facts	48	50	43	0.88
Total	87	83	76	0.89

Table 1 demonstrates that a high stability coefficient defines the analysis conducted by the researcher, both for each element independently and for the elements as a whole, as indicated by the stability coefficients for the various aspects of the study. It is reliable in its final form.

1) Designing the "Proposed Unit"**:** The proposed unit on "Bacteria and Viruses" for the biology course was created by integrating the idea of successful intelligence with the applications of augmented reality to enhance lateral thinking and science fiction in the first-year high school female students (Al-Humaidi and Al-Kandari, 2019; Al-Saadi, 2019; Al-Sari and Al-Faiz, 2016; Qatami, 2016; Palos & Maricutoiu, 2013; Prieto et al. 2015) The studies that dealt with the application of augmented reality in education include Al-Duhaiman, 2020; Al-Enazi, 2021; Sabri and Al-Rahili, 2016; Hindawi, 2018; Abdel-Aal, 2019; Muhammad, 2019; Al-Otaibi, S. 2020 Roman, 2017).

The topics of the unit "Bacteria and Viruses" of the biology course for the first grade in High School were issued by the Ministry of Education for 2021 and were reformulated, and several activities and assessment questions were added under the intelligence of the "theory of successful intelligence" and the "applications of augmented reality" in a manner that is appropriate for the age of the students (females) of first grade in High School and their developmental level In the application areas, diversity was taken into account, and various augmented reality

applications were used to bring an element of suspense and excitement to the lessons.

The proposed unit was presented in its initial form to a group of arbitrators specializing in curricula and teaching methods to obtain their opinions on the contents of topics, activities, and assessment questions suitable for the age of first-year female High School students, as well as for the development of divergent thinking and science fictions. The arbitrators judged it necessary to make the following modifications so that the proposed unit, in its final form, would apply to the research sample:

- First Lesson – Bacteria: It consists of the following activities based on the theory of effective intelligence and applications of augmented reality: (explanation of the general structure of bacteria, distinguishing between archaea and bacteria and their taxonomic classification, description of the mechanism of bacterial survival alone in harsh environmental conditions, and clarification of the relationship between bacteria and humans).
- Second Lesson – Viruses: It encompasses the following activities based on the principle of effective intelligence and augmented reality applications: (explanation of the general structure of viruses, comparing the sequence of events in viral replication by lysis and fusion cycles, retroviral replication and clarification of the structure of prions and their effect on pathogenesis).

Second: Manual for teaching the suggested unit based on the theories of "successful intelligence" and "augmented reality applications" in biology. The handbook has been created for the teaching of the proposed unit on "Bacteria and Viruses" in biology for the first grade of High School based on the theories of "successful intelligence" and "applications of augmented reality." The initial version of the manual was presented to the same arbitrators for their opinions and comments. It was needed on the clarity of the directives, the soundness of the formulation of the objectives and procedures included in the manual and the extent to which they are related to the theory of successful intelligence and applications of augmented reality, the suitability of each lesson to the objectives set for it, the scientific validity of the content, and the clarity of the evidence. The revisions considered necessary by the arbitrators were made so that the finalized evidence would be appropriate to the research sample.

Third: Test of Lateral Thinking in the Unit "Bacteria and Viruses" of the High School Biology Course for Freshmen. The test was created using the following procedures:

- Identifying the Test Objective: The exam's objective was to measure the level of lateral thinking skills among students in the experimental and control groups during the "Bacteria and Viruses" unit of the first-semester biology course for ninth graders. The test was conducted to ensure that the two groups had comparable levels of lateral thinking skills before and during the research's teaching experiment and to determine the experiment's impact on developing these skills.

- Sources of Building the Test: The information was taken from previous studies that had dealt with the skills of lateral thinking (Khalafallah and Nasr, 2020; Al-Shibawi, 2018; Faizah, 2017; Lamb et al., 2015) and accordingly, the following lateral thinking skills were identified: generation of concept, presentation of alternatives, the realization of relationships and production of ideas.

- Designing the Items of the Test: The test consisted of four sections, each covering one skill of lateral thinking skills and containing six questions; hence, the total number of questions on the lateral thinking skills test was 24. Each section was designed according to the skill that is to be measured, and correction keys were identified for each section of the test to be used in correcting the questions included in these sections, except the questions relating to the skill of idea generation, which were essays and relied on the student's ideas in answering them.

- Designing the Instructions of Test: General instructions were included at the beginning of the exam to acquaint the student with the test's goal and its various sections. The students were then provided guidelines and an example for each section of the exam to ease the process of answering the questions. In constructing these instructions, first-year High School students' knowledge level and stage were taken into account so that they may understand and comprehend the strategy for answering each section of the exam based on the competence that each section tests.

- Determining the Validity of the Test: The test was presented in its initial form to the same arbitrators of the research to obtain their opinions regarding the clarity of the instructions, the scientific and linguistic validity of its vocabulary, the appropriateness of its questions to the skills it measures, and the appropriateness of the suggested alternatives in each question, as well as the test's suitability for female students. Some arbitrators suggested altering the phrasing of some choices, cutting some questions, and modifying the scientific language to make it more accurate and understandable for the student. The requested changes were implemented, and the test was prepared for use in the exploratory sample of the research.

- Conducting the Exploratory Experiment for the Test: The test of lateral thinking skills was administered to an exploratory sample of 20 female students (different from the research's primary sample) to determine the following:

- The appropriate time for the test: The arithmetic mean of all the times it took students to answer test questions was calculated, and it was determined that 35 minutes is the optimal application time.
- Calculation of the Difficulty Coefficients for the Test: The difficulty coefficient represents the "% of examinees that responded incorrectly" to a question. The coefficients for the test of lateral thinking skills were computed for each of the following competencies: concept creation, alternative provision, and relationship realization. The talent of "creation of ideas" was removed because the questions that assess this skill are essay-based and rely on the student to supply an answer, i.e. there is no right or incorrect answer. It was determined that the difficulty coefficients ranged from 0.20 to 0.76, indicating that the test is acceptable in ease and difficulty since a question whose difficulty coefficient exceeds 0.80 is a very difficult question, whereas a question whose difficulty factor is less than 0.20 is a straightforward question.
- Calculating the Discrimination Coefficients for the Test: The discrimination coefficient for the vocabulary of the lateral thinking skills test was calculated, and the discrimination coefficients for the questions on the lateral thinking skills test ranged between (0.40-0.60) for each of the following skills: concept generation, providing alternatives, and recognizing relationships. Since the item with a discrimination coefficient between 0.20 and 0.39 is acceptable and the item with a discrimination coefficient of 0.40 or higher has good discrimination, it can be retained (Allam, 2011). Therefore, the questions on the test of lateral thinking skills have a sufficient capacity for differentiation.
- Calculating the Stability of the Lateral Thinking Skills Test: The stability of the test was calculated using Kuder Richardson-21. Table 2 shows the values of the stability coefficients.

Table 2. Values of Stability Coefficients and Distribution of Items of Lateral Thinking Skills Test

Skill	Number of Questions	Stability Coefficients
Concept generation	1, 2, 3, 4, 5, 6	0.89
Providing the Alternatives	7, 8, 9, 10, 11, 12	0.80
Realization of Relations	13, 14, 15, 16, 17, 18	0.82
Production of Ideas	19, 20, 21, 22, 23, 24	0.88
Test as a whole		0.80

Table 2 demonstrates that all values of the stability coefficient for Lateral Thinking Skills Test topics and the test as a whole are high, indicating that the test has a high level of stability and is suitable for the research's basic sample.

Fourth: Scale of Science Fiction for the Students of First Grade in High School. The scale was designed according to the following:

1) Identifying the Objective of the Scale: It aimed to determine the level of science fiction among the first-grade students in High School.

2) Sources of Building the Scale: The scale was created using information obtained from past studies and research dealing with science fiction, such as the following: (Sabri and Al-Ruhaili, 2016; Hindawi, 2018; Abdel-Aal, 2019; Muhammad, 2019; Al-Otaibi, R. 2020; Roman, 2017)

3) Identifying the Science Fiction: As stated previously, science fiction specifies six skills: alertness, flexibility, imagery, daydreaming, withdrawal from reality, and direction maintenance. Each skill contains five sub-skills.

4) Preparing the scale in its Initial Form: In its initial version, the scale consists of thirty sub-skills dispersed among the principal science fiction skills. The replies for each item on the 5-point Likert scale were rated as follows: always, often, sometimes, rarely, and never.

5) Formulation of the Scale Instructions: The test instructions page was divided into two sections. The first section concerned the student's initial data, while the second section introduced the learner to the process of responding to scale items. The instructions included several questions and how they were to be answered.

6) The Validity of the Scale: The scale was presented to the same arbitrators as the research to verify the appropriateness of its item for measuring science fiction, as well as to ensure the linguistic and scientific integrity of its vocabulary and instructions and its suitability for the age level of first-year High School students.

7) The Scores of the Scale: The scale responses were numbered as follows: a score of (5) is given for the response "always", a score of (4) for the response "often", a score of (3) for the response "sometimes", a score of (2) for the response "rarely" and a score of (1) for the response "never" and that is because all items of the scale are positive statements.

8) Applying the scale to an Exploratory Sample: The scale was used on the same sample as the Lateral Thinking test, i.e., first-year high school students, after converting it to an electronic scale to calibrate the scale according to the following:

- Ensuring the clarity and appropriateness of the scale to the level of female students, as the application revealed that the scale is precise for all sample members.
- Specifying the time required to apply the scale: The members of the exploratory sample were called after the researcher requested them to specify the start time and finish time for the test, and the appropriate time for applying the scale was then defined as twenty minutes.
- Validating the Internal Consistency of the Scale: The Pearson correlation coefficient was determined to validate the internal consistency between each item of the scale and its corresponding dimension, as well as between the dimensions of the scale and the scale's total score. The results are presented in Table 3.

Table 3. Values of Pearson Correlation Coefficients for the Scale

Awareness		Flexibility		Visualization	
Item No.	Correlation Coefficients and Its Significance	Item No.	Correlation Coefficients and Its Significance	Item No.	Correlation Coefficients and Its Significance
1	**0.85	6	**0.91	11	**0.99
2	**0.89	7	**0.88	12	**0.78
3	**0.84	8	**0.85	13	**0.91
4	**0.90	9	**0.92	14	**0.98
5	**0.90	10	**0.84	15	**0.95
Dimension as a whole	**0.81	Dimension as a whole	**0.72	Dimension as a whole	84** .0
Daydreaming		Withdrawal from the Reality		Maintaining the Direction	
16	**0.85	21	**0.98	26	**0.97
17	**0.91	22	**0.86	27	**0.95
18	**0.98	23	**0.91	28	**0.91
19	**0.87	24	**0.94	29	**0.98
20	**0.87	25	**0.85	30	**0.93
Dimension as a whole	**0.85	Dimension as a whole	**0.89	Dimension as a whole	**0.87

(**) means that it is statistically significance at the significance level of 0.01 or less

Table 3 shows a positive, statistically significant correlation between the items of the scale and its dimension and between the dimensions of the scale and the overall score of the scale; that is, the scale has high internal consistency, and it can be trusted.

Table 4. Values of Stability Coefficients for the Scale of Science Fiction and Distribution of Items to the Skills

Main Skill	Number of Items	Stability Coefficients
Awareness	1, 2, 3, 4, 5	0.88
Flexibility	6, 7, 8, 9, 10	0.85
Visualization	11, 12, 13, 14, 15	0.91
Daydreaming	16, 17, 18, 19, 20	0.87
Withdrawal from Reality	21, 22, 23, 24, 25	0.83
Maintaining the Direction	26, 27, 28, 29, 30	0.71
Scale as a whole		0.94

- Verifying the Scale's Stability: Cronbach's alpha coefficient was used to verify the scale's stability. Table 4 shows the stability coefficient values for the science fiction scale and the distribution of its items to the skills.

Table 4 demonstrates that the stability coefficients for the dimensions of science fiction and the scale are strong, indicating that the scale has an appropriate level of stability and pertains to the final form of the primary sample.

9. Research Execution Procedures

The present study was conducted using the following procedures

1) Acquiring formal letters to aid the researcher's work.

2) The pre-application of the "lateral thinking test" and the "science fiction scale" to the research sample, i.e., the first-year High School students in the experimental and control groups, to ensure that the two groups have comparable levels of lateral thinking and science fiction. Tables 5 and 6 display the arithmetic mean, standard deviation, T-Test, and statistical significance for the pre-application scores of the Lateral Thinking Test and the Science Fiction Scale for the experimental and control groups.

Table 5. Arithmetic Mean, Standard Deviation, and T-Test and Their Statistical Significance for the Scores of the Students of the Experimental and Control Groups in the Pre-application of the Lateral Thinking Test

Skill	Experimental Group (34)		Control Group (37)		T-Value	Significance Level
	arithmetic mean	standard deviation	arithmetic mean	standard deviation		
Concept Generation	12.62	1.35	12.54	1.35	0.24	0.81
Providing Alternatives	11.91	1.73	11.81	1.91	0.23	0.82
Realization of Relationship	15.56	2.12	14.87	2.37	1.30	0.20
Production of Ideas	1.79	1.32	1.49	1.23	1.01	0.32
Test as a whole	41.88	4.01	40.45	3.22	1.65	0.10

Table 5 demonstrates that there is no statistically significant difference at the level (0.05) between the average scores of the students in the experimental and control groups on each of the lateral thinking skills and the test as a whole, indicating that the experimental and control groups are of equal lateral thinking ability.

Table 6. Arithmetic Mean, Standard Deviation, and T-Test and Their Statistical Significance for the Scores of the Students of the Experimental and Control Groups in the Pre-application of the Science Fiction Scale

Skill	Experimental Group (34)		Control Group (37)		T-Value	Significance Level
	arithmetic mean	standard deviation	arithmetic mean	standard deviation		
Awareness	7.50	0.99	7.19	1.35	1.10	0.28
Flexibility	7.79	1.00	7.69	1.12	0.39	0.70
Visualization	7.53	0.96	7.97	1.14	0.72	0.08
Daydreaming	7.65	0.81	7.72	1.19	0.31	0.76
Withdrawal from reality	6.94	0.92	6.97	0.97	0.14	0.89
Maintaining the direction	7.88	1.04	7.78	0.63	0.49	0.63
Test as a whole	45.35	2.24	45.30	2.05	0.11	0.91

Table 6 demonstrates that there is no statistically significant difference at the 0.05 level between the average scores of students in the experimental and control groups on each of the science fiction skills and the scale as a whole, indicating that the level of science fiction is the same for both groups.

1) Applying the research experience by implementing the proposed unit on "Bacteria and Viruses" based on the successful intelligence and applications of augmented reality for the experimental group and teaching the unit "Bacteria and Viruses" based on the curriculum issued by the Ministry of Education for the control group during the same period.

2) The post-experiment application of the two research tools to the experimental and control groups determines the experiment's success.

3) Data collection, analysis of outcomes, and derivation of the most significant recommendations and proposals from the research.

10. Statistical Methods of the Research

The packages of the statistical program for the social sciences (SPSS 18) were utilized, together with the following statistical techniques:

1) Using the Holisti equation to determine the stability of the "Bacteria and Viruses" unit.

2) Using the Kuder Richardson-21 to adjust the "lateral thinking skills" exam by computing the difficulty coefficients, coefficients of discrimination, and coefficients of stability.

3) Adjusting the science fiction scale using the Pearson correlation coefficients and Cronbach's alpha stability coefficient.

4) Arithmetic means, standard deviations, and T-test for two unrelated (independent) groups to verify the equivalence of the two groups: experimental and control, and to identify differences between the two groups after implementing the research's teaching experiment.

5) The Eta Squared (2η) equation for calculating the magnitude of the effect of the independent variable (the proposed unit based on the theory of effective intelligence and augmented reality applications) on the dependent variables: (creative problem solving - science fiction)

11. Presentation of the Results of the Research

Following are the research results gained by answering its questions, validating its hypotheses, and then discussing these results in light of prior research findings. In light of the subsequent findings, several recommendations and suggestions for future research were offered.

- **The results related to the first objective of the research and test of the first hypothesis**: The objective stated: "What is the effect of teaching a proposed unit based on the theory of successful intelligence and applications of augmented reality in biology in developing the lateral thinking?" The first hypothesis of the research stated: "There are no statistically significant differences at the level of significance (0.05) between the average scores of the students of the two groups; Experimental and control in the post application of the lateral thinking test". To address the question and verify the hypothesis, arithmetic averages, standard deviations, and the (T-Test) were calculated, as well as the value of (T) for the experimental and control groups' post-lateral thinking test scores. To determine the influence of the independent variable (teaching a proposed unit based on the idea of practical intelligence and the uses of augmented reality in biology) on the dependent variable (lateral thinking), the effect size equation (Eta squared) was utilized. The relevant results are shown in Table 7.

Table 7. Arithmetic Mean Standard Deviation, Value of T and Their Statistical Significance, and Eta Squared Equation (2η) for the Scores of the Students of the Experimental and Control Groups in the Post-application for the Test of the Skills of "lateral thinking" in the Unit "Bacteria and Viruses."

Skill	Experimental Group (34)		Control Group (37)		T-Value	Significance Level	Value of (η^2)
	arithmetic mean	standard deviation	arithmetic mean	standard deviation			
Concept Generation	22.44	1.13	18.12	4.06	6.23	0.001	0.34
Providing Alternatives	23.26	0.67	15.11	4.16	11.78	0.001	0.65
Realization of Relationship	21.41	1.79	17.73	3.84	5.24	0.001	0.27
Production of Ideas	5.12	0.95	3.27	1.47	6.36	0.001	0.36
Test as a whole	72.24	2.37	54.22	6.76	15.22	0.001	0.76

Table 7 demonstrates that, at the level (0.05), there is a statistically significant difference between the average scores of students in the experimental and control groups on each of the lateral thinking skills and lateral thinking exams. This was in the experimental group's favor. Thus, the research hypothesis was rejected. The alternative hypothesis was accepted, which states that there are statistically significant differences at the level of significance (0.05) between the average scores of the experimental and control groups on the post-application of the lateral thinking test and that these differences are in favor of the experimental group. Table 7 reveals that the values of (η^2) for each of the lateral thinking skills and the lateral thinking test as a whole are more significant than (0.14). If the value of (2) is equal to or greater than (0.14), the size of the effect is deemed to be extensive (Abu Daqqa and Safi, 2013). This suggests that teaching a proposed unit based on the theory of practical intelligence and applications of augmented reality in biology has a considerable impact on the development of lateral thinking.

- **Results related to the second objective of the research and test of the second hypothesis:** The objective stated: "What is the effect of teaching a proposed unit based on the theory of successful intelligence and applications of augmented reality in biology in developing the science fiction?" The second hypothesis of the research stated: "There are no statistically significant differences at the level of significance (0.05) between the average scores of the students of the two groups; Experimental and control in the post application of the science fiction scale". To answer the question and validate the hypothesis, arithmetic averages, standard deviations, and the (T-Test) were calculated, as well as the value of (T) for the experimental and control groups' findings in the post-application of the science fiction scale. To determine the influence of the independent variable (teaching a suggested unit based on the theory of effective intelligence and the uses of augmented reality in biology) on the dependent variable (science fiction), the effect size equation (Eta squared) was utilized. Table 8 displays the relevant results.

Table 8. Arithmetic Mean, Standard Deviation and Value of T and Their Statistical Significance and Eta Squared Equation (2η) for the Scores of the Students of the Experimental and Control Groups in the Pre-Application for the Science Fiction Scale in the Unit "Bacteria and Viruses"

Skill	Experimental Group (34)		Control Group (37)		T-Value	Significance Level	Value of (η^2)
	arithmetic mean	standard deviation	arithmetic mean	standard deviation			
Awareness	13.35	1.39	8.76	0.64	17.63	0.001	0.83
Flexibility	13.35	1.48	9.11	0.57	15.75	0.001	0.79
Visualization	12.82	1.42	9.51	0.56	12.68	0.001	0.71
Daydreaming	13.03	1.14	9.46	0.51	16.79	0.001	0.81
Withdrawal from Reality	12.38	1.16	9.43	0.50	13.75	0.001	0.74
Maintaining the Direction	13.50	1.24	8.97	0.65	19.09	0.001	0.85
Test as a whole	78.44	6.46	55.24	1.23	20.60	0.001	0.87

There is a statistically significant difference at the 0.05 level between the average scores of experimental and control group students on each dimension of the science fiction dimensions and scale as a whole, as shown in Table 8. This was in the experimental group's favor. Consequently, the null hypothesis was rejected. The alternative hypothesis was accepted, which states that there are statistically significant differences at the level of significance (0.05) between the average scores of students in the experimental and control groups on the post-application of science fiction scale and that these differences favor the experimental group. Table 8 reveals that the values of (η^2) for each science fiction skill and the scale as a whole are more significant than (0.14). It indicates that teaching a proposed unit based on the theory of successful intelligence and applications of augmented reality in biology significantly impacts the development of lateral thinking and science fiction.

12. Discussion and Interpretation of the Results of the Research

The research findings demonstrated that the experimental group outperformed the control group on the post-application of both the lateral thinking skills test and the science fiction scale. It indicates that teaching the proposed unit based on the theory of successful intelligence and applications of augmented reality in biology significantly impacts the development of lateral thinking and science fiction. The researcher credits the findings of the study to the following:

12.1 First: Concerning the Development of "Lateral Thinking Skills"

The teaching of the proposed unit based on effective intelligence theory and augmented reality applications in

biology led to the development of lateral thinking skills for various reasons, including:

- Using the students' analytical, creative, and practical abilities in the activities and assignments in the suggested unit allowed the students to look at the problems from multiple perspectives and produce alternatives and potential answers.

- The topic analysis approach contributed to discovering multiple linkages between distinct concepts, classifying and comparing them novelly, and helping use these scientific concepts in diverse educational circumstances.

- The use of "augmented reality" technology contributed to female students being more able to focus and understand because the visual 3D effects that visualized the stuff increased students' ability to be creative and active during the learning process as they interact with scientific ideas and opinions based on virtual reality in explaining scientific phenomena.

The findings of the study agreed with those of other studies that underlined the necessity of promoting lateral thinking through the use of technological breakthroughs and teaching approaches that rely on students' engagement in learning, such as (Khalafallah and Nasr, 2020; Al-Shibawi, 2018; Faizah, 2017; Lamb et al., 2015).

12.2 Second: Concerning the Science Fiction

The teaching of the suggested unit based on the theory of effective intelligence and applications of augmented reality in biology led to the development of science fiction skills for a variety of reasons, including the following:

- The features of "augmented reality" contributed to presenting the topics with animated virtual three-dimensional images, which enhanced the students' ability to imagine and connect actual reality with virtual reality and their capacity to predict the future facts of scientific phenomena.

- Employing the theory of "successful intelligence" and "virtual reality" together in presenting and explaining unrealistic or invisible ideas with the naked eye made the students more aware of the scientific events and phenomena occurring around them and gave them greater flexibility in presenting creative ideas based on their expansive imagination.

- The use of practical applications based on augmented reality for the ideas developed by the students contributed to the consolidation of these ideas among the students and their retention as innovative solutions to the problems at hand.

The findings of this study concurred with previous research (Sabri and Al-Rahili, 2016; Hindawi, 2018; Abdel-Aal, 2019; Muhammad, 2019; Al-Otaibi, R. 2020; Roman, 2017), indicating that science fiction has a tight association with the development of creative ideas and a variety of patterns of thought. Science fiction broadens the students' knowledge and ideas and improves their ability to correctly apply those ideas to solving real-world problems, as fertile imagination produces creative ideas, and this necessitates placing students in an environment that stimulates the imagination and promotes the generation of creative ideas. This can be accomplished by integrating the theory of successful intelligence with augmented reality, which combines actual and virtual reality to present scientific phenomena and train female students to use their imaginations to predict future events based on current data and educational experiences gained through this application.

13. Research Recommendations and Suggestions

The research recommends integrating the theory of "successful intelligence," its three capabilities, and the applications of "augmented reality" in explaining and interpreting scientific phenomena, as this promotes different types of thinking among students and encourages them to examine scientific topics and phenomena from multiple perspectives. In addition, they will be able to assess and link these themes and generate innovative solutions and alternatives to various scientific challenges.

More research should be undertaken to adapt the conclusion of the present study to the actual world by developing a concept for a high school biology curriculum that combines the theory of successful intelligence and its three abilities with the applications of augmented reality. Future research should also examine its impact on the development of various higher-level thinking, given that technology integration with learning has become a priority in education due to the technological and cognitive demands of the modern era.

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