

STEM-Integrated Enrichment Program's Impact on 21st-Century Skills of Gifted High School Students

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Abstract

The study aimed to identify the impact of an enrichment program in the light of STEM integration approach in developing the 21st Century skills of Gifted students at the secondary level. The study used a quasi-experimental design, The sample of the study included 60 student from the second year of high school, at Jamal Abdel Nasser High School for Gifted Students, in the capital, Sana'a, and divided into two groups: experimental (30) and control (30). The researcher built a 21st Century skills test, consisting of 46 items. The researcher also built the enrichment program according to the STEM approach. The results showed The enrichment program, in the light of the STEM approach studied by the experimental group, led to the development of the 21st Century skills included in the study. The study recommended developing curricula for Gifted students in the light of 21st Century skills and using the STEM approach, training teachers on how to use STEM approaches in teaching the gifted, and designing complementary activities and integrating them into the curricula in order to achieve the development of 21st Century skills among the Gifted students.

Keywords: *Enrichment program, STEM entrance, 21st Century skills, Gifted students*



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INTRODUCTION

In an era described as the era of knowledge industry; The real investment has become the investment in human wealth, and that sustainable development is the development that depends on the productive human mind. The Gifted students and their energies, potentials and mental capabilities are considered the national wealth and its adornment. They must be taken care of and utilized as the first development tool if they are properly cared for and provided with capabilities and opportunities that are commensurate with their capabilities and preparations, meet their special needs, develop their tendencies and refine their talents, which would provide them with opportunities to prove their talents. Their role is to provide the community with their expertise and renewable and energetic energies.

According to Al-Qabbali (2012), The category of Gifted students and their energies and capabilities is a national wealth that must be taken care of and benefited from, in a way that benefits the Gifted students themselves, and society in general. Therefore, many countries have embraced and cared for this group, prepared special programs for them, and provided the necessary capabilities that would Provide opportunities to prove their role and provide society with their expertise and renewable and energetic energies.

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In this context, Muhammad (2019) indicates that the most prominent requirements of the 21st century are to prepare individuals with many skills that qualify them to face rapid developments and adapt to work requirements, cultural and economic issues of society, and enable them to continue their education for life, and solve problems that they face in their lives, and they have the ability to live and work in the era of knowledge production in various fields of life.

Given the importance of these skills as a necessity for the success of individuals in education and life, many international organizations and educational institutions have sought to define them as learning outcomes that students must possess in order to adapt to the world around them, including the 21st Century Skills Partnership Organization, which is represented by the skills of learning, innovation, critical and creative thinking, and a solution Problems and communication with others, information and media culture, information and communication technology culture, vocational and life skills, which are flexibility, adaptation, initiative and self-direction, social skills, production capacity, leadership and responsibility (Al-Saeed, 2018: 10).

The educational programs offered to students are considered one of the most important and basic pillars that play a prominent role in providing students with the necessary knowledge and developing the necessary skills to keep pace with the needs and requirements of the era in which they live. The STEM entrance is also one of the modern entrances that are used with Gifted students in the field of scientific and technological education, and one of the most prominent and important educational reform projects and programs in the current period. Many studies have called for the importance of adopting the STEM approach, such as: Yildirim (2016), (Ozkan, Topsakal (2017), Hilal (2021), Taha (2019), Al-Ghamdi (2019), Al-Saeed (2018), El-Demerdash, M. & Kortenkamp, U (2009), Al Ahwal (2021), Sarican and Akgunduz (2018), Wahba, and others (2022), and El-Sayary (2014). By organizing the content of the study around educational situations that remove barriers between the four fields (science, technology, engineering, and mathematics) when taught, the STEM approach is one of the approaches that have proven effective in providing learners with many different aspects of learning. According to Dejarnette (2018), Teaching science, technology, engineering and mathematics to high achievers They gravitate greatly towards science because Their inherent curiosity and creativity. study Yildirim (2016) indicates that applying the STEM educational approach improves academic achievement, problem-solving, and creative thinking, while a study (Ozkan, Topsakal, 2017:115) confirmed that most STEM activities are fun and exciting for students, and a study (Akgunduz & Akpinar, 2018:1) revealed that All students showed positive attitudes towards the study of mathematics and science after carrying out activities and tasks according to the STEM approach, and that engineering applications such as design, finding alternative solutions to problems, and drawing drawings are effective in developing student motivation for learning.

The problem of the study is the absence of enrichment programs in the schools of the Gifted students in the Republic of Yemen, which meet the requirements and needs of the Gifted students, and contribute to students' acquisition of the skills of the first century. This led to the need to develop the curricula of the Gifted students, and to design enrichment programs for them that are compatible with modern educational trends and theories, and to meet those calls that called for the need to provide the opportunity for Gifted students to engage and immerse themselves in different life situations, and to link what they learn to their daily lives, and to remove barriers between subjects. In a way that helps them keep pace with the requirements of the era in which they live, and prepared to join the jobs of the 21st Century, and this was confirmed by a study they conducted (Al-Shuja' and Al-Haddad, 2016). It aimed to evaluate the Gamal Abdel Nasser High School program for the Gifted students in the light of international standards for the education of the Gifted students, and concluded that the criterion for the availability of enrichment

programs was weak, and recommended the need to develop modern enrichment programs that are compatible with the requirements of the current era and meet the needs of the Gifted students.

Research Objectives

The study problem can be formulated through the research question, "What is the effect of an enrichment program in the light of STEM integration in developing the 21st Century skills of Gifted students at the secondary level?"

The study is expected to contribute to enriching the field of teaching and learning mathematics through the following additions:

1. Determining a list of the 21st Century skills that must be developed for Gifted students at the secondary level.
2. Providing a practical model for designing an enrichment program in the light of STEM integration approach based on the rules of teaching design science in designing educational units based on integrated curricula designs and broad curricula, centered around the learner.
3. Providing a modern teaching approach and appropriate strategies for developing 21st Century skills for Gifted students in the secondary stage, and benefiting from the teacher's guide in designing other study units or designing mathematics programs according to the STEM approach.
4. It directs the attention of those in charge of school curricula to achieving integration between science, mathematics, engineering and educational technology subjects by presenting a model for a proposed enrichment program designed according to the STEM approach.
5. It is a response to the calls of researchers, and the global trend to study the effectiveness of the STEM approach in teaching Gifted students.
6. Benefiting from the results of the study and its recommendations and proposals in conducting other studies in the same field of STEM and 21st Century skills.

RESEARCH METHOD

Research Design

In this study, set at Gamal Abdel Nasser High School in Sana'a for the academic year 2021-2022, the impact of the STEM approach on 21st-century skills acquisition among gifted students was explored within the context of real functions. This integrated approach highlighted the applicability of mathematics in real-world scenarios, aiming to foster critical thinking and adaptability in our modern, ever-evolving landscape.

Study assignments

To answer the study questions, a hypotheses was formulated as, "There are no statistically significant differences at the significance level (α X0.05) between the mean scores of the control group and the experimental group in the post- test 21st Century skills."

The limits of the study

Spatial boundaries: Gamal Abdel Nasser High School for Gifted Students, the capital Sana'a.

1. Time limits: the academic year 2021-2022 AD.

2. Objective boundaries: represented by the unit of real functions (algebraic, trigonometric, exponential, and logarithmic), from the second-grade secondary book, part one, scientific section.
3. Objective limits: The study was limited to some 21st century skills, namely: creative thinking, problem-solving, technical literacy, information and communication technology, productivity, accountability.

The Philosophical Framework for STEM Entrance

The STEM approach is based on the philosophy of learning based on the integration of science, technology, engineering and mathematics, and is based primarily on integrating the student into performance educational experiences, which requires providing an active learning environment for the student, enabling him to practice educational activities and experiences, in the form of challenges, tasks and problems, that provoke his thinking in The direction of employing the knowledge he acquires in solving the problems he faces, applying it in new situations, and producing new knowledge that enables him to actively participate in society and the labor market.

STEM majors and Principles

STEM is represented in the following majors: 1. Science, 2. Technology, 3. Engineering, 4. Mathematic. The principles on which STEM is based is based on removing the barriers between the four disciplines, and replacing these barriers with merging, overlapping, linking, integration, or mixing. Al-Shammari (2018: 27) mentioned some principles that curricula designers are supposed to be aware of and follow when designing curricula according to the STEM approach, as follows:

1. The principle of integration: Thinking about solving problems in a comprehensive manner, in which concepts intersect and applications overlap between oriented disciplines.
2. The principle of planning: it includes good planning in formulating tasks and activities, and putting students in front of challenges that stimulate their thinking.
3. The principle of cooperation: It means cooperation between teachers applying the entrance and teachers of its four majors.
4. The principle of evaluation and training: reviewing performance according to the outputs of feedback and training, according to new information that is nominated.
5. The principle of diversity: This principle focuses on diversity in performance, tasks, outputs, evaluation tools, and learning strategies.
6. The principle of 21st Century skills: Taking into account the consistency of content, activities and tasks provided with 21st Century skills, such as problem-solving, effective communication, collaborative work and design thinking.
7. The principle of teaching skills: the teacher develops his performance and tools if he decides to teach according to the STEM approach and in line with the STEM philosophy.
8. STEM entrance goals in education

The United States of America has set three general goals to achieve the desired effectiveness of STEM education, which were mentioned by the National Research Council (2012) in America as follows:

Goal 1: Increase the number of students who eventually enroll in degrees that qualify for advanced jobs in science, technology, engineering, and mathematics, and expand the participation of women and

minorities in those fields.

Goal 2: to increase the number of the workforce capable of managing the fields of (science, technology, engineering, and mathematics), and to expand the participation of women and minorities in that workforce.

Goal Three: Literacy in science, technology, engineering, and mathematics (STEM) for all students, including those who do not pursue careers related to STEM fields, as personal and societal decisions in the 21st century increasingly require scientific and technological understanding.

Teaching mathematics in the light of STEM

There is no doubt that mathematics represents an obsession for most students, as students see it as a dry material full of numbers that may be of no use. Teaching through the STEM curve is to break this stereotyped view of mathematics, and that teaching mathematics in light of the STEM approach must employ the relationship between the progressive presentation of ideas and between its application, as this works to provide a base for deep understanding, as well as makes the student satisfied and convinced of what is presented to him. Teaching in the light of STEM requires the availability of some advantages and taking them into account, as follows:

1. Keeping the teacher in constant contact with the latest research and studies in the educational field.
2. Opening the door for students to discuss mathematical topics and express their views on them.
3. Developing alternative assessment methods and integrating peer assessment into work.
4. Using scientific platforms specialized in mathematics.
5. Integrating mathematics in all disciplines and emphasizing the importance of using it.

21st Century Skills

In response to the requirements of the 21st Century and its challenges that impose on educational systems the need to develop the skills necessary for life and success in this century, many educational institutions and organizations have sought to define the skills of the 21st Century, and among these institutions is the 21st Century skills partnership, which has classified skills into three groups, namely :

1. Learning and innovation skills
 - a. Innovation and creativity.
 - b. Critical thinking and problem solving.
 - c. Communication and sharing skill.
2. Information technology and media.
 - a. Information literacy.
 - b. Media literacy.
 - c. Information and communication technologies culture.
3. Life and work skills:
 - a. Flexibility and adaptive.
 - b. Initiative and self-direction.
 - c. Social interaction skills and multicultural interaction
 - d. Productivity and accountability.
 - e. Leadership and responsibility.

Objectives of developing 21st Century skills

Attention to the development of the skills of the 21st Century is a basic requirement in the era of the knowledge-based economy in order to provide a workforce that possesses multiple skills to deal with the characteristics of this era. In this regard, several studies have been reported, such as the study of Al-Khazim and Al-Ghamdi (2016), and the study of Saudi (2013), a set of goals that the 21st century skills seek to achieve for learners, summarized by the researcher as follows:

1. Helping learners develop their cognitive, psychological and skill competencies, which they need to succeed in life.
2. Developing basic knowledge of various academic subjects. 21st century skills cannot succeed without developing basic knowledge of the academic subject. In order for students to be able to think creatively and critically, and to communicate effectively, this must be based on academic knowledge.
3. Making learners capable of critical thinking, problem solving, communication, cooperation, technological literacy, flexibility, adaptability, innovation, creativity, interest in global affairs, and media education.
4. Preparing students to face the rapid changes and preparing them for a future full of inventions, discoveries and unfamiliar technologies.

21st Century Skills Standards

The 21st Century Skills Partnership has identified basic criteria that must be worked on in order to achieve these skills (Magner, Soule, H, & W esolowski, k, 2011: 192), which are as follows:

1. Educational environments
2. Professional development
3. Curriculum and teaching methods
4. Standards and evaluation:

Many scholars and educators have agreed that teaching mathematics and learning 21st century skills support each other, and that this happens when a number of conditions are met, as indicated by the study of (Shalabi, 2014), (Al-Khazim and Al-Ghamdi, 2016), (Rabat, 2018) (Abdel-Aal, 2018) as follows:

1. That the teaching of mathematics be based on new curricula based on an inquiry strategy that allows learning of appropriate 21 century skills with the availability of supporting educational materials.
2. That students practice the skills of investigation and technological design, and allow them to use a wide range of technology that makes them engage in solving real problems.
3. The assessment should focus on students' progress in acquiring 21st century skills, as well as mastery of the content of the study materials.
4. Teaching mathematics should provide students with opportunities to search and explore for knowledge, and to discover this knowledge themselves.
5. Continuing professional development opportunities should be provided for mathematics teachers that support the integration of the 21st century skills of these teachers.
6. A school environment that supports the development of 21st century skills should be provided for students.
7. 21st century skills should be integrated purposefully, deliberately and systematically into mathematics education curricula.

Curriculum for Gifted students

Indicates Ghanem (2012: 28) that the curriculum for Gifted students depends on diversity in activities and elements of learning, and there are five elements of diversity: advanced content in its sources and texts, the learning process based on flexible groups and the entrances of multiple intelligences, stimulating independent production based on performance, preparing The appropriate environment in the diversity of the place and sources and the participation of learning mentors, and methods of realistic assessment, and states (Colanfelo, N., & Davis, G. A., 1997) that the design of the curriculum of the Gifted students is characterized by the following elements:

1. A meaning-centered approach that focuses on real-life concepts, issues and problems.
2. The content of the curriculum is focused and organized so that it includes a thorough, complex and in-depth study of the main ideas, problems and topics that make knowledge integrated across all systems of thinking.
3. Provides higher-order thinking skills such as analysis, synthesis, and evaluation.
4. Allows the growth and application of creative thinking skills to help students re-imagine and understand available knowledge, as well as generate new knowledge.
5. It enables students to explore constantly renewable knowledge in order to enable them to form the attitude that considers knowledge worthy of tracing its sources in an open world.
6. It encourages students to be exposed to specialized and appropriate resources, to choose and use them.
7. Allows self-learning through active learning and problem-solving.
8. Linking topics in an integrated, interwoven framework.
9. Curriculum based on technology as tools for the learning process.
10. A curriculum that allows opportunities for independent learning.

Data Collection Method

The current study followed the semi-experimental approach, as it is the appropriate approach to investigate the impact of the enrichment program, through two equal groups, in terms of: the mathematical background, the chronological age of the students, the skills of the 21st century, and the subject teacher, with pre- and post-measurement, through the study measures and the following table Explain that.

Table (1) shows the experimental design of the study

The experimental group	The control group
Tribal application to test the skills of the 21 st century	
Teaching the enrichment program prepared in the study	Teaching the mainstream program in general education
Post-application of the 21 st century skills test	

Study Sample

The sample of the study consisted of (60) students from the second year of secondary school (scientific section) at Jamal Abdel Nasser High School for Gifted Students, in the capital Sana'a, where the school was chosen in an intentional way, because it is equipped with the necessary technologies for the implementation of the study, and the fact that the researcher works as a teacher of mathematics In it, two

divisions were randomly selected from among the five divisions of the second secondary grade, one representing the experimental group and the other representing the control group, where the experimental group studied the program prepared by the researcher, and the control group studied the usual program approved by the Ministry of Education, Table (2) Shows the distribution of the study sample. Table (2) Distribution of the study sample (experimental and control)

the group	Class	div	the number
The experimental	second secondary	Third	30
the control group	second secondary	The first	30

Study Tool:

The current study tool was represented by the "21st century skills test", which includes: creative thinking skill, problem-solving skill, technical culture and communication skill, accountability skill, and productivity), and table (3) explains this.

Table (3) 21st century skills test specifications

the tool	Paragrap h number	ratio
Creative thinking skills test	15	%33
Problem-solving skill test	8	%17
Test the skills of digital culture and communication and information technology	13	%28
Accountability and productivity skill test	10	%22
the total	46	%100

Grading System:

Test scores were determined according to the nature of the test and the type of paragraph as follows:

1. Creative Thinking Skill Test: Scores were estimated based on the following criteria:
 - a. The subject gets the total scores for the creative thinking skills test through the sum of the total scores obtained in the following dimensions: fluency, flexibility, and originality.
 - b. The degree of fluency is calculated by the number of correct responses related to the activity after excluding the repeated ones.
 - c. The degree of flexibility is calculated by the number of categories to which the responses belong.
 - d. The sum of the originality scores obtained by the subject on each response, where a score of (zero) is given if there are no final answers, or if the answers are meaningless, and (one score)

is given if the answers are familiar and normal, and (two degrees) is given if they are The answers are somewhat strange, and (three degrees) are given if the answers are completely strange and rarely appear in the answers of most of the respondents.

2. Problem Solving Skill Test: Scores are based on the following criteria:
 - a. Two marks are calculated for the paragraphs of the type of pans, so that a quarter of a mark is given for each step of solving the problem.
 - b. One point is calculated for items of multiple choice type.
 - c. One point is calculated for paragraphs of the type of completing the void.
3. Digital Literacy and ICT Skills Test: Scores were assessed based on the following criteria:
 - a. One point is calculated for items of multiple choice type.
 - b. One point is calculated for paragraphs of the type of completing the void.
4. Accountability and Productivity Skill Test: Scores were estimated based on the following criteria:
 - a. One point is calculated for items of multiple choice type.
 - b. Three marks are calculated for the paragraph of the pans.

Validity of the test

The validity of the test was confirmed by presenting it to a group of experts and specialists in the field of curricula and teaching methods, the field of educational technology and the STEM approach, the names of the arbitrators to find out and specify the following:

- The suitability of the paragraphs for the subject of the study and the researched group.
- The integrity of the wording and the linguistic accuracy of the vocabulary used.
- The extent to which the indicators are compatible with the standards and their affiliation with the axes.
- The validity of the indicators in the expression of specific scientific practices.
- The arbitrators' amendments to the test were adopted, and what was agreed upon was amended, and some vocabulary was reformulated.

Test stability

The study tool was applied exploratory to a group of (15) students from the second year of scientific secondary school at Gamal Abdel Nasser High School for Gifted students at the end of the second semester of the academic year 2020-2021, and the stability coefficient of the 21st century skills test in the four skills was calculated using Cronbach's alpha equation, By applying the test once, its value was the stability coefficients as shown in Table (4).

By looking at the coefficients in table (4) above, we find that the stability coefficient for each skill was appropriate, and also the stability of the test for all skills was (0.81), and this value indicates that the test has high stability, and calls.

Table (4) the values of stability coefficients for the study tool

the tool	Stability Coefficient
Creative thinking skills test	0.76
Problem-solving skill test	0.82
Test the skills of digital culture and communication and information technology	0.78
Accountability and productivity skill test	0.80
the test as a whole	0.81

Design and organization of the enrichment program

The enrichment program consisted of the student's book and the teacher's guide. The guides were prepared according to the steps of Preparing the student's book: The enrichment program prepared in this study is one of the types of programs for the care of the outstanding, represented by the depth and expansion of the scientific material provided to the Gifted students, which has a major role in refining and developing the skills of the Gifted students according to their trends, tendencies, and characteristics, and it consists of a set of scientific concepts And the process characterized by depth and diversity in the field of the real function from the mathematics book for the second secondary grade, within the STEM integrative approach to the fields of: For the fields of: science, technology, engineering, and mathematics, and in accordance with the requirements of the 21st century, as the program was built to provide qualitative additions that differ from what is offered by the regular school curriculum, and the program has been designed according to the following steps:

1. Examination of previous literature and research in the field of designing and building curricula, the STEM approach, the applied curricula in some STEM schools and the international projects based on it.
2. Reviewing the 21st century skills framework of the Partnership for 21st Century Skills and the mechanisms for integrating them into education curricula.
3. Reviewing the characteristics of the Gifted students, and the nature of the teaching and learning programs that meet their needs.
4. View the mathematics curricula (with all its components) for the secondary stage.
5. Examining science curricula for the secondary stage in cooperation with teachers of physics, chemistry and biology, and identifying topics related to topics of functions.
6. Consulting with engineers in the fields of design, architecture, and mechatronics to determine the engineering design concepts that can be included in the enrichment program, in accordance with the content of the program and the level of the study sample.
7. Defining a list of criteria for integrating technology into education at the secondary level.
8. View the standards of CCSSM and NCTM, 2010 for the secondary stage, and specify a list of standards that must be achieved by students in the secondary stage.
9. View the technical programs that can be used to integrate technology into the program.

10. See the types of enrichment programs suitable for Gifted students.

Adjust the program and verify its Validity

After completing the preparation of the enrichment program (student's book and teacher's guide), it was presented to a group of arbitrators and experts specialized in the field of caring for Gifted students, as well as in the field of curricula and teaching methods for mathematics and science, as well as in the field of learning techniques and engineering design. The names of the arbitrators (Annex 5); To take their opinions and suggestions about the teacher's guide and the student's book in terms of the following:

- The suitability of the content of the program to achieve its desired objectives.
- The suitability of the content of the program to the level of Gifted students in the second year of high school.
- The suitability of teaching methods and methods to achieve the objectives of the programme.
- The suitability of educational activities to achieve the objectives of the program.
- The integrity of the formulation of educational activities in terms of educational, linguistic, terminological, and scientific aspects.
- Distribution of activities on topics, their suitability for the level of students, and their compatibility with the STEM approach
- Skills included in educational activities.
- The suitability of educational aids for the activities they include.
- Appropriateness of evaluation methods used in the program.
- The time allotted for program implementatio.

Statistical Tools

In the current study, the researcher used the following statistical methods through the SPSS program:

1. Calculating the means and standard deviations for the test scores in the various variables of the study.
2. T-Test. T-test to check the equivalence of the experimental and control groups.
3. Cronbach's Alpha coefficient and the split half method using Spearman Brown's equation to find the stability of the 21st century skills test.
4. Effect size by calculating the value of (eta square)
5. The researcher also used percentages.

FINDINGS AND DISCUSSION

To answer the main question of the study the arithmetic means and standard deviations were calculated, and the differences between the two groups were calculated using the T-test, and the effect size of the independent variable (STEM entrance) was measured on the dependent variable (21st century skills), the researcher calculated the effect size, where Eta square was used From the value of (v) calculated as follows:

$$\eta^2 = \frac{t^2}{t^2 + df}$$

Where: t is the value of the calculated test, df is the degree of freedom (df=n1 + n2-2), and the eta-square indicates a percentage of the variance of the dependent variable due to the independent variable, while the effect size indicates the percentage difference between the means of the two groups in standardized units. Effect size using eta-square (η^2) using the equation:

$$d = \frac{2\sqrt{\eta^2}}{\sqrt{1-\eta^2}} \quad \text{Where } d : \text{effect size, } \eta^2 \text{ eta-square.}$$

The effect size associated with the value of eta-square (η^2) takes three levels:

- - The effect size is small if it is $0.01 < \eta^2 < 0.06$
- The effect size is medium if it is $0.06 < \eta^2 < 0.14$
- - The effect size is large if it is $\eta^2 > 0.14$

The results were as shown in the following table (6):

Table (6) T-test results for two independent samples in the post application of the 21st Century skill test η^2 , d and the effect size of the program on the 21st century skill.

Skill	Group	Number	Arithmetic mean	Standard deviation	Degrees of freedom	Calculated t-value	Significance level	" η^2 " value	d-value	Effect size
Creative thinking	Experimental	30	34.77	4.71	58	12.9	0.00	0.74	3.39	very big
	control	30	23.07	1.57						
Problem Solving	Experimental	30	18.6	3.793	58	10.762	0.00	0.67	2.83	very big
	control	30	10.2	1.972						
Information and communication culture	Experimental	30	26.70	3.292	58	10.8	0.004	0.67	2.83	very big
	control	30	19.2	1.919						
productivity and accountability	Experimental	30	9.33	2.090	58	3.7	0.01	0.19	0.97	very big
	Control	30	7.63	1.402						

From Table (6), it is clear that the calculated value of t in the post creative thinking skill test is (12.9), and this value is statistically significant at the level of significance ($\alpha < 0.05$). Also, the difference between the mean scores of the students of the experimental and control groups is equal to (11.7), in favor of the group. Thus, the null hypothesis (1) was rejected, and the alternative hypothesis was accepted. It also turns out that the value of η^2 calculated for the creative thinking skill is equal to (0.74) and the value of d is equal to (3.39), which indicates that the size of the effect of the independent variable on the dependent variable was with an effect rate of (74%), which is a high percentage, and indicates that a large percentage of The differences are attributed to the independent variable the enrichment program.

In the problem-solving skill, the calculated value of t was (10.762), and this value is statistically significant at the level of significance ($\alpha < 0.05$), and the difference between the mean scores of the students of the experimental and control groups is (8.4), in favor of the experimental group, and thus the null hypothesis was rejected (2), accepting the alternative hypothesis. It shows that the value of η^2 calculated for the problem-solving skill is equal to (0.67), and the value of d is equal to (2.83), which indicates that the size of the effect of the independent variable on the dependent variable was with an effect rate of (67%), which is a high percentage, and indicates that a large percentage of The differences are attributed to the enrichment program.

In the post-test of information and communication culture, it is clear that the calculated value of t is equal to (10.8), and this value is statistically significant at the level of significance ($\alpha < 0.05$), and the difference between the mean scores of the students of the experimental and control groups is equal to (7.5), in favor of the experimental group, and thus The null hypothesis (3) was rejected, and the alternative hypothesis was accepted. The value of η^2 calculated for the skill of information technology culture and communication technology is equal to (0.67), and the value of d is equal to (2.83), which indicates that the size of the effect of the independent variable on the dependent variable was with an effect rate of (67%), which is a high and appropriate percentage, and indicates that A large percentage of the differences are attributed to the enrichment program.

Finally, in the post-test of productivity and accountability skills, the calculated t -value was (3.7), and this value is statistically significant at the level of significance ($\alpha < 0.05$), and the difference between the mean scores of the students of the experimental and control groups is equal to (1.7), in favor of the experimental group, and thus it was rejected The null hypothesis (4), and the acceptance of the alternative hypothesis. The value of η^2 calculated for the skill of productivity and accountability is equal to (0.19), and the value of d is equal to (0.97), which indicates that the size of the effect of the independent variable on the dependent variable was with an effect rate of (19%), which is a high percentage, and indicates that a large percentage of The differences are attributed to the enrichment program.

Discuss the Results

By presenting the previous results, it can be said that the enrichment program in the light of the STEM approach studied by the experimental group led to the development of the 21st century skills included in the study, represented in: creative thinking skill, problem-solving skill, information technology and communication technology skill, productivity an accountability skill . Compared to the usual program taught by the control group.

The results of the current study agreed with most of the previous studies and research that used the STEM approach to develop 21st century skills, such as the studies of Hilal (2021), Taha (2019), Al-Ghamdi (2019), Al-Saeed (2018), and (El-Demerdash, M. & Kortenkamp, U, 2009), Al Ahwal (2021), Sarican and Akgunduz (2018), and El-Sayary, 2014).

These studies have concluded that employing the STEM integrative approach has an effective impact on developing creative thinking skills (one of the skills of the 21st century) among students at various educational levels.

These results can be attributed to the following:

1. The enrichment program is designed to help students develop creative thinking skills, and this is evident through mathematical tasks and various activities that put students in situations that challenge their thinking, stimulate their creative abilities, and solve various problems with perseverance and more control, and through reflection on the required tasks, and research And investigation, and through worksheets that include presenting perceptions and problems that provide students with opportunities for thinking, and at the same time push the student towards creative imagination that leads to the emergence of creative solutions to the problems posed.
2. The method of designing the enrichment activities in a way that is deepening and expanding, and linking them to the four branches of STEM in a manner commensurate with the capabilities of the Gifted students It led to the expansion of their perceptions, and this is what drives them to produce and generate a large number of creative responses.
3. The program included enrichment activities that are open-ended and related to the daily life of the students, which made them accept them while they felt their importance, and motivate them to present as many responses as possible.
4. The program provided students with the opportunity to practice the role of scientists and engineers in thinking and investigation, practicing design skills, learning through projects, experiments, collaborative work, and collective thinking, which led to the development of creativity and innovation.
5. Employing the STEM approach helped students see problems from many angles and enabled them to have many ideas. Training in investigation skills, solving realistic (life) problems, and what each of them includes in terms of observation skills, reflection, analysis, conclusion, interpretation, logical reasoning, criticism and evaluation Solutions and opinions, led to the development of students' problem-solving skills.
6. Diversity in the tools and means to assist in the implementation of the program, where a number of interactive activities and computer programs were employed in presenting and clarifying the activities of the program, which helped students in understanding the components of the mathematical problem from different angles and aspects, discussing and presenting multiple ideas to solve the same problem, and emphasizing the interpretation And justifying the solution, and judging the reasonableness and logic of the solution, which enhanced the students' ability to solve problems.
7. Teaching according to the STEM approach provided students with an opportunity to change their beliefs in viewing science, mathematics, and technology as mere separate subjects. Rather, it focused in large part on activities and processes such as viewing mathematics as a servant and facilitator for learning science, and the integrative role of technology that cannot be isolated from mathematics, science, and engineering. And that it is an interaction between ideas, man and machine, and this contributed to the learners' acquisition of knowledge and concepts related to the STEM approach, and transferred them as experiences and strategies to deal with the problems they face, and made it easier for them to choose appropriate sources of knowledge, determine the extent of their need, and its relationship to the nature and dimensions of the problem that they are about to face and solve.
8. The use of the STEM approach enabled the student to develop digital and informatics culture, through

the student's research in the various sources of knowledge in books and the Internet about knowledge, revision, processing and criticism of knowledge.

9. The use of computer programs and applications, the virtual lab during the implementation of the activities, and the mathematical tasks included in the program, help the student to develop the skill of digital culture.
10. Teaching some of the subjects of the program with the help of several websites, and using many educational software and technological means; Contribute to the development of students' capabilities in dealing with digital technology, and the development of communication technology skills.
11. Employing the problem-centered learning strategy, which allowed the student to perform specific tasks and activities to be completed at a specific time, and provided them with the skills of setting goals, managing time and self, and working actively to accomplish the required activities while setting priorities for work.
12. Training in practicing the skill of design and learning about projects, such as engineers, led to the acquisition of skills of accuracy, planning, confidence, self-reliance, responsibility and perseverance.

CONCLUSIONS

By looking at the theoretical literature of the study and its results, the researcher reached the following conclusions:

1. Employing the STEM approach in the educational process makes education meaningful for learners.
2. To develop 21st century skills among students, an appropriate learning environment should be provided that is exciting and stimulating for students' thinking and puts them in front of realistic situations and problems that require creative and participatory solutions.
3. The electronic market is full of various computerized educational programs that can be obtained and used easily, so that every teacher can employ them while teaching.
4. Students learn technical skills faster and (sometimes) outperform their teachers.
5. The Gifted students interact more when they are exposed to realistic problems and are asked to think about solving them, and they have great insistence on searching and finding solutions to these problems.
6. proposals

In light of the results of the current study, the following studies are suggested:

1. The effectiveness of using modern educational approaches in developing the skills of the 21st century among Gifted students.
2. Studying the perceptions of those in charge of educating and caring for gifted students about STEM approach and 21st century skills.
3. Studying the obstacles of applying the STEM approach to the teaching and learning of Gifted students.
4. Evaluation of the educational programs provided to the Gifted students in the light of the skills of the 21st century.

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