

The Effectiveness of a Learning Program Based on STEAM in Computer Science for Gifted Students in Developing Scientific Reasoning

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Abstract

The current research aimed to identify the effectiveness of the educational program based on STEAM in both scientific reasoning and innovative thinking of gifted students within the computer subject in their fifth preparatory grade. To achieve this goal, the null hypotheses have been adopted: There is no significant difference at the 0.05 level between the ranks of learners' scores in the pre-test and post-test of scientific reasoning for gifted students who studied computer science according to the STEAM educational and learning program. The descriptive and quasi-experimental methods were adopted during the current research. The former was used for the purpose of building the educational program, while the latter was related to the application of the experiment, thereby demonstrating the effectiveness of implementing the program on a sample of gifted students in their fifth preparatory grade in computer science at the Mohobi Baghdad School, numbering (10) students in the academic year 2022-2023. The appropriate experimental design for the group, based on pre-test and post-test, has been adopted through the application of the Aloson scientific inference test.

Keywords: Educational Program, STEAM Approach, Scientific Reasoning, Computer Field, Gifted Students.

Introduction

Educational Learning programs are considered a miniature part that can represent the educational curriculum, by considering a set of educational experiences and steps that can be implemented in the form of detailed activities that represented to learners within one of the specific categories, in an effort to achieve the intended educational and learning goals that are specified for a known duration of time (Al_Kinani,2020,2).

And therefore we find that educational and learning programs include all types activity and regular experiences to be implemented according to a studied and pre-prepared context, and become these programs seek to achieve educational goals, they must be carefully constructed because they aim to raise young people, and this can be done by choosing components of educational programs in light of the developmental needs of learners, in addition to the nature of the academic subject and the material environmental, and time resources allocated to implement the educational process (Zayer et al.,2014,36-37). The educational program includes a group of elements that together from the overall structure of the educational program. These elements are basic and each of them has a rule in computing, implementing, and determining the course of the program, as well as determining the extent of its quality, so the most prominent of these elements that were reached through reviewing the literature and previous studies are the ones show in figure (1) below:

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Figure1. Show the Elements of Educational Program

In the first element “Goals”, we found that it includes all the outcome expected or occur when implementing the educational learning program, and light of its procedures and capabilities through them the features of the rest of the elements are drawn and defined, which constitute the rest of program (Al-Qudhah et al.,2020:36). The second element is the “content”, which is the tangible part of the educational program that is directed to the learner and the learning process, it includes all the experiences that are developed by its planners, whether cognitive, emotional or affective component in pursuit of comprehensive growth for the learner (Al-Kasbani,2014:122). The third element is about teaching and learning strategies which considered the applied aspect of the program because it is sequenced in successive implementation steps, the teacher works to employ them as teachings skill appropriate to the educational - learning situation and learner (Al_Saeedi,2020,6). The fourth element was activities that include all the actions that the learner seeks to do with the intention of achieving the set goals (Al-Qudhah et al.,2020:38). The fifth element very important, it is about the educational tools and educational technologies, these will become an important assistant in arousing the interest of the learners, renewing their activity, satisfying their needs, while exciting them towards the lesson and subject (Ashtiwa and Ribhi,2015:39-40). The sixth element is the exercises, the research believe that the training is considered an approved context for developing the various aspect of necessary knowledge and skills and it is possible to employ them in developing the learners scientific reasoning and other aspects, its directed by the teachers and take place under their direct supervision within the subject. And the last element is the evaluation which indicates correcting that is crooked by issuing a judgment on it after identifying the area of weakness and strength, thus we find that it includes negative and positive aspects (Eyal and Khalid,2014:6). From all this, we can say that evaluative process regardless of its diver’s form and methods with the feedback contribute to the decision- making aspect that leads to predicting the facts, diagnosing them and establishing reality to achieve important in the educational process (Al_Zind,2018:37).

Since the educational program is based on a STEAM approach, it is essential to understand this educational trend and its components, at the beginning of Twenty-one century, attention shifted clearly from the social aspect of STEAM approach to aspects that flow into teaching basic scientific content, and thus its trend known as science, Technology, and society (STS) developed into a new concept based on teaching societal scientific issues (Socio-Scientific-Issues) also known as (SSL)(Al_Jalal and Saeed,2019:4). The topics that will be addressed are embodied in the word (STEAM), which each letter refers to a specific topic, the science include all kinds of science, here learners link and apply the principles of them knowledge with the other elements in the integrative approach (Jolly,2017:5), While the technology, may include equipment, tools and scientific products involved in industrial arts, and learners actually produce prototypes to solve problems while learning how to use them and how new technologies affect everyone (Jolly,2017,5), and because the computer is one of the most prominent elements of technology, media groups can be used to create programs and systems and bridge links between other elements (Bank and David,2014:29). The engineering field considered a channel for integrating and applying science, mathematics, and technology,

which force the elements must integrate and reach a scientific solution to achieve the application of concepts with a design that they find solves a problem, and the engineering design process (EDP) is the systematic way in which learners learn problem solving (Jolly,2017,6). The Art element in STEAM approach should be placed as an important element within the curriculum according to this integrative approach due to its central importance after its role diminished due to several factors, including the need for supplies and time (Cofield,2017:15), it could be drawing, music, graphics, videos, movement, and sculpture, all of which aim to enhance learners' "innovation", reduce stress while improving long memory (Maslyk,2016:8). Mathematics, is the last element in "STEAM" term, it includes the abilities to analyze, understand and interpret advanced solutions for problems (Jolly, 2017:7).

The integrated STEAM approach adds value to the teaching and learning processes, teaching procedures, educational content, and even the goals and the elements they achieve, activities and enrichment with opportunities that allow students to think and reflect contribute to raising their achievement with development of personality and thinking and teaching a subject area that overlaps with another subject enhances understanding (Bank and David,2014:226). So, in computer subject that designated to the Gifted schools in Iraq, the learners in the first and second grade tend to deal with various systems must notably, the binary system and learn to programming some games by using blocking languages according to various and constantly renewed applications, and learning how to design and programming websites, while in the fourth grade learned a set of applications related to preparing programs for smart devices, in the fifth grade the gifted students learn a precedent that makes it easier for them to deal with technology in a broader way than that they learned in their previous stages, its include a set of instructions that prepare and create simplified robots, if we take a closer look at the usual curricula, we find that the goals and directions of educational institutions no longer recognize only the learners' memorization of the courses presented to them, but they are now directed with care and attention to making young people more thinkers and capable of analyzing situations, extracting hypotheses, setting the, and verifying them, extrapolating situations, and solving problems, the research finds it important to address the most prominent matters urged by educational institutions in developed countries, namely scientific reasoning.

Scientific reasoning skills are also linked to problem-solving skills, and therefore it can be said that scientific reasoning is an indicator of problem-solving, including interest in information systems and drawing reasonable conclusions from observed patterns with the ability to evaluate at every stage of it (Kundariati and others,2021:197). Inference is affected by scientific thinking when the causes that led to a phenomenon are revealed. Thus, it combines deduction which find that the content of a part is generalizable to the whole, and induction which moves in the direction of gathering evidence that contributes to achieving the validity of the information and thus the generalizations that are adopted in deduction (Al-mousawi,2016:71), it can also be considered one of the elements of intelligent behavior with a clear ability to solve problems and generate modern knowledge based on scientific results and strategies (Al-Timimi and Zaid,2019:56).

Scientific reasoning consist of (Abduction), (Retrodiction), (Deduction), (Induction), the abduction generates possible explanation for puzzling observations, the Retrodiction for the first time, the possible probabilities of the observation are used, Deductions, by moving from premises to conclusions according to logical rules, Induction, tracing and moving from part to whole, here both deduction and induction lead the research process, which is described by applying "if... then... therefore" to find reasons and used it and testing the observation (Lawson,2009:356).

The current research focuses on investigating the reality of learners with levels that do exhibit poor achievement, specifically the gifted individual in Baghdad Iraq, who, to the best of the researcher's knowledge, have not yet undergone an educational program in computer science subject, this aligns with the call of made by (Saber's study :2021) to nurture gifted individuals across all dimensions, rather than limiting it to academic achievement. It is inappropriate to leave this group without inquiry or development in their educational programs. In order to clarify all of this and to understand the extent to which their abilities in scientific reasoning and innovative think can be developed, the research problem was formulated with the following question 'what is the effectiveness of the educational program based on STEAM in developing scientific reasoning in computer subject for the gifted students in fifth grade?'

The theoretical importance of the research lies in directing attention to the role of educational programs designed according to the latest educational approaches and frameworks, with the focus on a STEAM approach, it may also contribute to uncovering the potential for developing scientific reasoning in computer science, as well as identifying expected challenges, highlighting the gifted students with exploring the possibility of implementing educational program for them. Practically, the significance of the research is evident in building an educational program that enhances computer science field and its topic related to robotics for the fifth preparatory students, additionally, its aimed to prepare the scientific knowledge content for computer science, which is currently lacking, along with a teachers guide for that outlines the most suitable strategies for each lesson and how to benefit from integrating STEAM elements into the program lessons, while encouraging learners to engage in inquiry, and scientific reasoning.

Literature Review

STEAM Approach: the STEAM approach is considered an inclusive educational that encompasses academic and professional disciplines related to science, technology, engineering, mathematics, and the fields of art and humanities have been added, influencing the teaching of these four fields, as expansion of multidisciplinary approach (Spector,2015:5). The learning based STEAM approach has been flourishing remarkably, this success is attributed to the efforts of teachers, supervisor, school administrators and other specialist who promote this mindset, they crown it with manufacturing by involving both learners and adults in creativity, innovation, and production that achieves communication, interaction, and fruitful collaboration (maslyk,2016:13), and learning the branches of integrated introduction is considered enjoyable and motivating for learners, as it clarifies, the importance of what they are studying while generating a greater understanding of their peers' projects (Banks and David,2014:226).

There are many studies that deal with STEAM approach, such as (Al-Shattii,2020) which found significant differences in favor of the post-test for the experimental group, and this indicates the effectiveness of the program designed according to the STEAM approach (Al-Shattii,2020).

2. Scientific Reasoning: S.R. can be considered one of the formal of intelligent behavior, with a clear ability to solve problems and generate new knowledge based on specific rules and precise practical strategies in order to logically organize the available information (Al-Mosawi,2016:17), this term refers to an interpretation of the evidence that is observed (Jardis and Crystal,2016:), the essence of scientific reasoning is based on four conclusions, which are:

Abduction: which works to generate possible interpretations for puzzling observations.

Retroduction: for the first time, the possible probabilities for observation are being used.

Deduction: moving from premises to conclusions according to logical rules.

Induction: involving tracking and moving from the part to the whole. (Lawson,2009:356)

There is many studies thar found the importance of S.R. such as (kant,2016), which found that is a big effect of the simulation on the result of S.R. test (Kant,2016).

Material and Method

The methodology of this research included adopting both the descriptive and quasi-experimental approaches, at the first we adopting during the preparation and construction of the educational- learning program according to STEAM, while the application process of the program prepared within the descriptive curriculum for gifted students and for the computer subject was within the quasi-experimental way.

Research Design and Data Collection

There is a need to prepare designs with quasi-experimental control when it is difficult to provide total control, which is related to the difficulty of selecting the sample (Younis and samaa,2022:74), its relied on a single sample for conducting both pre-test and post-test, so it is suitable for the objective of modifying or changing one of the behavioral patterns or cognitive processes (Al-Nahi and Haidar,2019:215), thus the quasi-experimental design is considered helpful for establishing control within the acceptable and necessary limits available (Al-Kinani and Nidhal,2011:74), this research formula aims to find effective and practical solutions to what is being addressed, and thus it is considered to have high value (Abu-Awad,2024:161).

By reviewing general models that serve as precise pathway for the steps in preparing educational programs, the most prominent were the ADDIE model and the ASSURE model. The most suitable was to adopt is the ASSURE model due to its alignment and accuracy with the necessary steps for preparing the educational program according to the approach of (STEAM). To find the aim of the research which is finding the effect of this program on the S.R for the gifted school students, we can clarify the type of experimental design for the current research as the following figure:

Group	The pre-test	The independent variable	The dependent variable	The post-test
One experimental group	Lawson's scientific reasoning test	The educational program based on the STEAM approach	Scientific reasoning	Lawson's scientific reasoning test

Figure2. Show The Experimental Design to the Research

Research Community and Sample

The overall community consisted of fifth-grade students from seven schools for gifted, distributed across seven provinces throughout Iraq, totaling 66 students.

The research sample applied consisted of ten learners located in Baghdad. The reason for selecting a sample from the community was the geographical distance between the schools of gifted, along with proximity of the gifted in Baghdad school, to the researcher's residence, in addition to the necessary administrative procedures for its implementation. The sample representative of the study population without bias and carries the characteristics of the community number (Al-Jabir and Dawood,2014:70).

Instruments

This research has two variables, the first one represented by the educational program based on the STEAM approach, and the other variable which is the dependent variable is scientific reasoning. We can also be categorized into two types:

Independent variable, it was only one, namely as 'the educational program based on STEAM approach'.

Independent variable, it was only one, known as 'Scientific Reasoning'.

The tool which used to measuring the effect of the independent variable is 'Lawson Test' , consist of 24 MCQ questions.

Validity and Reliability of the Instrument

To achieve the research objective, the Lawson-test for scientific reasoning, consist of 24 items, was adopted. Twelve of these items are dedicated to questions, each followed by a paragraph containing potential reasoning that explain the appropriate answer to question. The given version of this test was obtained along with its correction key.

Test-Validity: the validity of the translation was verified, It was also presented to group of specialists to obtain apparent validity, were it was agree upon the validity of the items based on the chi-square value, which was calculated to be 8, grater than the tabulated value at a significance level of 0.01, this indicates that it is ready for pre-test and pos-test applied on the research sample.

Reliability (Stability) of the test: in order to access the reliability of the test, it was administrated to the research community 'excluding the research in Baghdad', consist of 56 learners. By applying the split-half method to the odd and even items and using Person's correlations coefficient, a reliability coefficient of 0.82 was obtained. using the Sperman-Brown formula, the reliability was found to be 0.902, which is considered strong. Additionally, the reliability was recalculated using Rulon formula, resulting in a reliability of 0.88. thus, the test accepted as a reliable.

Research Hypothesis

The hypotheses to this research determine the effect of the independent variable on the dependent variable, we can represent it as following:

-there are no Statistically significant differences at 0.05 between the main responses of the research sample in the pre-test and the post-test for scientific reasoning when applying the educational program designed according to the STEAM approach, represented as 'H0: M1=M2'.

Data Analysis

The current research aims to identify the effectiveness of the educational program designed according to the STEAM approach in Scientific Reasoning among gifted students.

In light of the hypothesis, we can find the different between the pre-test and post-test using nonparametric statistics, and by relying on the Wilcoxon for small related samples. Therefore, it is important to consider the conditions for applying this test in terms of ensuring the type of data, we used SPSS statistical program, we can reach the results of ranks. Since the calculated value for the Wilcoxon test is less than the tabulated value at 9 degrees of freedom and a significance level of 0.05, the null hypothesis, which states that there are no statistically significant differences between the pre-test and post-test rank means of the research group in scientific inference, is rejected. Thus, the alternative hypothesis, which posits that there are statistically significant differences at the 0.05 significance level between the means of the pre-test and post-test, is accepted. This indicates that the differences were positive in favor of the post-test for the experimental group, shown in the table below:

Table1. Show the Difference Between the Ranks for the Pre and Post-Test

Pre-Test- Post-Test	No. of them	Diff. of mean	Total rank	Average of ranks	Wilcoxon value		Degree of freedom	The significance when 0.05
					table	calculated		
	1	negative	2.50	2.50	5	2.5	9	significance
	9	positive	2.83	2.83				

Conclusion

Since the calculated ranks is lower than the tabulated value at a degree of freedom9 At a significance level of 0.05, the null hypotheses which posits that are no statistically significant differences between the pre-test and post-test means of the research group, is rejected.

Thus, the alternative hypothesis is accepted, indicating that there are significant differences at the 0.05 significance level between the post-test and pre-test means in favor of the post-test. This suggests that the differences are positive in favor of the post-test for the experimental group.

To determine the effectiveness, we can identify the effect size that illustrate the effectiveness of the educational program designed according to STEAM approach in developing scientific reasoning, Cohen's equation was adopted as it is suitable for finding the effect value for a small, purposive, related samples, thus, the result of its calculating was equal to 1.05 which fall within the range of a big effect of the independent variable on the depending variable. This represents the answer to the research question

Founding Statement

As researchers, we founded this research ourselves.

Author Contribution

Zainab Fattah Yousif (Methodology- writing original draft- writing and editing- Project applying-resources-funding- data analysis)

Naz Badr Khan Al-Sindi (methodology- project administration- resources- founding)

Data Availability Statement

The data were obtained throughout the implementation of this study project at the school at Baghdad gifted school.

Conflict of Interest

We as authors, declare that no conflict of interest in this research writing.

Acknowledgments

Thanks, and appreciation to the:

Ministry of education in Iraq, for their cooperation in providing the necessary administrative facilities and official correspondence to obtain approval for implementing the educational

program at the school of gifted students in Baghdad.

Gifted Guardianship committee, for the facilities and cooperation provided to ensure the success of the experience.

Administration of gifted school in Baghdad, which allow the researcher to applying the educational program.

Gifted schools in Iraq, for their

facility in some questionnaire.

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- DOI: <http://dx.doi.org/10.25130/jtuh.28.2021.23>