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The reality and obstacles of implementing primary teachers with the engineering design in teaching science

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ABSTRACT

The research aims to determine the science teachers' knowledge level in elementary schools about the engineering design concept. It determines the application level of engineering design among the science teachers at the elementary level in teaching science and highlights the obstacles faced in implementing these. The descriptive survey method was used to achieve the research aim by applying a questionnaire to a sample of 97 science teachers in primary schools in Riyadh city. The research was limited to the concepts of engineering design and engineering practices as mentioned in the next generation of NGSS science standards. It was found that science teachers were unaware of the importance of developing engineering design skills among students. It might be due to ineffective teachers' training in engineering design skills development. It is strongly suggested to educate supervisors about the importance of directing male and female teachers to apply engineering design in science teaching for the elementary stage. It is essential to provide appropriate educational laboratories and means for employing engineering design and teaching science for the elementary stage.

1. Introduction

In recent years, worldwide reform efforts in science education have called for teachers to use integrated curricula for teaching science. It is based on Science, Technology, Engineering, and Mathematics (STEM). It is an acronym that refers to one or more of the four disciplines (science, technology, engineering, and mathematics) related to each other and are essential elements in preparing the next generation of scientifically educated citizens (McComas, 2013). Many of these have emerged, calling for the adoption of engineering in science education. The STEM approach has contributed to review engineering design education and has developed engineering design skills. It provides an ideal integration of science, technology, engineering, and mathematics (STEM) content that helps apply scientific knowledge to design and create solutions to problems (NAE and NRC, 2014; NRC, 2012; Ting, 2016). There is an importance for society's engineering design in general, which is confirmed by the National Research Council's call-in science education and science standards (NRC, 2012; 2013). In light of this, the next generation of science education standards (K-12 NGSS) emphasizes integrating engineering practices and engineering design into science curricula (NRC, 2013). The concept of engineering design is one of the ideas that have been taken up recently. It is also mentioned in the Next Generation Science Standards (NRC, 2013). The Accreditation Committee for Engineering and Technology (ACET) curricula has emphasized that engineering design is designing a system, component, or process to meet desired needs (Haik and Shahin, 2010). It is an iterative decision-making process that applies basic sciences, mathematics, and engineering sciences to transform resources towards a specific goal optimally. It is based on the design process's critical elements, including goal setting, standards, aggregation, analysis, construction, testing, and evaluation. Sneider (2011) has defined it as an iterative and systematic method to find solutions to a wide range of problems. It includes generating ideas, identifying problems, and designing drawings and models for a possible resolution to meet people's needs and desires.

Engineering design is integrated into science education to incorporate science, technology, engineering, and mathematics (STEM). It works as a catalyst for its learning. It provides an ideal entry point for embedding Engineering Practice (EP) in

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current curricula and a structured approach to solve naturally occurring problems. In all fields of science, technology, engineering, and mathematics (STEM), it provides an opportunity to locate intersections and build connections between these disciplines. It contributes to improving scientific knowledge and its application in a real context. Accordingly, it requires training teachers to apply engineering design in science education. And have been confirmed the importance of training teachers and improving their awareness of the next generation of science standards, including engineering design and engineering practices Several studies have dealt with engineering design in science education. Daugherty (2012) has sought to identify integrating engineering concepts in science education from Boston, USA. The results have indicated the possibility of including engineering concepts (design, analysis, modeling, and systems) and its curricula in science education through teaching based on engineering design. Dankenbring and Capobianco (2016) understand the relationship between teaching students in the curriculum based on engineering design and understanding the relationship between the earth and the sun through everyday science and engineering concepts. The results have indicated the curriculum's effectiveness based on engineering design to improve students' understanding and gain scientific concepts. Both Sheplanjul and MOBA have analyzed nine engineering educational programs developed to teach in primary education and the extent of their incorporation in engineering design skills. The results have shown that the engineering design skills for developing possible solutions and the models' actual design were included to a high degree. Simultaneously, the inclusion of skills for setting clear goals and setting standards and restrictions was of a medium degree. The study has recommended the necessity of bridging the gap in engineering design skills that were not appropriately included in educational programs (Chabalengula and Mumba, 2017). Hammack and Ivey (2019) have studied primary school teachers' perceptions of integrating engineering design in science education and its obstacles. The researcher has used the descriptive-analytical method. The sample contained 542 primary school teachers in Oklahoma State in the United States of America. An electronic questionnaire and discussion groups have collected data. The results have revealed positive perceptions of primary science teachers about integrating engineering design into science education, a lack of in-service training on integrating engineering design into science education, and the lack of time available for teachers to apply integration. The study has recommended providing training programs for elementary science teachers on integrating engineering design into science education, providing necessary resources and support for teachers.

The Next Generation Science Standards (NGSS) document (NRC, 2013) and the Science Education Framework (NRC, 2012) document have emphasized the importance of learning students' engineering practices and knowing the purpose of engineering. It links it with applied sciences to enable students to solve problems. In comparison, engineering design and engineering practices in the Saudi science curricula are still absent (Al-Ahmed and Al-Buqami, 2017). A decrease is found in engineering practices in science curricula in the Kingdom of Saudi Arabia. No research has dealt with the teachers' application of engineering design reality in science teaching at the elementary level and identifying obstacles to its application in Saudi Arabia. It shows a research gap that requires teachers' understanding of engineering design, the reality of their application, and the obstacles facing its use in teaching science at the primary level. The research's importance lies in the availability of theoretical content about engineering design and its use in teaching science. Furthermore, the research's practical implication is that it is expected to develop the science curricula at the elementary level to enhance the learning engineering design aspects and develop the professional growth programs for science teachers. It highlights the science teachers' knowledge level in elementary school about the engineering design concept. It demonstrates the application level of engineering design among the science teachers at the elementary level in teaching science. It reveals the obstacles of the application science teachers of engineering design at the elementary level in teaching science. The researcher defines the application of some basic engineering practices that engineers use while solving engineering design problems. It is used to identify issues, develop and use models, plan and execute investigations, analyze and interpret data, use mathematics and computational thinking, design solutions, and communicate information in a real context, enabling scientific knowledge to be applied in problem-solving.

2. Research methodology

The research was applied in the first semester of the academic year 1442 AH to primary schools in Riyadh city. The plan of study is to know the awareness about training and workshops and the inclusion of engineering design in the curriculum as well as the provision and equipping of laboratories. It was limited to engineering design concepts and engineering practices presented in the next generation of NGSS science standards. The descriptive and analytical method was used. The necessary work is done within the scope of the research. This type of research aims to describe the phenomenon studied in terms of its nature and degree of existence without going beyond that to study relationships. The descriptive analyses were used because of the reason that these analyses reflect the pure opinions of sample respondents without any deep statistical analyses. Hence, descriptive analyses suit most in the type of the studies like our study to present the respondents' opinions. Because it represents a perception of the

current situation by collecting data from the original community as a whole or selected decision, it analyzes these and classifies these with complete neutrality. Besides, it develops predictions and results applicable to the community in which the research was conducted. Therefore, it was appropriate for the topic of the study. It aimed to know the engineering design's application reality for male and female teachers in teaching science at the primary level and the obstacles to its application.

The research community consisted of all primary science teachers in Riyadh city. It contained 962 teachers comprised of 502 male teachers and 460 female teachers.The research sample was randomly selected from primary science teachers in Riyadh city. The research tool was applied to 10% of the entire research community comprising of 51 male and 46 female teachers, an electronic questionnaire was distributed among 97 teachers, and 100% of the questionnaires were retrieved. Based on the nature of the data and the method followed in the research, it was the most appropriate tool to achieve this research's objectives. The questionnaire was built considering the literature and previous studies related to the research topic. It consisted of three domains in its initial form. The first domain explained teachers' knowledge level of the engineering design concept, including 6 items. The second domain described the application level of science teachers to engineering design in science education for elementary school students. It included 26 items, which were divided into 5 dimensions. Here, asking questions and identifying problems included 7 items, the use of mathematics and computational thinking comprised 4 items, building interpretations and designing solutions included 6 items, evaluating possible solutions included 4 items, and applying and developing possible solutions included 5 items. The third domain highlighted the obstacles to using engineering design in science education to elementary school students. It included 26 items, divided into 4 categories. These were obstacles related to the teacher that provided for 6 items, obstacles related to the curricula that included 12 items, and obstacles related to educational supervision that provides for 4 items, and obstacles related to the school environment had 4 items.

The research has used a (Likert) questionnaire, the five-point scale, to evaluate all the items. The score (5, 4, 3, 2, and 1) expresses (very high, high, medium, low, and very low). To interpret the results, the range (5-1=4) was calculated and then divided by the number of scale categories to obtain the category length 4/5=0.80. After that, this value was added to the lowest value in the scale or the scale's beginning, which is the correct way to determine each category's upper limit and so on until the range of each scale category. It is as follows: From 1 to 1.80 represents a low score, from 1.81 to 2.60 represents a low score, from 2.61 to 3.40 represents an average score, from 3.41 to 4.20 represents a high score, and from 4.21 to 5.00 is a very high score.

The research tool was set according to the validity of the questionnaire. The questionnaire's validity is intended to ensure its suitability to measure what it is prepared to find. It includes all the elements that the research should contain on the one hand and the clarity of its paragraphs and vocabulary. On the other hand, so that it is understandable to those who use it. A questionnaire's validity was verified through the research questionnaire's apparent reality (the arbitrators' integrity). The questionnaire was presented to 10 of the arbitrators. They were specialized in the curricula and methods of teaching science. They included doctors, professors, and supervisors to express their views on the appropriateness and comprehensiveness of the primary data variables and the importance and clarity of the items' linguistic formulation. They validated the extent of its measurement of what it was set for and its scale gradations. In light of the consequential amendments, suggestions, and comments from the referees, the necessary adjustments were made so that the research tool became clear and appropriate to measure what it was set for. Furthermore, the internal consistency validity of the research questionnaire was verified. The internal consistency validity was calculated using Pearson's correlation coefficient between each item's score and each domain's total score to which it belonged in the questionnaire. The results are shown in Tables 1-5.

Table 1: Pearson correlation coefficient between each item of the teachers' knowledge level of the engineering design concept and the overall domain degree.

Item no.	Correlation coefficient	Item no.	Correlation coefficient	Item no.	Correlation coefficient
1	0.54	3	0.50	5	0.76
2	0.30	4	0.49	6	0.52

It is clear from Table 1 that the correlation coefficient between the score of each paragraph and the total score of the domain is statistically significant, which indicates the cohesion of the domain items. It is clear from Table 2 that the correlation coefficient between the score of each item and the total score of the domain is statistically significant, indicating the cohesion of the domain items. It is clear from Table 3 that the correlation coefficient between the score of each item and the total score of the domain is statistically significant, which indicates the cohesion of the domain items. It is evident from Table 4 that the correlation coefficient between the score of each domain and the total questionnaire score is statistically significant, which indicates the coherence of questionnaire

domains. The questionnaire's stability was calculated using the Cronbach Alpha reliability factor. Table 5 shows the stability coefficient values for each domain of the questionnaire and the whole scale.

Table 2: Pearson correlation coefficient between each item of the science teachers' application level of the engineering design domain and the total domain degree

Domain	Item No.	Correlation coefficient	Domain	Item no.	Correlation coefficient	Domain	Item no.	Correlation coefficient
Ask questions and identify problems	1	0.54**	Use mathematics and computational thinking	1	0.55**	Evaluate possible solutions	1	0.66**
	2	0.30*		2	0.50**		2	0.56**
	3	0.31*		3	0.47**		3	0.75**
	4	0.47**		4	0.49**			
	5	0.49**					4	0.73**
	6	0.33*						
	7	0.54**						
			Build interpretations and design solutions	1	0.45**	Application and development of possible solutions	1	0.79**
				2	0.72**		2	0.77**
				3	0.64**		3	0.69**
				4	0.30*		4	0.68**
				5	0.31*		5	0.70**
				6	0.60**			

*Statistically significant at the (0.05) significance level or less; ** Statistically significant at the significance level (0.01) or less

Table 3: Pearson correlation coefficient between each domain item of the engineering design application obstacles in science education for elementary school students and the total domain score

Domain	Item No.	Correlation coefficient	Domain	Item no.	Correlation coefficient
Obstacles related to teacher	1	0.54**	Obstacles related to curricula	1	0.54**
	2	0.30*		2	0.50**
	3	0.31*		3	0.47**
	4	0.47**		4	0.32*
	5	0.49**		5	0.45**
	6	0.33*		6	0.72**
				7	0.44**
Obstacles related to school Environment	1	0.52**		8	0.48**
	2	0.56**		9	0.43**
	3	0.66**		10	0.41**
	4	0.70**		11	0.56**
Obstacles of educational supervision	1	0.51**		12	0.61**
	2	0.54**			
	3	0.45**			
	4	0.40**			

*Statistically significant at the (0.05) significance level or less; ** Statistically significant at the significance level (0.01) or less

Table 4: Pearson correlation coefficient between each domain score and the questionnaire total score

Domain	correlation coefficient
Teachers' knowledge level of the engineering design concept.	0.58**
The application level of the engineering design in science teachers in science education among primary school students.	0.48**
Obstacles to applying engineering design in science education among primary school students.	0.51**

*Statistically significant at the (0.05) significance level or less; ** Statistically significant at the significance level (0.01) or less

Table 5: The values of each questionnaire domain's stability coefficient and the whole questionnaire

Domain	Cronbach Alpha
Teachers' knowledge level of the engineering design concept.	0.58
The application level of the engineering design science teachers in science education among primary school students.	0.82
Obstacles to applying engineering design in science education among primary school students.	0.90
Whole questionnaire	0.88

It is evident from Table 5 that the stability coefficient values are all high, and these are statistically acceptable.

3. Research results and discussion

The text of the research's first question was: "What is the knowledge level of science teachers in the elementary stage of the engineering design concept?" The frequencies, arithmetic averages, standard deviations, and percentages of teachers' knowledge level domain for the engineering design concept were calculated to answer this question. The results are shown in Table 6.

It is clear from Table 6 that the arithmetic averages of the domain items are ranged between 1.78 to 4.31. The response on the knowledge level of science teachers for the engineering design concept domain shows a medium score, where the general arithmetic mean is 2.85. It is due to the lack of authorities' interest in teachers' professional development by providing training courses and workshops to introduce science teachers to the engineering design concept. It is because of the

absence of training programs to use in science teaching and design and implementation.

Table 6: Arithmetic averages, standard deviations, and percentages of science teachers' knowledge level domain for the engineering design concept

	Item	Average	standard deviations	General opinion	Order
1	I know the engineering design concept.	2.42	0.95	Low	3
2	I have the knowledge that qualifies me to apply engineering design in science teaching of engineering design.	2.01	0.81	Low	5
3	I have previous experience applying engineering design in teaching science.	1.78	0.81	Very low	6
4	Science books include concepts related to engineering design.	2.30	1.00	Low	4
5	I need to know engineering design.	4.27	0.76	Very large	2
6	I need an engineering design training program.	4.31	0.74	Very large	1
	Domain total average	2.85	0.85	Medium	

Besides, the supervisors' role in educating teachers and guiding them to the mechanism for employing design engineering in science education is not up to the mark. Significant responsibility falls on the teachers` shoulders in the light of the developments in teaching methods and recent trends in applying the STEM approach, which calls for linking science, technology, engineering and mathematics, and keeping pace with the twenty-first-century requirements. These results agree with Al-Baz's (2018) study results, which have indicated the weak level of knowledge, teaching practices, and design thinking of science teachers while serving in Egypt. Similarly, elementary teachers' low level of expertise has indicated integrating engineering design into science education in the United States (Hammack and Ivey, 2019). Moreover, Kruse and Wilcox (2017) have mentioned the weak engineering design skills of teachers and students in Iowa in the United States of America.

The second question's text was, "What is the application level of the science teachers in primary school, engineering design in science education?" The frequencies, arithmetic means, standard deviations, and percentages of the application-level dimensions among science teachers in the elementary stage were calculated to the questionnaire's engineering design in science education. Table 7 shows the arrangement of science teachers' application level at the primary level domain and engineering design in science education. According to each dimension's general arithmetic mean and the general questionnaire average as a whole, the order of domains is arranged.

Table 7: Application level of the engineering design in science education according to the general arithmetic mean and the standard deviation of each dimension, and the general questionnaire average

Domain	Mean	Standard deviation	Agreement degree	Order
Ask questions and identify problems	3.01	1.04	Medium	4
Use mathematics and computational thinking	2.64	0.94	Medium	5
Build interpretations and design solutions	3.31	0.98	Medium	2
Evaluate possible solutions	3.09	1.02	Medium	3
Application and development of possible solutions	3.40	0.93	Medium	1
The whole questionnaire	-	0.98	Medium	

Table 7 shows that the arrangement of the dimensions comes as follows: Applying and developing possible solutions in the first place and the least practice is the use of mathematics and computational thinking. The focus of the application level among science teachers in the elementary stage engineering design in science education, in general, came with a medium degree, as the general average for the whole domain is 0.09. After asking questions and identifying problems, the response results show a moderate degree, where the general arithmetic average has reached 3.01, according to the research sample response. It indicates the lack of adequate training among primary school science teachers in raising problems related to science and formulating questions about it, providing hypotheses scientifically appropriate to these problems, and applying scientific methodologies in solving these. The researcher believes that science teaching requires the teachers to present some life and scientific problems related to scientific phenomena and theories. So the teachers need to be familiar with methods of presenting scientific problems and formulating questions hypotheses about these. They must be able to solve these through strategies and plans. The domain 'ask questions and identify problems' is of a moderate degree. This indicates these results agree with Al-Baz's (2018) study findings, which have stated the weak application of design thinking among science teachers while serving in Egypt. Besides, the study of Al-Munir and Abdel-Alim (2018) has indicated a weakness in Egyptian teachers' engineering design process application. After asking questions and identifying problems, the survey of Maeng et al. (2017) has suggested that the teachers' application level of the engineering design among the primary stage in science education in the United States of America was of a moderate degree. It resulted from a professional development program in raising this level. A study by Dankenbring and Capobianco (2016) has indicated the weak application of teachers of the engineering design approach to understand the relationship between the earth and the sun among students in the United States. The response to the dimension of using mathematics and thinking has shown that it was of a moderate degree, where the general arithmetic means was 2.64. The

researcher believes that applying mathematics and reflection in the engineering design dimension in teaching science requires that the teachers have good experiences in this field. It requires their training in practical terms to apply this in science education through workshops conducted by the Ministry of Education. Teachers cannot individually develop their abilities in this field. These results agree with previous studies' results (Al-Baz, 2018; Al-Munir and Abdel-Alim, 2018; Maeng et al., 2017; Dankenbring and Capobianco, 2016).

Building the interpretations and designing solutions has shown that it is of a moderate degree, where the general arithmetic average reaches 3.31. The researcher believes that the teachers' awareness of current education requirements and trends requires various experiences in building interpretations and designing solutions to complex science problems. The importance and effectiveness of achieving the science education goals need developing their skills and abilities to face complex issues in the real world. It is necessary to make them able to solve complex problems that face them in their daily lives, using practical methods and logical thinking. It requires male and female teachers' capabilities and experiences, either through training or through self-education, that teachers do themselves to develop their skills. These results also agree with previous studies' results (Al-Baz, 2018; Al-Munir and Abdel-Alim, 2018; Maeng et al., 2017; Dankenbring and Capobianco, 2016). The response results also show that the possible solutions are mainly evaluated, as the general arithmetic average reaches 3.09. The researcher believes that this result is logical because many of the topics raised in science are related to real problems. The significant global challenges facing humankind can be presented, addressed, evaluated, and expressed opinions about these. This is what has required the science teachers to have reasonable practice and extensive experience in this field. These results agree with previous studies' results (Al-Baz, 2018; Al-Munir and Abdel-Alim, 2018; Maeng et al., 2017; Dankenbring and Capobianco, 2016). Applying and developing possible solutions dimension has shown a moderate degree, as the general arithmetic average reaches 3.40. The researcher believes that this is due to the lack of science teachers' practice in the elementary stage for practical activities to develop and implement solutions. It may be the reason that science curricula do not include activities related to this, and training courses for teachers to develop this type of skills are not available in a suitable way to enable teachers to employ these skills in teaching science.These results are consistent with previous studies' results (Al-Baz, 2018; Al-Munir and Abdel-Alim, 2018; Maeng et al., 2017; Dankenbring and Capobianco, 2016).

The research's third question text was, "What are the engineering design application obstacles of the science teachers at the primary level in teaching science?" The frequencies, arithmetic averages, standard deviations, and percentages of the domain dimensions of engineering design application obstacles of the science teachers at the primary teaching science level were calculated. The results are shown in Table 8, which shows the arrangement of the engineering design application obstacles of the science teachers at the primary level in teaching science according to each dimension's general arithmetic mean and the general average for the whole questionnaire.

Table 8: Engineering design application obstacles of the science teachers at the primary level in teaching science according to the general arithmetic mean and standard deviation of each dimension, and the general average of the whole questionnaire

Domain	Mean	Standard deviation	Agreement degree	Order
Teacher obstacles	4.10	0.78	Large	2
Curricula obstacles	4.05	0.82	Large	3
Educational supervision obstacles	4.04	0.92	Large	4
School environment obstacles	4.24	0.81	Very Large	1
The whole questionnaire	4.11	0.83	Large	

Table 8 shows that most of the dimensions related to the application of engineering design obstacles come from the school environment, teachers, educational supervision, and then curricula. The application obstacles among science teachers in elementary school and engineering design in science education generally have a large degree, as the general average for the whole domain is 4.11. The researcher believes that this might be due to the science teachers' weak awareness of developing the engineering design skills importance among students and the ineffective teachers' training in engineering design skills development. The science teachers lack the skills to use modern technologies because they are not sufficiently qualified to teach science. Therefore, it is essential to provide teachers with sufficient skills and abilities related to engineering design through training courses offered by the Ministry and workshops that include reasonable practices associated with this field. Also, teachers have a great responsibility to develop their skills and abilities in line with modern education requirements and what the educational community calls for linking science with technology, engineering, and mathematics. These results agree with previous studies' findings, which indicated the weak interest of science teachers in applying engineering design skills in Oman's Sultanate (Hammack and Ivey, 2019; Al Hinai et al., 2020).

The results have shown that there are curricula obstacles largely, as the general arithmetic average reaches 4.05. It shows that teachers do not care about their teaching of science and consider these as enriching activities, which waste class time and hinder the curriculum's teaching plan. Therefore, it is crucial to focus on this area in the curriculum

through actions, content, evaluation, experiments, and everything related to the curriculum to become more expert. It is reflected in the development of science-related engineering design skills for male and female students. These results agree with Al-Buqami and Al-Jabr's (2019) findings, which have indicated the weakness of including curricula in the scientific materials for engineering design applications. Al-Baz's (2017) study has revealed the flaw in having the chemistry curriculum content for the first grade of secondary school engineering design skills for the next generation of science standards NGSS.

The results have shown that the educational supervision obstacles are tremendous, as the general arithmetic average reaches 4.04. The researcher believes that this confirms the first domain's primary school science teachers' inability to apply engineering design in science education. It shows the absence of supervisors' support, guidance, and teachers' evaluation to use this field in science education. It may be due to their lack of essential knowledge and awareness of the application concepts and areas. These results agree with Rashidiya and Hamad's (2019) study, which has indicated the weak educational supervision role in encouraging science teachers to use engineering design to acquire common concepts and engineering design skills among ninth-grade female students, Sultanate of Oman. Daugherty's (2012) study has indicated a lack of awareness among educational supervisors on integrating engineering concepts in science education in Boston, Massachusetts, in the United States.

The school environment obstacles have shown large values, as the general arithmetic average reaches 4.24. It shows the lack of interest in providing appropriately equipped laboratories to enhance engineering design employment in science teaching. Therefore, it is essential to employ engineering design in science education to develop all educational elements that can contribute to this material and humans (including curriculum designers, administrators, school leaders, supervisors, teachers, curricula, and the academic environment). These results agree with previous studies' findings, which have indicated the school environment's weakness in material and human capabilities that help develop engineering design thinking skills and the scientific sense of middle school students in Egypt (Hammack and Ivey, 2019).

4. Conclusions and recommendations

After analyzing the results, the response on science teachers' knowledge level for the engineering design concept domain is 2.85 a medium score. Similarly, the focus of the application level among science teachers in the elementary stage engineering design in science education, in general, has come with a medium degree with a general average of 3.09 for the whole domain. However, the application obstacles among science teachers in elementary school and engineering design in science education generally have a large degree, as the general average for the whole domain is 4.11. It shows the science teachers' weak awareness of developing the engineering design skills importance among students and the ineffective teachers' training in engineering design skills development.

It is recommended to educate supervisors about the importance of directing male and female teachers to apply engineering design in science teaching for the elementary stage. There is a need to arrange training courses to develop engineering design skills for primary science teachers. There is a dire need to organize workshops to train primary school science teachers on practical engineering design activities. It is necessary to include the elementary stage content related to engineering design in science curricula, including activities, objectives, evaluation, topics, and other content elements. It is strongly suggested to provide appropriate educational laboratories and means for employing engineering design and teaching science for the elementary stage.

Furthermore, this research suggests a proposed conception of science curricula for the elementary stage based on engineering design and studying its impact on developing many educational outcomes for students of this stage. It emphasizes studying the effect of an engineering design-based strategy on developing higher-order thinking skills of students in the elementary school stage.

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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