Artículo de investigación

Secondary School Biology Teachers' Perceptions of Science, Technology, Engineering and Mathematics (STEM) Educational Trend and the Level of Teaching Self- Efficacy

Представления учителей биологии средней школы о науке, технике, технике и математике (STEM) Тенденция в образовании и уровень самоэффективности обучения

Percepción de los profesores de biología de la escuela secundaria de la ciencia, la tecnología, la ingeniería y la matemática (STEM) Tendencia educativa y el nivel de autoeficacia de la enseñanza

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Abstract

This paper attempts to identify the perceptions of secondary school biology teachers on Science, Technology, Engineering and Math (STEM) educational trend and the related teaching requirements. Being conducted with 37 secondary school biology teachers in AlKharj Governorate in Saudi Arabia, the study also measures their level of teaching self-efficacy in the light of that STEM educational trend. A test and a questionnaire were prepared for this purpose. The data that were collected via the survey and the given test were analyzed. Pearson Correlation Coefficient was used to validate the internal consistency of the questionnaire. The statistical stability of the test and the questionnaire were calculated according to Alpha-Cronbach Coefficient. The results of the study show that there is a weakness in the teachers' knowledge of the STEM trend. Their opinions and answers reveal that their perceptions of this kind of education and the related teaching requirements is weak. The results also show that the level of teaching self-efficacy in the light of the STEM educational trend ranges from medium to high. In addition, while there are no statistically significant differences in three different variables, there are statistically significant differences in other two variables in the study. The study ends with some recommendations that can help in developing the teachers' perceptions on STEM education and their teaching self-efficacy.

Аннотация

В этой статье предпринята попытка определить восприятие учителей биологии в средней школе в области науки, технологий, техники и математики (STEM) и связанных с ними требований к преподаванию. В исследовании, проводимом вместе с 37 учителями биологии в средней школе в провинции Аль-Хардж в Саудовской Аравии, также измеряется уровень их самообучаемости в свете этой образовательной тенденции STEM. Для этого были подготовлены тест и анкета. Данные, которые были собраны с помощью опроса и данного теста были проанализированы. Коэффициент корреляции Пирсона был использован для проверки внутренней согласованности вопросника. Статистическая устойчивость теста и вопросник были вычислены в соответствии с альфа-Кронбах коэффициента. Результаты исследования показывают, что существует недостаток в знаниях учителей тенденции STEM. Их мнения и ответы показывают, что их восприятие такого рода образование и связанные с ними требования обучения является слабым. Результаты также показывают, что уровень обучения самоэффективность в свете STEM образовательного тренда в диапазоне от среднего до высокого. Кроме того, в то время как нет никаких статистически значимых различий в трех различных переменных, существуют статистически значимые различия в двух других переменных в

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Key Words: STEM, teaching self-efficacy, teacher's perceptions, education. science education, and biology teachers.

исследовании. Исследование заканчивается с некоторыми рекомендациями, которые могут помочь в разработке представлений учителей на STEM образования и их преподавание самоэффективности.

Ключевые слова: STEM, обучение самоэффективности, восприятие учителя, образование. естественнонаучное образование и преподаватели биологии.

Resumen

Este artículo intenta identificar las percepciones de los maestros de biología de la escuela secundaria sobre la tendencia educativa de Ciencia, Tecnología, Ingeniería y Matemáticas (STEM) y los requisitos de enseñanza relacionados. Realizado con 37 profesores de biología de la escuela secundaria en la gobernación de AlKharj en Arabia Saudita, el estudio también mide su nivel de autoeficacia docente a la luz de esa tendencia educativa STEM. Se preparó una prueba y un cuestionario para este propósito. Se analizaron los datos que se recopilaron a través de la encuesta y la prueba dada. El coeficiente de correlación de Pearson se utilizó para validar la consistencia interna del cuestionario. La estabilidad estadística de la prueba y el cuestionario se calcularon de acuerdo con el coeficiente de Alpha-Cronbach. Los resultados del estudio muestran que existe una debilidad en el conocimiento de los docentes sobre la tendencia STEM. Sus opiniones y respuestas revelan que sus percepciones de este tipo de educación y los requisitos de enseñanza relacionados son débiles. Los resultados también muestran que el nivel de autoeficacia docente a la luz de la tendencia educativa STEM varía de medio a alto. Además, aunque no existen diferencias estadísticamente significativas en tres variables diferentes, existen diferencias estadísticamente significativas en otras dos variables en el estudio. El estudio finaliza con algunas recomendaciones que pueden ayudar a desarrollar las percepciones de los maestros sobre la educación STEM y su autoeficacia docente.

Palabras clave: STEM, enseñanza de autoeficacia, percepciones del profesor, educación. profesores de educación científica y biología.

Introduction

Our contemporary world is characterized by its rapid developments in the field of scientific knowledge that have encompassed many different areas of life. This creates a great challenge for both students and teachers, the educational curricula in general, especially science curricula, at the different levels of education. This is why the educational systems are in a bad need to take active roles in keeping up with this growing momentum and in preparing scientifically qualified generations that should be able to cope with the various life problems and challenges (Dare et al., 2015; Bruce-Davis et al., 2014; Asghar et al., 2012).

Accordingly, many countries are doing their best to improve practices and policies that help them to offer a distinguished education that should match and meet the requirements of the economic conditions of the knowledge age in which we live. There will not be an economic sustainable development as well as a human development without distinguished educational programs for the future generations (students) and appropriate training for their teachers (Herro and Quigley, 2017; Park et al., 2016; Wang et al., 2011; Skrikoom et al., 2017).

The integration of Science, Technology, Engineering and Mathematics (STEM) is an important approach for reforming and developing science education (Bybee, 2010; Lessing et al., 2016). It is a crucial step on the way of eliminating the scientific literacy (Khaga, 2015). STEM education opens the doors for the students to have the knowledge that enable them to develop their scientific background and determine their aspired future careers (Lou et. al, 2013). This was confirmed by another study by Hausamann when stating that the STEM education attracts learners to learn these subjects and encourage them to choose the technology field when involving in the future market after their graduation (Hausmann, 2012).

STEM Education in Saudi Arabia

STEM education in Saudi Arabia is still in its first steps. Reviewing the Saudi educational curricula at the different educational levels shows that these curricula are designed according to the approach of separate subjects that rely mainly on knowledge and achievement. According to the Saudi educational system, Science and Mathematics are taught as compulsory subjects in the primary and middle schools, but, in secondary schools, the students study these subjects only if they choose the scientific track (Alahmad, 2010). The problem is not connected with the students only, but also it is connected with the teachers themselves.

Research findings (Alenazi, & Al-Gabr, 2017; Nadelson at.al, 2013; Stohlmann et.al, 2012; Ndeke et.al, 2017; Smith et al., 2015; Hsu et al., 2011) show that the teachers of the scientific subjects face problems regarding their pedagogical knowledge and teaching self-efficacy. Their classroom practices depend largely on transferring the textbook knowledge to their students with emphasis on scientific principles and laws.

Investigating the science (specifically biology) teachers' view of the STEM educational trend and how their views influenced their classroom practices, they expressed negative opinions regarding this kind of education. Their opinions and responses reveal that their knowledge of this kind of education is inadequate and distorted. In a broad sense, there have been gaps in the Saudi 's experience with this kind of education. This is due to the absence of policies, necessary educational legislation, national plans and the lack of the formal STEM education in the Kingdom up till now (Aldosari, 2015).

The attempts of STEMing the educational system of any nation is not an easy task. It cannot happen in a day and night. This fundamental transformation needs several requirements. In addition to the financial, pedagogical and training requirements, the most important one is that STEM education requires a positive educational culture at schools. The school culture plays an important role when implementing STEM at schools. STEM integration requires a different school culture from that in the non-STEM schools. The culture of a STEM school should be built on collaboration among teachers, students and the administrative team. This leads to creating a collaborative and supportive STEM community in school (Al-Deghaidy & Mansour, 2015).

In order to develop the STEM educational trend in Saudi Arabia, this study is trying to add but a brick in the several and different walls of the huge building of STEM education. It seeks to identify the secondary school biology teachers' perceptions of the (STEM) educational trend and their level of teaching self-efficacy.

Objectives and Questions

It should be borne in mind that Saudi Vision 2030 aims to conduct a nation where the Saudis participate in building a knowledge-based and innovative economy. The purpose of this study is to reveal the perceptions of secondary school biology teachers regarding the Science, Technology, Engineering and Mathematics (STEM) educational trend. Moreover, it aims to measure the level of the teaching self-efficacy of biology teachers in the light of this STEM trend. This study is focusing on secondary school biology teachers in AlKharj Governorate in Saudi Arabia as a sample of the Saudi biology teachers in the Kingdom. The following research questions are used to fulfil the purpose of the study:

1. What are the perceptions of the secondary school biology teachers in Al-Kharj governorate about the Science, Technology, Engineering and Math (STEM) educational trend?
2. What is the level of the teaching self-efficacy of biology teachers in Al-Kharj Governorate in the light of the Science, Technology, Engineering and Math (STEM) educational trend.
3. Are there statistically significant differences at the level of significance (0.05) among the responses of the study sample according to the variables (years of experience and number of training courses in the field of (STEM))?
4. Are there statistically significant differences at the level of significance (0.05) among the grades of the study sample in the test according to the variables (years of experience and number of training courses in the field of (STEM))?

Methodology

The researcher followed the descriptive approach to identify the perceptions of secondary school biology teachers in Alkharj Governorate regarding the STEM educational trend and the related level of teaching self-efficacy in the light of that trend.

Participants and their characteristics

The participants of this study included the secondary school Saudi biology teachers in Al-Kharj Governorate in Riyadh Region, Saudi Arabia. This governorate was chosen because it has the main campus of Prince Sattam Bin Abdulaziz University in which the researcher is working. The total number of the involved participants is 37 biology teachers. The following table shows their demographic characteristics:

Table 1. Frequency and Percentages of Demographic Variables

Variable	Answer	Frequency	Percentage
Experience Years	From (5) to (10) years	16	43.2%
	More than (10) years	21	56.8%
	Total	**37**	**100.0%**
Number of training courses in the field of (STEM)	I have never attended any training course in the STEM field.	25	67.6%
	One training course and more in the STEM field.	12	32.4%
	Total	**37**	**100.0%**

The above table shows that (56.8%) of the study sample had (more than 10 years) of experience and (43.2%) of them had (5) to (10) years of experience. The same table shows that (67.6%) of the study sample did not attend any training course in the field of STEM and (32.4%) of them had one or more training courses.

Data Analysis

The collected data of the study were classified and analysed by using the constant comparison method. After codifying the collected data and entering it into a computer, and in order to determine the length of the cells of the five-item scale (highest and lowest points) that was used in the study, the range (5-1-4) was calculated and then divided by the number of cells of the scale to obtain the correct cell length (4/5 = 0.8). This value was then added to the lowest value in the scale (or beginning of the scale, which was the integer1) to determine the upper limit of this cell, and thus the cell length was as follows:

Table 2. length of cells shows the averages of the terms

Coding	Cell length	Availability degree
5	4.20-5.00	Very high
4	3.40-4.19	High
3	2.60-3.39	Medium
2	1.80-2.59	Low
1	1.00-1.79	Very Low

Table 3. Breakdown of the practice rates of concepts

Coding	Cell length	Practice degree
1	0.0% - 33.3%	Low
2	33.4% - 66.6%	Medium
3	66.7% – 100%	High

Statistical Methods

To achieve the objectives of the study and analyze the collected data, many appropriate statistical methods were used by utilising statistical packages for Social Sciences (SPSS). The researcher used the following statistical methods:

1. Descriptive statistics (frequencies, ratios, arithmetic mean, and standard deviation).
2. Alpha-Krobach Coefficient to measure the statistical stability of the questionnaire.
3. Pearson Correlation Coefficient to validate the internal consistency of the questionnaire.
4. Coefficients of Easiness and difficulty and discrimination for testing.
5. T test for the independent samples to indicate the differences between the sample of the study in the test and the scale according to the variables (years of experience, the number of training courses in the field of (STEM)).

Instrumentation

To achieve the objectives of the study, a test and a questionnaire were prepared for this purpose; they were reviewed by specialists in the field of curricula and methods of teaching, measurement and evaluation. Pearson Correlation Coefficient was used to validate the internal consistency of the questionnaire. The statistical stability of the test and the survey were calculated according to Alpha-Krobach Coefficient. The overall statistical stability of the survey is (0.966) and that of the test is (0.817); this means that they have high stability ratios.

Internal Consistency of the Survey:

Once the face validity of the study instrument was ascertained, the researcher applied it to the study. Using the sample data, the researcher calculated the Pearson Correlation Coefficient to ascertain the internal consistency of the instrument. The correlation coefficient was calculated between the score of each statement and the total score of the axis to which it belongs as shown in the following table:

Table 4. Correlation coefficients between the score of each statement and the total score of the individual axis to which it belongs, and also the total axis correlation for the whole survey.

	Axis	**Level of the teaching self-efficacy of biology teachers in the light of the Science, Technology, Engineering and Math (STEM) education trend**			
Individual Axis	Statement No.	correlation coefficient (statement to axis)	P-value (Sig)	correlation coefficient (axis to whole survey)	P-value (Sig)
Level of self-efficacy of biology teachers in developing their knowledge in Science, Technology, Engineering and Math	1	0.770**	0.000		
	2	0.733**	0.000		
	3	0.856**	0.000		
	4	0.646**	0.000		
	5	0.743**	0.000	0.926**	0.000
	6	0.788**	0.000		
	7	0.478**	0.001		
	1	0.691**	0.000	0.951**	0.000

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	2	0.775**	0.000		
	3	0.575**	0.000		
	4	0.680**	0.000		
	5	0.731**	0.000		
	6	0.702**	0.000		
Level of self-efficacy of biology teachers in applying teaching strategies	7	0.895**	0.000		
	8	0.883**	0.000		
	9	0.896**	0.000		
	10	0.878**	0.000		
	11	0.882**	0.000		
	12	0.936**	0.000		
	13	0.800**	0.000		
	14	0.903**	0.000		
	15	0.764**	0.000		
	16	0.840**	0.000		
	1	0.736**	0.000		
	2	0.760**	0.000		
Level of self-efficacy of biology teachers in class management	3	0.627**	0.000		
	4	0.646**	0.000		
	5	0.694**	0.000	0.845**	0.000
	6	0.716**	0.000		
	7	0.751**	0.000		
	8	0.755**	0.000		
	9	0.726**	0.000		

means that the correlation is statistically significant at the level of significance (0.01) and less.**(**)**

The previously mentioned table (4) shows that all correlation coefficients were statistically significant. That means that all statements are related to the axes to which they belong and that the axes were also elated to the survey as a whole, and that none of it can be excluded. Moreover, the coefficients of easiness, difficulty and discrimination have been measured. The following table shows the coefficients of easiness, difficulty and discrimination:

Table 5. Shows the easiness, difficulty and discrimination coefficients

Statement No.	Easiness	Difficulty	Discrimination
1	0.43	0.57	0.40
2	0.27	0.73	0.25
3	0.49	0.51	0.45
4	0.22	0.78	0.20
5	0.38	0.62	0.35
6	0.30	0.70	0.28
7	0.54	0.46	0.50
8	0.30	0.70	0.28
9	0.24	0.76	0.23
10	0.38	0.62	0.35
11	0.11	0.89	0.10
12	0.22	0.78	0.20
13	0.41	0.59	0.38

The Statistical Stability of the Survey:

The following table shows the coefficients of the statistical stability of the survey according to Cronbach's Alpha:

Table 6. shows the factors of the statistical stability according to Cronbach's Alpha

No.	Type	Number of Statements	Cronbach's Alpha Factor
1	Level of self-efficacy of biology teachers in developing their knowledge in Science, Technology, Engineering and Math	7	0.838
2	Level of self-efficacy of biology teachers in applying teaching strategies	16	0.963
3	Level of self-efficacy of biology teachers in class management	9	0.875
	Whole Survey (Overall Stability)	**32**	**0.966**
	Whole Test (Overall Stability)	**13**	**0.817**

The aforementioned table (6) shows that the overall stability factor of the survey was 0.966, while the overall stability factor for the test was 0.817. This shows that the instrument of the study (the survey) is characterised by a high level of stability, which helps achieve the objectives of the study and make the statistical analysis accurate and reliable.

Discussion and Findings

Through this study, the researcher explored the secondary school biology teachers' perception of the STEM educational trend and their teaching self-efficacy while activating it into their classrooms. To identify and measure this, the study focused mainly on four questions. Based on the theoretical foundation of the study and the results drawn from the survey conducted by the researcher, the following sections present the researcher's interpretation, discussion and findings of the study through answering the four questions of the study.

RQ1: ¿What are the perceptions of the secondary school biology teachers in AlKharj Governorate about the Science, Technology, Engineering and Math (STEM) trend?

To answer this question, a glance should be given at the following table:

Table 7. Sample's Perceptions of the (STEM) tren

No.	**Concepts**	**Sample's Perceptions of the (STEM) trend**			
		Frequency	**Percentage**	**Arrange**	**Description**
7	A discussion was held among biology teachers about the relationship among teaching Science, Technology, Engineering, and Math; the most important is that teaching Science, Technology, Engineering, and Math should be in an integrative way because these fields contribute together in understanding the scientific phenomena and dealing with them.	20	54.1%	1	Medium
3	Specialists in education stress the importance of the learner	18	48.6%	2	Medium

	centered approach because the role of the biology teacher when the students are engaged in inquiry education activities is represented in raising questions .that guide the students' thoughts				
1	Specialists in science-teaching recommend the importance of corporating engineering into science learning because solving the scientific problems requires .engineering solutions	16	43.2%	3	Medium
13	Biology teachers differ on the importance of educational technology used in teaching and learning Biology; it is important since it encourages students to .think	15	40.5%	4	Medium
5	Biology teachers differ on the extent of using inquiry education activities in teaching; it must be used to learn the scientific .concepts	14	37.8%	5	Medium
10	A discussion was held among biology teachers about the teaching environments of science subjects; it is important because it stimulates competition among .students	14	37.8%	6	Medium
6	Biology teachers differ on how they can develop the students' understanding of non-absolute knowledge that can be corrected; the most important is that in which the teacher concentrates on one key concept without explaining other facts or concepts to give the students the opportunity to start inquiries.	11	29.7%	7	Low
8	There are many ways to hold discussions and dialogues in classrooms; the most important is that in which the students are allowed to discuss and evaluate their opinions and ideas according to all available evidence.	11	29.7%	8	Low
2	While teaching a scientifically important concept; the most supported concept is that in which the student will learn the concept as a scientific problem or phenomenon in other related.	10	27.0%	9	Low
9	The students differ on the best method to make predictions about the complex systems with multiple variables; the best method represented in modeling in the computer.	9	24.3%	10	Low

4	Biology teachers disagree on the mechanism of implementing inquiry education activities; the most important is that in which the student is free to choose a guided experience, the design procedures, and analysis in order .to build new knowledge	8	21.6%	11	Low
12	When a biology teacher asks a student to answer a scientific question; the best method is represented in guiding the students to follow written steps starting with searching, then developing the product, and .finally evaluating it	8	21.6%	12	Low
11	A discussion was held among Science supervisors regarding the class-time management by the biology teachers; the most important is that biology teachers give more time for carrying out and repeating practical .experiments	4	10.8%	13	Low
	Total	**158**	**32.8%**	**-**	**Low**

Table (7) shows the following:

The overall ratio of the sample of the study regarding the Science, Technology, Engineering and Mathematics (STEM) educational trend and the related requirements of teaching is (32.8%). This means that the perceptions of the sample of the study on the STEM trend and the related requirements of teaching is weak. **Accordingly, regarding the Science, Technology, Engineering and Mathematics (STEM) educational trend is (weak).**

The concepts were arranged according to percentages; the top three ones are:

- The concept: (A discussion was held among biology teachers about the relationship among teaching Science, Technology, Engineering, and Math; the most important is that teaching Science, Technology, Engineering, and Math should be in an integrative way because these fields contribute together in understanding the scientific phenomena and dealing with them) came first with a percentage of (54.1%) and a (medium) practice.
- The concept: (Specialists in education stress the importance of the learner centered approach because the role of the biology teacher when the students are engaged in inquiry education activities is represented in raising questions that guide the students' thoughts) came second with a percentage of (48.6%) and a (medium) practice.
- The concept: (Specialists in science-teaching recommend the importance of corporating engineering into science learning because solving the scientific problems requires engineering solutions came third with a percentage of (43.2%) and a (medium) practice.

The least three concepts are:

- The concept: (Biology teachers disagree on the mechanism of implementing inquiry education activities; the most important is that in which the student is free to choose a guided experience, the design procedures, and analysis in order to build new knowledge) came eleventh with a percentage of (21.6%) and a (weak) practice.
- The concept: (When a biology teacher asks a student to answer a scientific question; the best method is represented in guiding the students to follow written steps starting with searching, then developing the product, and finally evaluating it) came twelfth with a

percentage of (21.6%) and a (weak) practice.

- The concept: (A discussion was held among Science supervisors regarding the class-time management by the biology teachers; the most important is that biology teachers give more time for carrying out and repeating practical experiments) came thirteenth with a percentage of (10.8%) and a (weak) practice.

RQ2: ¿What is the level of the teaching self-efficacy of biology teachers in Al-Kharj Governorate in the light of the Science, Technology, Engineering and Math (STEM) trend?

To answer this question, a glance should be given at the following table:

Table 8. Arithmetic Mean and Standard Deviation for the three axes

No.	Axis	Arithmetic Mean	Standard Deviation	Arrange	Description
3	Level of self-efficacy of biology teachers in class management	3.94	0.93	1	High
2	Level of self-efficacy of biology teachers in applying teaching strategies	3.47	1.14	2	High
1	Level of self-efficacy of biology teachers in developing their knowledge in Science, Technology, Engineering and Math	3.28	1.19	3	Medium
	Level of the teaching self-efficacy of biology teachers as a whole (whole-questionnaire)	**3.56**	**1.09**		High

Table (8) shows the following:

The general arithmetic mean of the questionnaire as a whole is (3.56) with a standard deviation of (1.09). This arithmetic mean means that the degree of approval of the sample of the study is (high). **Accordingly, the axis: (Level of self-efficacy of biology teachers in developing their knowledge in Science, Technology, Engineering and Math) is (high).** More details are as follows:

- The third axis: (Level of self-efficacy of biology teachers in class management) came first with an average of (3.94) and a standard deviation of (0.93). This means that the degree of approval of the study sample on this axis is high. Accordingly, the (Level of self-efficacy of biology teachers in class management) is (high).
- The second axis: (Level of self-efficacy of biology teachers in applying teaching strategies) came second with an average of (3.47) and a standard deviation of (1.14). This means that the degree of approval of the study sample on this axis is high. Accordingly, the (Level of self-efficacy of biology teachers in applying teaching strategies) is (high).
- The third axis: (Level of self-efficacy of biology teachers in developing their knowledge in Science, Technology, Engineering and Math) came third with an average of (3.28) and a standard deviation of (1.19). This means that the degree of approval of the study sample on this axis is (medium). Accordingly, the (Level of self-efficacy of biology teachers in developing their knowledge in Science, Technology, Engineering and Math) is (medium).

To give more details, the following three tables give detailed descriptive statistics for the aforementioned three axes (table 8) and their related statements. **The following table deals with the first axis: level of self-efficacy of biology teachers in developing their knowledge in Science, Technology, Engineering and Math**:

Table 9. A Descriptive Statistics for each statement of the first axis: level of self-efficacy of biology teachers in developing their knowledge in Science, Technology, Engineering and Math

No.	Statement	Degree of approved					Arithmetic Mean	Standard Deviation	Arrange	Description
		Very High	High	Medium	Low	Very Low				
7	I have the proclivity to enroll in occupational development programmes apropos of Science, Technology, Engineering and Math.	24 64.9%	4 10.8%	4 10.8%	2 5.4%	3 8.1%	4.20	1.31	1	Very High
4	I relate scientific biology concepts to their applications in .the real world	5 13.5%	17 45.9%	11 29.7%	1 2.7%	3 8.1%	3.54	1.04	2	High
5	I have the ability to improve my arithmetic skills to understand and sort out educational and .scientific problems	9 24.3%	9 24.3%	13 35.1%	4 10.8%	2 5.4%	3.51	1.15	3	High
2	I employ modern educational techniques to understand and sort out educational and scientific problems.	7 18.9%	12 32.4%	8 21.6%	7 18.9%	3 8.1%	3.35	1.23	4	Medium
6	I cooperate with biology and science teachers and with experts in the field of science, technology, engineering or math for the purpose of enriching my knowledge and .burnishing my skills	7 18.9%	6 16.2%	10 27%	10 27%	4 10.8%	3.05	1.29	5	Medium
1	I stay in touch with the latest research in Science, Technology, .Engineering and Math	2 5.4%	6 16.2%	16 43.2%	9 24.3%	4 10.8%	2.81	1.02	6	Medium
3	I have the ability to improve my engineering design .skills	1 2.7%	10 27%	8 21.6%	6 16.2%	12 32.4%	2.51	1.28	7	Low
	General Average						**3.28**	**1.19**	**-**	Medium

Table (9) shows the following:

The general arithmetic mean for the statements of the first axis: " level of self-efficacy of biology teachers in developing their knowledge in Science, Technology, Engineering and Math" is (3.28) with a standard deviation (1.19). **Accordingly, the degree of approval of the study sample on this axis is "medium".** The statements were arranged according to the arithmetic mean; the top three ones are:

- Statement (7): (I have the proclivity to enroll in occupational development programmes apropos of Science, Technology, Engineering and Math) came first with an average of (4.20) and a standard deviation of (1.31). This means that the degree of approval of the sample on this statement is "high".
- Statement (4): (I relate scientific biology concepts to their applications in the real world) came second with an average of (3.54) and a standard deviation (1.04). This means that the degree of approval of the sample on this statement is "high".
- Statement (5): (I have the ability to improve my arithmetic skills to understand and sort out educational and scientific problems) came third with an average of (3.51) and a standard deviation of (1.15). This means that the degree of approval of the sample on this statement is "high".

The least three statements are:

- Statement (6): (I cooperate with biology and science teachers and with experts in the field of science, technology, engineering or math for the purpose of enriching my knowledge and burnishing my skills) came fifth with an average of (3.05) and a standard deviation of (1.29). This means that the degree of approval of the sample on this statement is "medium".
- Statement (1): (I stay in touch with the latest research in Science, Technology, Engineering and Math) came sixth with an average of (2.81) and a standard deviation of (1.02). This means that the degree of approval of the sample on this statement is "medium".
- Statement (3): (I have the ability to improve my engineering design skills) came seventh and the last one with an average of (2.51) and a standard deviation of (1.28). This means that the degree of approval of the sample on this statement is "low".

The following table deals with the second axis: level of self-efficacy of biology teachers in applying teaching strategies:

Table (10): A Descriptive Statistics for each statement of the second axis: level of self-efficacy of biology teachers in applying teaching strategies

No.	Statement	Degree of approved					Arithmetic Mean	Standard Deviation	Arrange	Description
		Very High	High	Medium	Low	Very Low				
4	I am able to encourage my students to retrieve their previous knowledge and .experience	13 35.1%	20 54.1%	3 8.1%	0 0.0%	1 2.7%	4.19	0.81	1	High
6	I can put forward brain-storming tasks for my students so that they provide creative solutions to .scientific problems	16 43.2%	13 35.1%	7 18.9%	0 0.0%	1 2.7%	4.16	0.93	2	High
1	I have the ability to help my students to see the connection between biology and	14 37.8%	16 43.2%	3 8.1%	2 5.4%	2 5.4%	4.03	1.09	3	High

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	the other sciences (physics, chemistry, geology, astronomy, etc) to understand and sort out .scientific problems									
3	I am capable of transforming the learning outcome into a tangible, thought-provoking issues.	11 29.7%	17 45.9%	5 13.5%	2 5.4%	2 5.4%	3.89	1.08	4	High
13	I trust in my ability to help my students develop their deductive thinking skills, which enables them to see the connection between .cause and effect	8 21.6%	13 35.1%	13 35.1%	2 5.4%	1 2.7%	3.68	0.97	5	High
15	I can enable my students to come up with logical explanations to scientific phenomena based on .evidence	9 24.3%	13 35.1%	10 27%	3 8.1%	2 5.4%	3.65	1.11	6	High
5	I trust in my ability to help my students enhance their inductive thinking, which enables them to put theories forward, based on quantitative or .qualitative data	6 16.2%	16 43.2%	10 27%	3 8.1%	2 5.4%	3.57	1.04	7	High
14	I can enable my students to determine criteria that improve their .designs	7 18.9%	14 37.8%	6 16.2%	7 18.9%	3 8.1%	3.41	1.24	8	High
12	I trust in my ability to train my students to create or draw their designs and to .test them	7 18.9%	9 24.3%	13 35.1%	6 16.2%	2 5.4%	3.35	1.14	9	Medium
10	I have the ability to help my students to determine on their own the investigation or .design procedures	4 10.8%	15 40.5%	9 24.3%	5 13.5%	4 10.8%	3.27	1.17	10	Medium
11	I can enable my students to determine the investigation or design proceduresand to decide on the	5 13.5%	13 35.1%	10 27%	5 13.5%	4 10.8%	3.27	1.19	11	Medium

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	suitable tools for .collecting data									
16	I trust in my ability to enable my students to exhibit their experiments and designs before experts in the areas of science, technology, engineering and math, and to discuss and defend their viewpoints, which will ultimately help enrich knowledge and serve the .community	6 16.2%	9 24.3%	11 29.7%	5 13.5%	6 16.2%	3.11	1.31	12	Medium
7	I can train my students to use mathematical formulae, for the purpose of predicting the relationships that hold between variables in phenomena or for the purpose of performing .suggested designs	5 13.5%	14 37.8%	4 10.8%	7 18.9%	7 18.9%	3.08	1.38	13	Medium
9	I can discuss with my students the alternatives to suggested designs and their appropriacy for the standards and .restrictions at hand	3 8.1%	11 29.7%	12 32.4%	5 13.5%	6 16.2%	3.00	1.20	14	Medium
8	I can teach my students to utilise computer simulations to represent phenomena or .suggested designs	6 16.2%	8 21.6%	10 27%	6 16.2%	7 18.9%	3.00	1.35	15	Medium
2	I have the necessary skills to help develop my students' geometrical know- .how	4 10.8%	9 24.3%	8 21.6%	9 24.3%	7 18.9%	2.84	1.30	16	Medium
	General Average						**3.47**	**1.14**	**-**	**High**

Table (10) shows the following:

The general arithmetic mean for all the statements of the second axis: "level of self-efficacy of biology teachers in applying teaching strategies" is (3.47), with a standard deviation (1.14). Accordingly, the degree of approval of the study sample on this axis is "high". The statements were arranged according to the arithmetic mean; the top three ones are:

- Statement (4): (I am able to encourage my students to retrieve their previous knowledge and experience) ranked first with an average score of (4.19) and a standard deviation of (0.81). This means that the degree of approval of the sample on this statement is "high".
- Statement (6): (I can put forward brain-storming tasks for my students so that they provide creative solutions to scientific problems) came second with the average of (4.16) and the standard deviation is (0.93). This means that the degree of approval of the sample on this statement is "high".
- Statement (1): I have the ability to help my students to see the connection between biology and the other sciences (physics, chemistry, geology, astronomy, etc) to understand and sort out scientific problems) came third with an average of (4.03) and a standard deviation of (1.09). This means that the degree of approval of the sample on this statement is "high".

The least three terms are:

- Statement (9): (I can discuss with my students the alternatives to suggested designs and their appropriacy for the standards and restrictions at hand) came fourteenth with an average of (3.00) and a standard deviation of (1.20). This means that the degree of approval of the sample on this statement is "medium".
- Statement (8): (I can teach my students to utilize computer simulations to represent phenomena or suggested designs) came fifteenth with an average of (3.00) and a standard deviation of (1.35). This means that the degree of approval of the sample on this statement is "medium".
- Statement (2): (I have the necessary skills to help develop my students' geometrical know-how) came sixteenth with an average of (2.84) and a standard deviation of (1.30). This means that the degree of approval of the sample on this statement is "medium".

The following table deals with the third axis: level of self-efficacy of biology teachers in class management:

Table 11. A Descriptive Statistics for each statement of the third axis: level of self-efficacy of biology teachers in class management

No.	Statement	Degree of approved					Arithmetic Mean	Standard Deviation	Arrange	Description
		Very High	High	Medium	Low	Very Low				
9	I constantly give my students advice on the safe use of lab tools and devices.	22 59.5%	9 24.3%	4 10.8%	2 5.4%	0 0.0%	4.38	0.89	1	Very High
7	I trust in my ability to apply class management criteria that enhance respect and cooperation among my students.	13 35.1%	17 45.9%	6 16.2%	1 2.7%	0 0.0%	4.14	0.79	2	High
5	I deal with my students in an appropriate way in the case of too much hubbub and activity in the lab during survey experiments.	10 27%	19 51.4%	7 18.9%	1 2.7%	0 0.0%	4.03	0.76	3	High

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1	I have the ability to encourage my students to present their ideas and discuss them with .others	10 27%	20 54.1%	4 10.8%	2 5.4%	1 2.7%	3.97	0.93	4	High
4	I guide my students to sources of knowledge (printed, electronic, human) that are necessary to grasp and sort out scientific .problems	12 32.4%	12 32.4%	9 24.3%	4 10.8%	0 0.0%	3.86	1.00	5	High
6	I am capable of supporting my students to get them to participate in survey .activities	7 18.9%	22 59.5%	5 13.5%	2 5.4%	1 2.7%	3.86	0.89	6	High
3	I give my students to create inductive groups .amongst themselves	8 21.6%	15 40.5%	10 27%	4 10.8%	0 0.0%	3.73	0.93	7	High
2	I help my students divide up the big tasks into smaller tasks in congruence with a .timetable	7 18.9%	18 48.6%	9 24.3%	1 2.7%	2 5.4%	3.73	0.99	8	High
8	I allow my students extra time to repeat the experiments or to ameliorate their .activities	12 32.4%	10 27%	10 27%	3 8.1%	2 5.4%	3.73	1.17	9	High
	General Average						**3.47**	**1.14**	**-**	**High**

Table (11) shows the following:

The general arithmetic mean for all the statements of the third axis: **"Level of self-efficacy of biology teachers in class management"** is (3.94) with a standard deviation (0.93). **Accordingly, the degree of approval of the study sample on this axis is "high".** The statements were arranged according to the arithmetic mean; the top three statements are:

- Statement (9): (I constantly give my students advice on the safe use of lab tools and devices) came first with an average score of (4.38) and a standard deviation of (0.89). This means that the degree of approval of the sample on this statement is "very high".
- Statement (7): (I trust in my ability to apply class management criteria that enhance respect and cooperation among my students) came second with a mean of (4.14) and a standard deviation of (0.79). This means that the degree of approval of the sample on this statement is "high".
- Statement (5): (I deal with my students in an appropriate way in the case of too much hubbub and activity in the lab during survey experiments) came third with an average of (4.03) and a standard deviation of (0.76). This means that the degree of approval of the sample on this statement is "high".

The least three statements are:

- Statement (3): (I give my students to create inductive groups amongst themselves.) came seventh with an average of (3.73) and a standard deviation of (0.93).
- Statement (2): (I help my students divide up the big tasks into smaller tasks in congruence with a timetable) came eighth with a mean of (3.73) and a standard deviation of (0.99).
- Statement (8): (I allow my students extra time to repeat the experiments or to ameliorate their activities) came ninth

and final rank with mean (3.73) and standard deviation (1.17).

RQ3: Are there statistically significant differences at the level of (0.05) among the responses of the study sample according to the variables (years of experience and the number of training courses in the field of (STEM)).

To answer this question, a t-test is used for the two independent samples (Independent Samples Test). This can be shown as follow:

Table 12. Results of the Independent Samples t-Test for the differences among the responses of the study sample according to the variables (years of experience and number of training courses in the STEM)

Variable	Axis	Category	No	Average	Standard Deviation	T Value	Degree of freedom	P-Value
Experience Years	Level of self-efficacy of biology teachers in developing their knowledge in Science, Technology, Engineering and Math	From (5) to (10) years	16	3.31	0.95	0.19	35	0.85
		More than From (10) years	21	3.26	0.79			
	Level of self-efficacy of biology teachers in applying teaching strategies	From (5) to (10) years	16	3.53	1.01	0.34	35	0.74
		More than From (10) years	21	3.42	0.88			
	Level of self-efficacy of biology teachers in class management	From (5) to (10) years	16	4.04	0.69	0.84	35	0.41
		More than From (10) years	21	3.86	0.65			
	Level of the teaching self-efficacy of biology teachers as a whole (whole-questionnaire)	From (5) to (10) years	16	3.63	0.80	0.46	35	0.65
		More than From (10) years	21	3.51	0.71			
Number of training courses in (STEM)	Level of self-efficacy of biology teachers in developing their knowledge in Science, Technology, Engineering and Math	No training course in (STEM)	25	3.20	0.87	-0.84	35	0.41
		One or more training courses in (STEM)	12	3.45	0.81			
	Level of self-efficacy of biology teachers in applying teaching strategies	No training course in (STEM)	25	3.34	0.92	-1.22	35	0.23
		One or more training courses in (STEM)	12	3.73	0.93			
	Level of self-efficacy of biology teachers in class management	No training course in (STEM)	25	3.76	0.67	-2.52*	35	0.02
		One or more training courses in (STEM)	12	4.31	0.49			
	Level of the teaching self-efficacy of biology teachers as a whole (whole-questionnaire)	No training course in (STEM)	25	3.43	0.76	-1.55	35	0.13
		One or more training courses in (STEM)	12	3.83	0.65			

Table (12) shows the following:

- There are no statistically significant differences at the level of significance (0.05) among the responses of the study sample on the axes: (level of self-efficacy of biology teachers in developing their knowledge in Science, Technology, Engineering and Math, level of self-efficacy of biology teachers in applying teaching strategies, level of self-efficacy of biology teachers in class management, and level of the teaching self-efficacy of biology teachers as a whole (whole-questionnaire)) according to the variable (years of experience).
- There were no statistically significant differences at the level of significance (0.05) among the responses of the study sample on the axes: (level of self-efficacy of biology teachers in developing their knowledge in Science, Technology, Engineering and Math, level of self-efficacy of biology teachers in applying teaching strategies, and level of the teaching self-efficacy of biology teachers as a whole (whole-questionnaire) according to the variable (number of STEM courses).
- There were statistically significant differences at the level of significance (0.05) among the responses of the study sample on the level of self-efficacy of the biology teachers in classroom management according to the variable (number of training courses in the field of STEM). these differences are connected to the members of the study sample who have one or more training courses in the field of (STEM).

RQ4: Are there statistically significant differences at the level of significance (0.05) among the grades of the study sample in the test according to the variables (years of experience and number of training courses in the field of (STEM)?

To answer this question, a t-test is used for the two independent samples (Independent Samples Test). This can be shown as follow:

Table 13. Results of the Independent Samples t-Test for the differences among the grades of the study sample in the test according to the variables (years of experience and number of training courses in STEM)

Variable	Axis	Category	No	Average	Standard Deviation	T Value	Degree of freedom	P-Value
Experience Years	Whole-test	From (5) to (10) years	16	4.31	1.49	0.53	35	0.60
		More than From (10) years	21	4.05	1.53			
Number of training courses in (STEM)	Whole-test	No training course in (STEM)	25	3.88	1.45	-2.69*	35	0.03
		One or more training courses in (STEM)	12	4.75	1.48			

Table (13) shows the following:

- There were no statistically significant differences at the level of significance (0.05) among the grades of the study sample in the test according to the variable (years of experience).
- There are statistically significant differences at the level of significance (0.05) among the grades of the study sample in the test according to the variable (number of training courses in the field of (STEM)); these differences are connected to the members of the study sample who have one or more training courses in the field of (STEM).

Conclusion and Recommendations

This study is the first of its kind in Saudi Arabia to investigate the perceptions of secondary school (specifically biology teachers) in Alkharj Governorate in Riyadh Region on Science, Technology, Engineering and Math (STEM) educational trend and measure their related level of teaching self-efficacy in the light of that trend. Some appropriate statistical methods were used to analyse the collected data. Secondary school biology teachers in Alkharj Governorate did not have enough understanding and knowledge of STEM education. Most teachers (67.6% of the study sample) did not attend any training course in STEM education. This indicates that most secondary school biology teachers in Alkharj Governorate have misconceptions and inadequate knowledge regarding STEM education.

The findings of this study validate the need to have more research study in this field. It is highly recommended that Ministry of Education in Saudi Arabia should dedicate special funds for STEM education. This will help in finding a highly qualified teachers in this field. Moreover, they will be able to have more training chances in this important field. In addition, STEM labs and resources should be available in all schools; this will help in improving the quality of learning. Furthermore, teachers will be more involved in STEM education. This, inevitably, will help them to deliver STEM in an innovative and creative way; something that will help their students to generate new ideas and be more innovative. At last but not least, the STEM education should be accompanied with more extra-curricular activities in order to help both the teachers as well as the students to participate effectively in this important educational trend.

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