

Self-efficacy in teaching science among student teachers

Yahya Ali Ahmed Faqih^{1*} , AbdulAziz Aboud Asiri¹ 

¹Faculty of Education & Sharia, Educational and Humanitarian Research Center, Najran University, Najran, SAUDI ARABIA

*Corresponding Author: yafaqih@nu.edu.sa

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ABSTRACT

This study aims to identify the degree of self-efficacy in teaching science at the elementary level among student teachers in the Higher Diploma in Science at Najran University. The study was conducted using the mixed method (quantitative/qualitative). The Science Teaching Efficacy Belief Instrument scale was applied to all student teachers enrolled in the science diploma program for the elementary stage (15 teachers) in 2022. Also, interviews ten teachers were conducted. The results revealed that the degree of personal science teaching efficacy among the study sample was high. Also, there was no statistically significant effect of specialization, educational stage, and teaching experience on self-efficacy beliefs in teaching science. In addition, the interviews showed that most of the teachers in the study sample believed in their ability to teach science at the elementary level.

Keywords: self-efficacy, teaching science, student teachers, science teacher

INTRODUCTION

Qualifying teachers is at the forefront of education development projects in most countries of the world; the teacher is the focus of the educational process and is relied upon to improve the learning environment and make it positive and compatible with the nature of life and the changes taking place in societies, especially, technical and scientific developments. Therefore, it has become necessary for teacher preparation and education programs to keep pace with all these developments. They should take into account the magnitude of the challenges that the teacher will face when moving from the preparation institution to the actual work environment and qualify him to be able to invest in all the foundations of the educational process and improve all its aspects to achieve comprehensive growth of learner personality.

The generation of the twenty-first century needs teachers who believe in their teaching abilities and mental skills, who can train this generation in modern skills and have the components of professional skills that work hand in hand with their abilities (Türkoğlu et al., 2017). In addition, the professional development of a teacher that extends its impact into the classroom necessarily leads to an improvement in students' learning (Seraphin et al., 2017).

The philosophy of efficiency in performance is a response to modern trends and its view of the educational process which believes that individuals who have high self-efficacy are more effective and influential and can challenge the difficulties they face. In teaching, teachers should be characterized by high self-efficacy because the best educational outcomes are the result of their teachers' high self-efficacy (Saka et al., 2016; Senler, 2016). There is no doubt that a strong relationship and close connection exist between self-efficacy among teachers and the perceptions they hold regarding any new educational issue or trend. It is known that individuals tend to exert great effort in activities and behaviors that they believe are most important in performing them. Individuals who feel strong in their self-efficacy view difficult tasks and obstacles as challenges they aspire to overcome. They actively participate in practices that they believe they can achieve success in performance. The interest in self-efficacy among pre-service teachers is due to Bandura's belief that it is easy to build competence beliefs in the early stages of learning and training and that if they are acquired, they become permanent and resistant to change (Palmer, 2006; Wan, 2005). Therefore, teacher self-efficacy is an expression of the teacher's academic, social, and professional ability that determines his way of dealing with and controlling the classroom environment, his planning of the educational process, his understanding of scientific content, choosing appropriate activities to motivate learners, identifying learners' potentials, and preparing the educational environment for them.

Studies have confirmed a positive relationship between teacher competence and learners' achievement (Zidan, 2010). Bandura (2007) confirms that self-efficacy plays a pivotal role in determining the degree of control over an individual's thinking patterns. It is also a vital factor in explaining the behavior of individuals. The individual's initiative and perseverance behavior depend on his expectations and judgments related to behavioral skills and competencies to deal with the challenges of the environment and the circumstances surrounding him (Abu Suleiman, 2007). Some studies confirm a positive correlation between self-efficacy on the one hand and both achievement motivation and emotional intelligence (Al-Mazrou, 2007), as well as compatibility and

professional commitment on the other hand (Hijazi, 2013). Bandura (2007) believes that self-efficacy is the perceived procedural ability not related to what the individual possesses but rather to his belief in what he can do regardless of the available resources. It is not enough to ascertain the degree of the teacher's ability, one must show the extent of his confidence in his ability to carry out the required activities in light of the requirements of the situation. Thus, individuals' assessment of their self-efficacy determines the level of difficulty they believe they will encounter in teaching. Creating the appropriate environment for learning depends on the teacher's talents and self-efficacy. A teacher, having a high sense of self-efficacy works to help low-achieving students, develops their motivation, enhances their self-confidence, and encourages them to achieve. Artino (2006) pointed out that it is not enough for the teacher to possess the requirements and skills necessary to perform his duties, he must also possess faith and confidence in his ability to carry out the required behavior in difficult circumstances.

The success of science education depends on the extent of attention to the competencies and skills of teachers and their rehabilitation following the requirements of the modern era. A science teacher in this era should have a deep understanding of the scientific content of his subject and develop his practical abilities and skills. Also, he should be able to teach scientific concepts and thinking methods to his students and instill in them positive attitudes toward learning science (Baljoun, 2011; Hassouna, 2009). Pajares (2002) also pointed to the strong relationship between science teachers' self-efficacy and their students' performance. The positive beliefs of science teachers towards teaching science and their students help develop their level and thinking. In contrast, science teachers with low self-efficacy cannot provide appropriate opportunities for their students to develop their scientific culture. They also do not encourage their students to diversify their thinking styles through activities and projects that stimulate this.

Teachers' behavior in teaching science depends on the beliefs built and formed during their pre-service preparation period as well as the extent of their self-confidence. The possibility of teaching science effectively in the elementary stage is weakened if the teacher's self-efficacy decreases. These results have been confirmed by many studies (El-Deghaidy, 2006; Stevens & Davis, 2007). In this regard, Menon and Azam (2021) indicated a positive relationship between a science teacher's self-efficacy and his knowledge of scientific concepts. The results of studies have varied. Abu Athra (2012) and Baljoun (2009) found that pre-service science teachers have high beliefs in their self-efficacy, whereas Nawafleh and Al-Omari (2012) revealed a low level of self-efficacy for students of science education in teaching science by inquiry. Flores (2016) found that science teachers have less self-efficacy compared to teachers of different subjects, whereas Saka et al. (2016) showed different levels of self-efficacy beliefs among pre-service science teachers.

Within the framework of the educational movement witnessed in pre-university education in the Kingdom of Saudi Arabia, new curricula have been developed to keep pace with scientific and educational developments. Courses such as critical thinking, digital skills, and life skills have been added. The Ministry of Education (2021) has also approved optimal investment programs for educational personnel and has begun offering them since 2021. This project aims to raise the efficiency of male and female teachers in many new courses and work to invest their capabilities to develop educational outcomes by rehabilitating teachers who are redundant in their specializations to enable them to teach other subjects. Given the importance of self-efficacy among teachers in general and science teachers in particular and its impact on teacher performance and student achievement, this study seeks to reveal the nature and level of self-efficacy in teaching science among a group of teachers who are not scientifically specialized in any of the fields of natural sciences. They had not previously taught science but rather enrolled in a one-year program that qualified them to teach science courses at the elementary level. Therefore, the study seeks to diagnose the reality of self-efficacy among these teachers, teaching science. It also examined the role of the qualification program in investing in their professional experiences and providing them with the knowledge, skills, and attitudes that enable them to achieve a better education for their students in science.

The study focuses on answering the following main question and sub-questions:

- RQ1** What is the degree of self-efficacy in teaching science at the elementary level among student teachers at Najran University?
- RQ2** What is the degree of personal science teaching efficacy at the elementary level among student teachers at Najran University?
- RQ3** What is the expected degree of impact on the outcomes of science teaching from the point of view of student teachers at Najran University?
- RQ4** What is the impact of the variables of scientific specialization, educational stage, and years of teaching experience on the responses of the study sample?
- RQ5** What are the impressions of the study sample about their self-efficacy and the role of the higher diploma in qualifying them to teach science at the elementary stage?

THEORETICAL FRAMEWORK

Teacher Self-Efficacy

The term self-efficacy appeared at the hands of the American scientist Albert Bandura, the founder of the theory of social cognitive learning in the seventies of the last century, specifically in (Bandura, 1977). He published an article entitled "Self-Efficacy: Toward a Theory of Behavior Modification." In his article, he emphasized the importance of self-efficacy and considered it a factor and means of modifying behavior and an indicator of the individual's expectations of successful performance in various tasks, planning for them realistically, and his abilities to carry out a specific behavior in an acceptable manner. Alpaslan et al. (2018)

believe that self-efficacy is related to the teacher's pre-service awareness of his ability to perform a job, his belief in his ability to teach, and to deal with the difficulties he faces to achieve quality education. It is essential to increase the teacher's confidence in his performance when carrying out teaching activities related to the teaching profession. An individual's beliefs about himself affect his ability to carry out the work entrusted to him. If the individual believes that he can accomplish the tasks assigned to him, he will have a strong motivation to carry out those tasks and overcome the difficulties he may face, and vice versa.

Many researchers have studied the reality of self-efficacy among teachers and its relationship to some variables. Ibrahim (2005) revealed a positive correlation between teachers' professional competence, general self-efficacy, and educational beliefs. It was found that there is an inverse correlation between teachers' professional competence and professional psychological stress. Al-Salhi (2013) showed statistically significant differences in the level of self-efficacy in favor of teachers with more teaching experience. While elementary school teachers outperformed their peers in other educational, no effect appeared for the specialization variable. Ashour and Murad (2018) detected the high self-efficacy of elementary school teachers and a strong positive relationship between teacher self-efficacy and the quality of teaching. Al-Kathiri (2011) concluded that the teachers in the study sample evaluated the effectiveness of their performance as (good). It was also found that teachers' perceptions of the effectiveness of their performance in teaching strategies are higher than their perceptions of classroom management and student activation. Years of experience have an influential relationship with teachers' perceptions of the effectiveness of their performance. Khalayleh (2011) found that the level of teachers' self-efficacy was high and that teachers believed that they were more effective in classroom management and less effective in student participation in the educational process. Also, there were statistically significant differences in male and female teachers' estimates of their self-efficacy due to the variables of academic stage and educational experience. Waeli and Aladdin (2013) indicated that job satisfaction, self-efficacy, and educational practices are associated with statistically significant positive relationships. It was revealed that female teachers had a higher sense of satisfaction and self-efficacy compared to male teachers. The results also showed statistically significant differences in teachers' self-efficacy due to levels of educational experience in favor of less than five years.

Self-efficacy in teaching science

The teacher plays the most important role in the educational development process because he is in direct contact with the learners. Therefore, emphasis must be placed on preparing it in a manner appropriate to the size of the roles relied upon and enabling it to contribute effectively to creating a scientifically literate generation. In light of this, recent trends in developing science curricula and teaching methods depend on preparing teachers before service and qualifying them during service for their renewed roles. Specialists stress the need to pay attention to emotional variables in teacher preparation programs, including studying teacher beliefs in scientific education. A teacher's possession of self-efficacy beliefs is one of the requirements that must be met in the teacher's teaching behavior in general and the science teacher in particular. This depends on the level of self-efficacy that he develops during his pre-service preparation period. Therefore, it is not only possible for a teacher to possess the necessary skills to teach but rather he must have faith in his abilities and teaching capabilities. Reda (2020) indicated that the more the teacher has a high self-efficacy in teaching, the more effective the process of developing the education system will be.

Self-efficacy in teaching science means the pre-service science teacher's confidence in himself and his ability to achieve a good teaching performance through various teaching strategies, good classroom management, and creating a positive impact on learning outcomes. This notion agrees with Menon and Sadler (2018), who indicated that self-efficacy plays a key role in determining the practices that a science teacher follows in teaching. It is one of the very important aspects that must be paid attention to in pre-service science teacher preparation. Bleicher and Lindgren (2005) showed that teachers' behavior in teaching depends on the beliefs built and formed during preparation before service and on the extent of their self-confidence. Their study also demonstrated a correlation between teaching effectiveness and teacher self-efficacy. Based on the above, it is clear that self-efficacy in teaching science is a term that expresses the science teacher's personal beliefs about his ability to perform his teaching tasks and his perception of the nature of the teaching practices that he will carry out in the future of his professional life. This is related to the teacher's beliefs and conviction in his ability to achieve learning outcomes for his students and his ability to implement various teaching strategies that affect the quality of teaching.

Many studies have been interested in investigating the level of self-efficacy among science teachers. Saleh (2005) concluded that the level of pre-service science teachers' self-efficacy is low compared to their in-service peers. Likewise, Amr (2012) concluded that science teachers' self-efficacy in the lower elementary stage was average. There were statistically significant differences attributed to years of experience in favor of those with years of experience (5-10). Similarly, Abed (2009) revealed that the students of the classroom teacher program possessed positive beliefs about their self-efficacy in teaching science and expected its outcomes, while their level of knowledge of scientific concepts was low. It was also shown that there is a positive correlation between the level of knowledge of scientific concepts and beliefs related to self-efficacy in science education. In addition, there was no relationship between the level of knowledge of scientific concepts and beliefs related to expecting the outcomes of science education. In the same vein, El-Deghaidy (2006) examined pre-service teachers' self-efficacy beliefs and their perceptions of themselves as science teachers and found an effect of the science teaching methods course, as students showed greater confidence in teaching science. Besides, a comparative study conducted by Tekkaya et al. (2004) on pre-service self-efficacy in teaching science among a sample of teachers in Turkey and America resulted in positive beliefs about teaching science among teachers in both countries, but they were stronger among Americans. This result was attributed to the number of hours devoted to training students and the admission system to teacher education programs. In addition, there were no statistically significant differences between the two groups regarding expectations of science teaching outcomes, and the gender factor did not affect beliefs related to science teaching in the sample as a whole. Saracaloğlu and Yenice (2009) addressed the level of self-efficacy of science teachers in elementary schools in light of some variables. He applied the study to science teachers in elementary schools in Aydin Province, Turkey. It was found that there was no effect of the variables of gender and years of experience on self-

Table 1. Distribution of study sample members according to categorical variables

Variable	Group	No.	%
Educational stage	Elementary	5	33.3
Data	Intermediate and secondary	10	66.7
Major	Islamic and social studies	7	46.7
Data	Arabic language	8	53.3
Years of experience	- 5 years	6	40.0
Data	5 years or more	9	60.0
Total	15	100	

efficacy, while there was an effect of the variables of specialization and job satisfaction. Al-Saghir (2009) concluded that the degree of teachers' teaching self-efficacy beliefs was moderate. Also, there was an effect on science teachers' teaching self-efficacy beliefs due to the gender variable in favor of males; however, experience, academic qualifications, and specialization did not affect beliefs in teaching self-efficacy. Hakami (2019) concluded that the study's sample of middle school science teachers in the city of Riyadh believed that they had high self-efficacy in teaching science in cognitive, skillful, emotional, and professional areas. Ecevit and Kingir (2022) found that self-efficacy beliefs in teaching science were higher than average and that females outperformed males in terms of teaching and learning style in estimating self-efficacy in teaching science. Karaçöp and Inaltekin's (2022) study showed that science teachers' job satisfaction was directly positively related to their self-efficacy, science teaching self-efficacy, and school culture. Loach's (2021) study revealed that participation in a teaching team at grade level had some effect on teachers' self-efficacy, while the number of years teaching did not have a significant effect on the level of self-efficacy in teaching science. The results of Chan and Lay's (2021) study revealed an effect of emotional orientations toward teaching science on teacher self-efficacy beliefs and behavioral practices related to teaching science.

It is clear from the above the importance of exploring the reality of self-efficacy in teaching science among science teachers before educational service and the necessity of working on its development. It also turns out that previous studies were conducted on either university students or in-service teachers. However, none of them addressed a category of teachers who practice teaching courses in disciplines other than science and are qualified to teach science at the elementary level, which is what characterizes the current study.

METHODS

A mixed methods research design (quantitative/qualitative) was used in this study. It is appropriate to provide qualified teachers to teach science to express their perceptions and beliefs related to their self-efficacy in teaching science through quantitative measurement tools such as standardized scales. It also allows the use of qualitative measurement tools, such as interviews that clarify the nature of responses, understand results, and draw conclusions.

Participants

The study population consists of teachers in the Higher Diploma in Science program at Najran University during the academic year 2022. Due to the limited number and accessibility to all of them, all population was included in the study. **Table 1** shows that most sample members work in post-elementary schools (middle and secondary). Sixty percent of them have teaching experience of more than five years. The proportions of the variables of years of experience and scientific specialization for the bachelor's degree converged. This means that the sample is homogeneous by scientific background and teaching experience.

Tools of the Study

Self-efficacy scale for teaching science

To determine beliefs related to the ability to teach science, the Science Teaching Efficacy Belief Instrument Form B (STEBI-B) was used in this study. The scale was built on Bandura's view of self-efficacy, and the original version of this scale was prepared by Enochs and Riggs (1990). Then, it was re-evaluated by Bleicher (2004). This scale has been used to evaluate the self-efficacy of pre-service teachers in several studies (Bleicher & Lindgren, 2005; Finson et al., 2000; Morrell & Carroll, 2003; Mulholland et al., 2004; Palmer, 2006; Plourde, 2002; Tekkaya et al., 2004; Wingfield et al., 2000; Yılmaz & Çavaş, 2008). Among the Arab studies that used this scale were Abed (2009), El-Deghaidy (2006) and Hassouna (2009). The scale consists of (23) statements divided into two domains: The first deals with teachers' beliefs about the ability to carry out the required teaching behavior of Personal Efficacy Teaching Science (PSTE) and includes (13) statements that measure pre-service teachers' confidence in their ability to teach science. The second domain deals with the expectation of a positive impact on learning outcomes, Science Teaching Outcome Expectancy (STOE) and includes (10) statements that measure these teachers' belief in the usefulness of their teaching of science and its positive impact on their students. All statements are answered on a five-point scale: Strongly agree, agree, not sure, disagree, and strongly disagree. Values (5, 4, 3, 2, 1) were given respectively to the positive statements, whereas the values of the negative expressions were reversed. While the range of the scores for the first domain (PSTE) ranged from 13 to 65, the range for the second domain (STOE) ranged from 10 to 50 degrees.

Validity and reliability of the scale

When the "Scale of Beliefs Related to Self-Efficacy in Science Education" was prepared by Enochs and Riggs (1990), validity and reliability were extracted. The alpha value for its first domain was (0.90) and its second domain (0.76). The scale was also used

Table 2. Means and standard deviations for the level of personal science teaching efficacy (PSTE)

No.	Statement	Mean	Standard deviation	Degree
1	I will constantly try to find better ways to teach science.	4.73	.458	Very high
2	No matter how hard I try, I cannot teach science as efficiently as I teach my original majors.	3.73	1.100	High*
3	I know well the steps necessary to teach scientific concepts effectively.	4.33	.617	Very high
4	I think I will not be able to set up science experiments very efficiently.	3.93	.961	High*
5	In general, my science teaching will be ineffective.	3.73	1.335	High*
6	I believe that I have a good grasp of scientific concepts that enable me to teach science at the elementary level effectively.	4.00	.845	High
7	I will find it difficult to explain science experiments to students.	3.67	.816	High*
8	I will be able to answer students' questions related to science.	3.80	.941	High
9	I doubt whether I will have the necessary skills to teach science.	3.93	1.033	High*
10	If I had the choice, I would not invite the principal to evaluate my teaching in science.	4.13	1.125	High*
11	When a student has difficulty understanding a scientific concept, I will not be able to help him understand it.	4.40	.632	Very high*
12	When I teach science in the future, I will always welcome student questions.	4.87	.352	Very high
13	I do not know what I should do to interest students in studying science.	4.33	.900	Very high*
The first domain: personal science teaching efficacy (PSTE)		4.12	.427	High

(*) Negative statement

in many studies, such as Tekkaya et al. (2004), in which the alpha value for its first domain was (0.86) and its second domain (0.79), and Bleicher and Lindgren (2005), in which the alpha value for its first domain was (0.84) and for its second domain (0.76). The scale was codified in Arab environments, such as Abed (2009), El-Deghaidy (2006) and Hassouna (2009). The modifications to the statement were minor, and the translations did not differ noticeably. Reliability values were appropriate in all these studies. In Abed's (2009) study, for example, the reliability coefficient for the total scale was (0.86), its first domain (0.82), and its second domain (0.73). To suit the scale in the local context, the researchers developed the scale translated into Arabic in the aforementioned studies to suit the study environment. Then, the proposed version was presented to (9) faculty members with expertise and specialization in science education, teacher preparation, and educational measurement. They confirmed the appropriateness of the scale for the Saudi society, the study sample, and its subject while suggesting minor modifications that were considered. The scale was then applied to a survey sample consisting of (20) science teachers who were not members of the study sample. After that, the internal consistency coefficient was calculated using the Pearson correlation coefficient between the items and the total score of the domain to which they belong and between the items and the domain with the total score of the tool after reversing the negative items. It turns out that the values of these coefficients were statistically significant at a significance level of (0.01). Pearson correlation coefficients ranged between (0.990** - 0.995**), and all of them were significant at (0.01). Reliability coefficients were calculated on the domains of the self-efficacy scale in teaching science and the total score of the scale after reversing the negative items through the Cronbach alpha equation. The total score for the scale was (0.93), and the reliability coefficients were (0.89) for the first domain and (0.91) for the second domain. These reliability coefficients are high and appropriate for the study.

Personal interview card

To obtain an interpretation of the results reached by applying the self-efficacy scale in teaching science, interviews were conducted with students according to a card prepared for that purpose. Some aspects that explain the answers that teachers gave using the scale have been clarified. Therefore, the interview questions were developed in light of the responses of the teachers in the study sample to the scale statements. It is worth noting that the approval of the Scientific Research Ethics Committee at Najran University was obtained for the study tools before applying them to the sample on February 12, 2022. A written consent was also obtained from the study sample members to participate in the study.

RESULTS

Quantitative Results

The means, standard deviations, and rank were calculated for the responses of the study sample members on the first domain related to the teacher's confidence in his ability to teach science after reversing the negative items. According to **Table 2**, the results suggest that, overall, the teacher has a high level of personal science teaching efficacy (PSTE), as indicated by the mean score for the first domain being 4.12 with a standard deviation of 0.427. This result indicates a generally positive and confident perception of the teacher's ability to teach science effectively at the elementary level.

The teacher is highly confident in constantly seeking better ways to teach science (Statement 1), understanding the steps necessary to teach scientific concepts effectively (Statement 3), and having a good grasp of scientific concepts for effective teaching (Statement 6). There is a strong belief in the ability to welcome student questions and effectively answer them (Statement 12). The teacher expresses confidence in dealing with challenging situations, such as helping students understand difficult scientific concepts (Statement 11). The teacher acknowledges an understanding of what to do to interest students in studying science (Statement 13).

There are a few areas of concern where the teacher's confidence is relatively lower. These include doubts about teaching science as efficiently as the original majors (Statement 2), setting up science experiments efficiently (Statement 4), and concerns

Table 3. Means and standard deviations for the impact of science teaching outcome expectancy (STOE)

No.	Statement	Mean	Standard deviation	Degree
1	When a student performs better than usual in science, it is often due to the teacher putting in more effort.	4.33	.816	Very high
2	When students' grades improve in science, it is often because the teacher is using more effective teaching methods.	4.47	.516	Very high
3	If students achieve low in science, it is often due to the use of ineffective teaching methods.	3.20	1.265	Medium
4	The weaknesses of the student's scientific background can be overcome by good teaching.	4.27	.884	Very high
5	In general, the teacher cannot be blamed for his students' low achievement.	2.87	1.246	Medium*
6	When an underachieving student improves in science, it is often due to extra attention given by the teacher to that student.	4.07	.884	High
7	The additional effort that the teacher makes in teaching science produces only a limited improvement in the achievement of some students.	3.40	1.121	Medium*
8	The teacher is usually responsible for his students' achievement in science.	3.13	1.246	Medium
9	There is a close relationship between students' achievement in science and their teachers' effectiveness in teaching science.	4.20	.775	High
10	If parents notice that their children are showing more interest in studying science, it is likely because of their teachers' performance.	4.20	.676	High
The second domain: expecting the impact of Science Teaching Outcome Expectancy (STOE)		3.81	.560	Very high
The total degree of self-efficacy in teaching science		3.99	.407	High

about the general effectiveness of science teaching (Statement 5). There is some apprehension about explaining science experiments to students (Statement 7) and doubts about having the necessary skills to teach science (Statement 9). The teacher is somewhat hesitant about inviting the principal to evaluate their science teaching (Statement 10).

Overall, while the teacher demonstrates a strong belief in their ability to teach science effectively, targeted support and professional development in specific areas of concern could contribute to a more well-rounded and confident science teaching approach.

In addition, the means, standard deviations, and rank were calculated for the responses of the study sample members on the second domain related to the degree of expectation of impact on the outcomes of science teaching from the perspective of student teachers at Najran University after reversing the negative items. **Table 3** presents the results.

The results of the Impact of Science Teaching Outcome Expectancy (STOE) assessment provide insights into the teacher's beliefs regarding the influence of teaching practices on students' performance in science. The second domain, focusing on the expectation of the impact of science teaching outcomes, yielded a mean score of 3.81 with a standard deviation of 0.560, indicating a very high level of confidence.

The teacher strongly believes that when students perform better in science, it is often attributed to the teacher putting in more effort (Statement 1) and using more effective teaching methods (Statement 2). There is confidence that weaknesses in students' scientific backgrounds can be overcome by good teaching (Statement 4), and there is a close relationship between students' achievement in science and teachers' effectiveness (Statement 9). The teacher acknowledges their role in influencing students' interest in studying science, with a belief that improved interest is likely due to effective teaching (Statement 10). When an underachieving student improves in science, the teacher attributes it to the extra attention given to that student (Statement 6).

There are some statements where the teacher expresses a more moderate degree of confidence. For instance, there is a belief that the additional effort made by the teacher in teaching science produces only limited improvement in the achievement of some students (Statement 7), and the teacher is not entirely responsible for students' low achievement in science (Statement 8). The statement asserting that the teacher cannot be blamed for students' low achievement in general (Statement 5) receives a lower degree and might be an area of potential concern.

Overall, the teacher exhibits a positive outlook on their impact on students' science achievement, with a very high expectation of the influence of effective teaching methods. While there are some areas of moderate confidence, these could be explored further to identify potential factors influencing the teacher's perception of limited impact or responsibility. The combined total degree of self-efficacy in teaching science, including both personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE), is 3.99, indicating a high overall confidence level.

In conclusion, the teacher demonstrates a robust belief in the positive impact of effective teaching on students' science performance. Addressing any concerns and exploring the nuances of perceived limitations could contribute to a more comprehensive understanding of the teacher's self-efficacy in the realm of science education.

Moreover, Mann-Whitney's test was used to show the significance of the differences between the mean ranks of the responses of the study sample members regarding the level of teachers' self-efficacy in teaching science according to the variables of scientific specialization, educational stage, and teaching experience. **Tables 4, 5, and 6** depicts the results.

Table 4 shows that for the PSTE domain, there is no statistically significant difference in the level of personal science teaching efficacy between teachers specializing in Islamic and social studies and those specializing in Arabic language (Sig. = 0.181 > 0.05). For the STOE domain, there is no statistically significant difference in the expectations of science teaching outcomes between teachers specializing in Islamic and social studies and those specializing in Arabic language (Sig. = 0.728 > 0.05). For the total degree of self-efficacy in teaching science, there is no statistically significant difference between teachers specializing in Islamic and social studies and those specializing in Arabic language (Sig. = 0.385 > 0.05).

Table 4. Mann-Whitney test for the significant differences between the mean ranks of the responses of the study sample members regarding the level of self-efficacy among teachers to teach science according to the specialization variable

Domain	Specialization	No.	Means	Sum of means	U	Sig.
The first domain: Personal science teaching efficacy (PSTE)	Islamic and social studies	7	6.36	44.50	16.500	.181
	Arabic language	8	9.44	75.50		
	Total	15				
The second domain: Expecting the outcomes of science teaching (STOE)	Islamic and social studies	7	8.43	59.00	25.000	.728
	Arabic language	8	7.63	61.00		
	Total	15				
The total degree of self-efficacy in teaching science	Islamic and social studies	7	6.93	48.50	20.500	.385
	Arabic language	8	8.94	71.50		
	Total	15				

Table 5. Mann-Whitney test for the significant differences between the mean ranks of the responses of the study sample members regarding the level of self-efficacy among teachers to teach science according to the educational stage

Domain	Educational stage	No.	Means	Sum of means	U	Sig.
The first domain: Personal science teaching efficacy (PSTE)	Elementary	5	9.40	47.00	18.000	.389
	Intermediate & secondary	10	7.30	73.00		
	Total	15				
The second domain: Science teaching outcome expectancy (STOE)	Elementary	5	7.50	37.50	22.500	.759
	Intermediate & secondary	10	8.25	82.50		
	Total	15				
The total degree of self-efficacy in teaching science	Elementary	5	9.20	46.00	19.500	.462
	Intermediate & secondary	10	7.40	74.00		
	Total	15				

Table 6. Mann-Whitney test for the significant differences between the mean ranks of the responses of the study sample members regarding the level of self-efficacy among teachers to teach science according to years of experience

Domain	Experience	No.	Means	Sum of means	U	Sig.
The first domain: Personal science teaching efficacy (PSTE)	- 5 years	6	9.33	56.00	19.000	.344
	5 years or more	9	7.11	64.00		
	Total	15				
The second domain: Expecting the outcomes of science teaching (STOE)	- 5 years	6	8.58	51.50	23.500	.679
	5 years or more	9	7.61	68.50		
	Total	15				
The total degree of self-efficacy in teaching science	- 5 years	6	9.58	57.50	17.500	.262
	5 years or more	9	6.94	62.50		
	Total	15				

In all three domains (PSTE, STOE, and total degree of self-efficacy), the Mann-Whitney Test results indicate no evidence to reject the null hypothesis, suggesting no statistically significant difference in the level of self-efficacy among teachers to teach science based on their specialization in either Islamic and social studies or Arabic language.

According to **Table 5**, for the PSTE domain, there is no statistically significant difference in the level of personal science teaching efficacy between teachers at the elementary stage and those at the intermediate and secondary stages (Sig. = 0.389 > 0.05). For the STOE domain, there is no statistically significant difference in the expectations of science teaching outcomes between teachers at the elementary stage and those at the intermediate and secondary stages (Sig. = 0.759 > 0.05). For the total degree of self-efficacy in teaching science, there is no statistically significant difference between teachers at the elementary stage and those at the intermediate and secondary stages (Sig. = 0.462 > 0.05).

In all three domains (PSTE, STOE, and total degree of self-efficacy), the Mann-Whitney Test results indicate no evidence to reject the null hypothesis, suggesting no statistically significant difference in the level of self-efficacy among teachers to teach science based on the educational stage (elementary vs. intermediate & secondary).

Table 6 shows that for the PSTE domain, there is no statistically significant difference in the level of personal science teaching efficacy between teachers with less than 5 years of experience and those with 5 years or more of experience (Sig. = 0.344 > 0.05). For the STOE domain, there is no statistically significant difference in the expectations of science teaching outcomes between teachers with less than 5 years of experience and those with 5 years or more of experience (Sig. = 0.679 > 0.05). For the total degree of self-efficacy in teaching science, there is no statistically significant difference between teachers with less than 5 years of experience and those with 5 years or more of experience (Sig. = 0.262 > 0.05).

In all three domains (PSTE, STOE, and total degree of self-efficacy), the Mann-Whitney Test results indicate no evidence to reject the null hypothesis, suggesting no statistically significant difference in the level of self-efficacy among teachers to teach science based on their years of experience (less than 5 years vs. 5 years or more).

Qualitative Results

The researchers used an interview card prepared in light of the results of applying the self-efficacy scale in teaching science. Ten students responded to the invitation to participate in the interview after being informed of its purpose. The interview was conducted after they completed the program courses. Below are the student's responses to the interview questions:

Question1 Teachers have had many opportunities to transfer to other specializations through the Optimal Investment Program. What are your motivations for applying for this program in general?

Students Teachers agreed that their goal was to gain some of the benefits of the program, especially increased opportunity for external transportation to their family's home areas and increased professional development hours.

Question2 How were you nominated to major in science? Why did you choose it among other specializations?

Students The nomination was made by the Department of Education from among ten other majors, and it was not of their choice. The nomination was subject to central controls in the Education Department.

Question3 After you graduate from the program, how do you describe its benefit in qualifying you to teach science as a new specialty for you?

Student1 It was wonderful, as she was familiar with all the topics of the specialty.

Student2 The benefit is great, and I believe that this study, along with good preparation for the subject, will make it easier for me and for the teachers who specialize in this field.

Student 3 I did not benefit from the program fully.

Students Good, wonderful, excellent, and useful.

Question4 Through your academic study of specialized science courses, describe the extent to which your understanding of scientific phenomena and concepts has changed, and cite examples of concepts that you had wrong.

Student1 Before specializing in the program, I undoubtedly had some misconceptions about some scientific concepts. I was not a specialist in this field, and of course, the program helped us correct that, whether through lectures or in the laboratory, examples of this include the concepts of speed, acceleration, force, motion, and others.

Student2 I improved a lot and learned a lot from phenomena and concepts.

Student3 Most of the concepts I took in the diploma were new and I had not studied them before.

Student4 Through my study of science, many concepts and phenomena were studied, such as the universe, objects, and earthquakes.

Student5 The change was in some concepts, especially in biology, earth science, and space... and I had wrong concepts, but after studying and benefiting from this program, many of my concepts changed.

Question5 When a teacher expresses high confidence in his ability to teach a course while his level of achieving the scientific concepts contained in this course is low, how do you explain that?

Student1 The teacher here may be under the illusion that achieving scientific concepts in the course is not that important for achieving educational goals.

Student2 Maybe he thinks this is unnecessary.

Student3 A mistake and he must develop himself further.

The responses of some came in the form of suggestions such as:

Enrolling in additional courses to raise his level.

Student5 Perhaps this teacher did not take advantage of the time and took enough of the material or the program in general, but if the teacher compensates for that by preparing and researching well for each lesson, he will be able to convey the information to the learner as little as possible.

Student6 Good.

Student7 It is wrong to teach a subject in which one does not specialize.

Question6 How capable are you now, after graduating from the program, to teach science at the elementary level?

Student1 After looking at the subjects of the elementary stage in science, and what was studied in the program, I will be able to teach the subject, especially since the subjects of the program were extensive and specific about the elementary stage and more than that.

Others After the program we were able to teach science, while one student stated that he “could without needing a diploma.”

Another described his ability as “good” while another defined it as “medium to high.”

Question7 Do you think that a teacher’s confidence in his ability to teach a subject necessarily means expecting high learning outcomes among his students?

Student1 The teacher is one of the elements in the school that helps students achieve high learning outcomes. There is the curriculum and the school environment, so the teacher’s confidence in his ability to teach a subject is part of other parts that help raise students’ learning outcomes.

Others Yes.

Student2 A large percentage of no.

Student3 Maybe...but the teacher must take into account the condition of the learners and the appropriate teaching method to raise their level.

Question7 If you were given a choice, now that you have graduated from the program, between teaching science or teaching the subject of your main specialty, which would you choose? And why?

The teachers unanimously preferred to teach their main specialization and justified this by having previous experience for several years. One of them welcomed teaching science alongside his specialty subject if the school needed it.

Question9 In your opinion, what is the impact of the course of study in the secondary stage (scientific/literary), the years of experience, and the educational stage in which the diploma-graduate teacher works on his ability to teach science in the elementary stage?

Student Years of experience may have an effect, and as for the course of study in secondary school, it may not constitute an effect because most of the subjects related to the secondary stage in chemistry, physics, and biology were studied in the program.

Another The science diploma is supposed to be for scientific majors only,

while others believed that the years of experience and the course of study at the secondary level do not affect or that their impact is limited.

DISCUSSION

The study identified the degree of self-efficacy in teaching science at the elementary level among student teachers in the Higher Diploma in Science at Najran University. The results showed that the degree of personal science teaching efficacy among the study sample was “high”. It was also found the total degree of science teaching outcome expectancy (STOE) was “very high”. This result means that the level of the teacher’s influence on students’ achievement is not as great as the teachers see in the study sample. In comparison with the results in general, it is clear that although the total degree of self-efficacy in science teaching came with a “high” degree, with an arithmetic mean (3.99), the expressions linking students’ achievement with the teacher’s performance received a lower degree (medium). Thus, the general result of these results agrees with those of previous studies, such as Abed (2009), Amr (2012), Ecevit and Kingir (2022), Hopkins (2007), Jale and Boone (2002), Koç (2006), Tekkaya et al. (2004), and Yılmaz and Çavaş (2008). Teachers in all of these studies expressed a degree ranging from medium to high in their beliefs about their level of self-efficacy in teaching science, despite the different environments of the studies and the long times for conducting them. This result may be attributed to the one human nature that unites teachers and is evident in the tendency of all of them, regardless of their cultures and preparation programs, to have confidence in success in teaching science and to believe in their ability to bring about the desired change among their students, even to a moderate degree. This result is reinforced by the fact that the teachers in this study have sufficient teaching experience that gives the teacher confidence in their success in influencing their students and making a clear change in their achievement.

In addition, there were no significant differences between the average responses of the study sample members regarding the level of self-efficacy in teaching science attributable to scientific specialization. This result differs from that of Saracaloğlu and

Yenice's (2009) study, which found an effect of the specialization variable. The results of the current study are consistent with those of Al-Saghir (2009), who did not find an effect of the specialization variable, and Al-Salhi (2013), who concluded that the teacher's specialization or the subject he teaches does not significantly affect teaching efficiency. This result means that teaching self-efficacy is general; anyone who has high competence can teach all courses with the same level of self-confidence and the ability to influence student achievement. The difference in the result here with Saracaloğlu and Yenice's (2009) study may be due to the different environments in which the study was conducted. The agreement with the results of other studies can be justified by the convergence of the Arab and local environments in terms of teacher preparation programs. Perhaps the reason is due to the prevailing belief that the teacher in the elementary stage should be able to carry out the task of teaching any subject.

Moreover, there were no significant differences between the mean responses of the study sample about the level of self-efficacy in teaching science due to the educational stage variable. Thus, the result differs from those of Al-Salhi's (2013) study, which showed a high level of belief in self-efficacy in teaching among elementary school teachers compared to middle and secondary school teachers. It also differs from that of Khalayleh (2011), who found that there are statistically significant differences in male and female teachers' estimates of their self-efficacy due to the variable of the school stage in favor of the elementary stage teachers. The difference between the results of the current study and these studies may be due to the fact that all teachers in the study sample were prepared to teach at all levels of education. This means that the teacher is qualified to work at any stage to which he is directed, which makes the teachers' responses similar despite the different educational stages in which they work.

Furthermore, there were no significant differences between the mean responses of the study sample members regarding the level of self-efficacy in teaching science due to teaching experience. This result is consistent with the studies of Al-Saghir (2009), Loach (2021) and Saracaloğlu and Yenice (2009). The studies have shown that there is an impact of teaching experience on self-efficacy beliefs in teaching. The result also aligns with that of the study by Luft et al. (2022), which concluded that teachers spending their initial five years in their professional careers do not undergo significant changes in their beliefs over time, despite substantial changes in their educational content knowledge and some of their teaching practices. However, the result differs from that of Amr (2012), in which the differences were in favor of teachers with (5-10) years of experience. It also differs from those of Saleh (2005), which found differences in favor of in-service teachers. In addition, the result did not intersect with that of Al-Salhi's (2013) study, which found a positive effect of years of experience on self-efficacy, and that of Al-Kathiri's (2011) study, which was in favor of the most experienced teachers (10 years or more). Moreover, the result is inconsistent with that of Khalayleh (2011), who found an effect of years of experience among teachers, and that of Waeli and Aladdin (2013), whose results showed that there are statistically significant differences in teachers' self-efficacy due to levels of educational experience in favor of fewer than five years. The researchers may attribute the result of the comparison with the aforementioned studies to the fact that all teachers in the study sample are well-experienced in teaching and practicing the teaching profession. Therefore, no significant differences appeared for this variable as they appear to be one category, which is not present in other studies that compared pre-service teachers with others during service, in which differences emerged between the two groups.

The qualitative findings complement the quantitative results by revealing that most of the teachers in the study sample believe in their ability to teach science at the elementary level. However, they still prefer to teach the subjects of their original major because of the confidence they gained as a result of experience and practice. None of them would have wanted to change their teaching career path had it not been for the temptations that accompanied the program aimed at rehabilitating them, the most important of which was increasing the opportunity for the program graduate to be transferred to his area.

CONCLUSION

This study dealt with self-efficacy in teaching science, and the concept of "competence" in psychology goes back to the social learning theory of the Canadian scientist Albert Bandura. The study assumed that an individual's beliefs related to his ability to perform a job affect how he performs that job. Despite the short qualification period (two semesters), the results of the study, based on the application of a standardized measure of self-efficacy in teaching science and interviews with teachers, were consistent with the principles of Bandura's theory. She stressed the need to pay attention to the emotional aspects of the teacher. Teachers expressed a high degree of confidence in their ability to teach science at the elementary level, with a lower degree regarding the impact on science learning outcomes, based on their previous experience in teaching other subjects, and the knowledge and skills they acquired during their studies in the Higher Diploma in Science program. Based on the results of the study, and in light of the theoretical framework and previous studies, it is recommended that self-efficacy for teaching science be given more attention when preparing science teacher preparation programs. The level of readiness to teach science must also be explored, and personal science teaching efficacy must be measured among those wishing to join science teacher preparation programs, or programs to qualify non-specialists to teach science because of its importance in predicting self-efficacy for teaching science. In addition, there is a need to include educational courses or activities in science teacher preparation programs aimed at enhancing the self-efficacy of science teaching among pre-service teachers. Moreover, those holding a science diploma must be enrolled in more training programs to cover the cognitive and educational aspects that graduates of the program have not acquired as required to raise their efficiency in teaching science.

In addition to what this study addressed, it is proposed to conduct studies on developing self-efficacy for teaching science among teachers through teaching strategies that are appropriate for science specialists and other non-specialists or those who have been qualified to teach science through short programs. There is also a need to conduct longitudinal follow-up studies on the level of self-efficacy for teaching science among teachers who graduated from the pre-service science program and track it during the first years of practicing science teaching. In addition, a study that deals with the comparison between male and female

teachers' self-efficacy in teaching science is suggested. Finally, the emotional dimension in teaching science among science teachers and its impact on their efficiency and teaching performance should be examined.

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