Journal of Positive School Psychology http://journalppw.com
2023, Vol. 7, No. 4, 892-913

Investigating The Relationship Between Female Teachers' Self-Efficacy And Their Practice Of Next Generation Science Standards

Essa A. Alibraheim[1], Thekriat S. Almubayreek[2]

[1] Assistant Professor, Department of Curriculum and Instruction, College of Education, Imam Abdulrahman Bin Faisal University, P.O. Box 2375, Dammam 31451, Saudi Arabia, ealibraheim@iau.edu.sa
[2]Graduate student, College of Education, Imam Abdulrahman Bin Faisal University

Abstract

The study sought to investigate the relationship between female teachers' self-efficacy and their practice of science standards for the next generation. The descriptive approach was used, where a questionnaire was distributed to 67 science teachers at the middle school level in Khobar, Saudi Arabia. The results showed that the level of self-efficacy of the participating female teachers was high (average = 3.761), and their practice of Next Generation Science Standards was also high (average = 3.871). In addition, there are no statistically significant differences in the level of self-efficacy or the practice of Next Generation Science Standards according to the variables of the years of experience and the academic major. The results also illustrated that there is a positive correlation at the 0.01 level between self-efficacy and the practice of the standards among the participating female teachers. The study recommends the importance of integrating the sources of self-efficacy related to the practice of Next Generation Science Standards in the teacher training programs because of its benefit in the teachers' practice of those standards. The current study also suggests conducting more future studies on the effectiveness of training programs based on Next Generation Science Standards and their impact on the development of self-efficacy and science teaching for female middle school teachers.

Keywords: Next Generation Science Standards, Self-efficacy, Female Science Teachers, Teaching science based on standards, middle school level

Introduction:

Science education is one of the important branches of pedagogy that have been focused on in this era. This is evident in the different education trends, which have made science an important branch when merging several disciplines, such as STEM, STEAM, and STREAM. STEM stands for integrating Science, Technology, Engineering, and Mathematics subjects into the curriculum to prepare learners with the individual life skills required for twenty-first century jobs (Roza et al., 2023). STEAM, this term refers to the addition of Arts to the four elements of STEM, because of the importance of arts in developing creative and innovative thinking among learners, and providing learners with moral values and responsibility (Ozkan, 2022). STREAM refers to the addition of Reading to the five elements of STEAM, due to the importance of reading in discovering new knowledge and developing critical creative thinking among learners (Nuangchalerm, 2020). It seems clear from previous modern educational

trends that science is an important and essential component.

Therefore, the development of science courses and curriculum are a necessary requirement in order to improve student learning. Saudi Arabia is one of the many countries that have developed their curriculum in science education at all levels, based on the latest contemporary global trends (Alhomairi, 2018). In order to ensure the achievement of the objectives of science education at the various educational stages, it is necessary that this education be based on standards that summarize best practices and experiences based on the results of educational research in teaching and learning science (Sundberg & Wahlstrom, 2012). Therefore, developed countries, especially the United States of America, have established specific and clear-cut scientific standards for science education.

In this regard, the Next Generation Science Standards (NGSS) represent the most significant development in science education in the United States of America (Shapiro, 2018). Since the emergence of these standards, many countries in the world have taken care to apply these standards, especially in the framework of the integrated education approach, STEM (Shahat et al., 2022).

The NGSS have been prepared with the goal of helping all students learn science, promoting their participation, and engaging them in authentic science learning experiences (Lilly et al., 2022; McCormick, 2019). These standards have altered many of the students' practices. Instead of memorizing scientific facts and terminology, what is required is understanding, analyzing, and interpreting them scientifically based on evidence. It also shifted from reliance on the teacher as the sole source of information to considering him/her as a guide, and recognizing that students are partners in the learning process (Altamimi, 2021).

Given the vital role of the science teacher in student teaching and learning, it is necessary to investigate the extent to which teachers are able to apply and practice the NGSS successfully. In addition, there is a need for more research about how teachers can practice these standards in the classrooms (Christian et al, 2021). Science educators also need to accept the fact that these standards require them to shift their educational paradigm (NGSS Lead States, 2013). Therefore, it is critical to investigate factors that may enhance teachers' ability to practice NGSS. Perhaps the most prominent of these factors is the self-efficacy of teachers with regard to teaching science.

Self-efficacy refers to a person's belief that he/she can move forward in performing the tasks assigned to him/her and overcome the problems that he/she encounters in doing so (Yulianti et al., 2021). According to Meiyanti et al. (2022), teachers' self-efficacy increases their effectiveness of teaching practices. Several studies (e.g., Okoro et al., 2022; Siaw et al., 2022) confirm that teachers' self-efficacy is not limited to improving their performance only, but also extends to indirectly affecting the performance of their students.

Therefore, the current study focuses on answering the main question, "What is the relationship between the self-efficacy of middle school science teachers and their practice of NGSS?" The study addresses the following sub-questions:

1. What is the level of self-efficacy of middle school science teachers?

2. What is the level of science teachers' practice at the middle school level of NGSS?

3. Does the level of self-efficacy of science teachers at the middle school level differ according to the two variables (years of experience - academic major)?

4. Does the level of science teachers' practice of NGSS at the middle school level differ according to the two variables (years of experience - academic major)?

5. Is there a correlation between the self-efficacy of science teachers at the middle school level and their practice of NGSS?

6. Are there statistically significant differences between middle school female science teachers with high and low self-efficacy in NGSS practice?

Theoretical Framework

Self-efficacy

The term self-efficacy refers to beliefs about an individual's ability to take actions necessary to achieve specific accomplishments (Bandura, 1986; Bandura, 1997; Bandura et al., 1997). Self-efficacy is defined as the individual's self-conviction of his/her ability to perform the task entrusted to him/her, and his/her sense of his/her ability to overcome the problems that he/she may encounter (Younes, 2018).

Bandura's social cognitive theory serves as the theoretical basis for the concept of self-efficacy. This theory defines how individuals acquire cognitive structures, tendencies (emotional, social, and cognitive), and behavioral competencies (Bandura, 1986). According to Bandura (1995), human achievement in general requires an optimistic sense of personal competence and positive beliefs in one's ability to achieve desired results. Teachers' beliefs about their personal competence influence their general attitudes towards the educational process and towards their teaching activities (Bandura, 1995). Teachers with high self-efficacy believe that difficult and challenging students can be taught with more effort and appropriate methods.

According to Bandura (2012), people's beliefs about their abilities grow and develop through four main modes, which are active mastery experience, vicarious experience, verbal persuasion, and physiological and affective states. These four main ways are known as the sources of self-efficacy. The mastery experiences are the most influential sources of self-efficacy because they provide the most authentic and reliable evidence of whether an individual is capable of doing all they can to succeed. Successes build a firm belief in one's personal competence, while failures establish a sense of distance from ability and competence. Moreover, people's self-efficacy is influenced in part by vicarious experiences by modeling the accomplishments achieved. Therefore, modeling is another effective tool for enhancing a sense of personal efficacy. The greater the similarity (with models), the greater the persuasive power of the successes and failures of these models (Bandura, 1995). In addition, social persuasion and encouragement is another means of reinforcing people's beliefs in their abilities to achieve the goal they seek. It is possible to maintain a sense of competence, especially when experiencing difficulties, if there are other people important to the individual who express belief in his/her abilities, as opposed to if they express skepticism about him/her (Bandura et al., 1997). The final source of self-efficacy is the psychological and emotional state of the individual. People depend, in part, on their psychological and emotional states in judging their abilities (Bandura, 1995). People are more likely to expect success when they are not surrounded by unpleasantness and are not highly stressed and agitated. In fact, the intensity of physical and emotional reactions is not important in itself, but how they are understood and interpreted (Bandura, 1995).

Practice of Next Generation Science Standards

NGSS represents the outcome of more than three decades of efforts to advance science education in the United States of America (Mercadante, 2017). These standards urge a fundamental transformation and development in science education, where they benefit from the latest research findings on how science is learned (Scannell, 2019). NGSS was prepared through a collaborative process involving 26 US states, as

well as the US National Research Council (NRC), the National Science Teachers Association (NSTA), the American Association for the Advancement of Science (AAAS), and the US nonprofit Achieve (Scannell, 2019).

The NGSS document had three main components, namely Science and Engineering Practices (SEPs), Crosscutting Concepts (CCs), Disciplinary Core Ideas (DCIs). The interdependent integration of these three components represents the most significant shift in science education according to the framework presented by the US National Research Council (Krajcik et al., 2014). These three dimensions must be integrated into the performance expectations of students in science, and what they are expected to achieve and understand (Judson, 2022). The standards are formulated as performance expectations that indicate what students should know and what they should be able to do at the end of the educational process (Scannell, 2019).

The NGSS are defined as statements used as yardsticks to judge the quality of what students know, and what students can do in three complementary areas, which are science and engineering practices, crosscutting concepts, and disciplinary core ideas (Shouman, 2019). Scientific and engineering practices refer to the basic practices that scientists employ when they conduct scientific research and design models and theories about the natural world. Also, attention is paid to integrating engineering into science education by including "design" as a focus in science education, such as designing experiments and models of all kinds (Hassanein, 2016). These practices were defined in eight practices: 1) asking questions and defining the problem, 2) using and developing models, 3) planning, executing and conducting an investigation, 4) collecting, analyzing and interpreting data, 5) immersing oneself in scientific arguments using evidence, 6) obtaining information and then evaluating it, 7) searching for solutions and interpretations, and 8) activating the use of mathematics and visual thinking. Moreover, crosscutting concepts mean the way the four disciplines of science (Physical Sciences, Life Sciences, Earth and Space Sciences, and Engineering Design) are interconnected to help students explore the relationships and interdependencies between those disciplines (Hassanein, 2016). Finally, the disciplinary core ideas refer to the main ideas related to the fields of science, which help learners to expand the study of the fields, and to show the relationships between them. The basic ideas, which number forty-four, were divided among four main areas: 1) physical sciences, such as structure and properties of matter, 2) life sciences, such as relationships in environmental systems, 3) earth and space sciences, such as the water cycle in nature, 4) Engineering sciences and technology and applications of science such as the impact of science, engineering and technology on society and the natural world (NGSS Lead States, 2013).

Conceptual Framework

Although the structure of self-efficacy in relation to science education has received research attention during recent decades, it is notable that few studies have focused on self-efficacy in relation to the practice of NGSS. This may be due to the recent emergence of the NGSS, which were released in 2013. By reviewing the educational literature, few studies were found that dealt with this aspect, such as the study of Shahat et al. (2022) that examined the self-efficacy beliefs of pre-service science teachers with regard to teaching science through engineering design processes, the study of Dennewiz (2020) that focused on science teachers' perceptions of self-efficacy in teaching science and engineering practices according to the NGSS, the study of Kaya (2020) that investigated the development of self-efficacy beliefs about science and engineering practices for pre-service science teachers, and the study of Romanillos (2017) that

focused on developing the self-efficacy of science teachers with regard to the scientific practices of their students.

Therefore, the current study sought to design a conceptual framework for the study of self-efficacy and its relationship to the practice of NGSS. This design is intended to support students' desired science learning outcomes described in the performance indicators that accompany the NGSS. These indicators indicate the importance of the science teacher's practice of the appropriate teaching behavior represented in the practices of NGSS. This behavior can be embodied through practices undertaken directly by the teachers or practices and activities performed by their students commissioned by them. This behavior is directly influenced by the beliefs of self-efficacy of science educators with regard to teaching science in general and the practice of NGSS in particular.

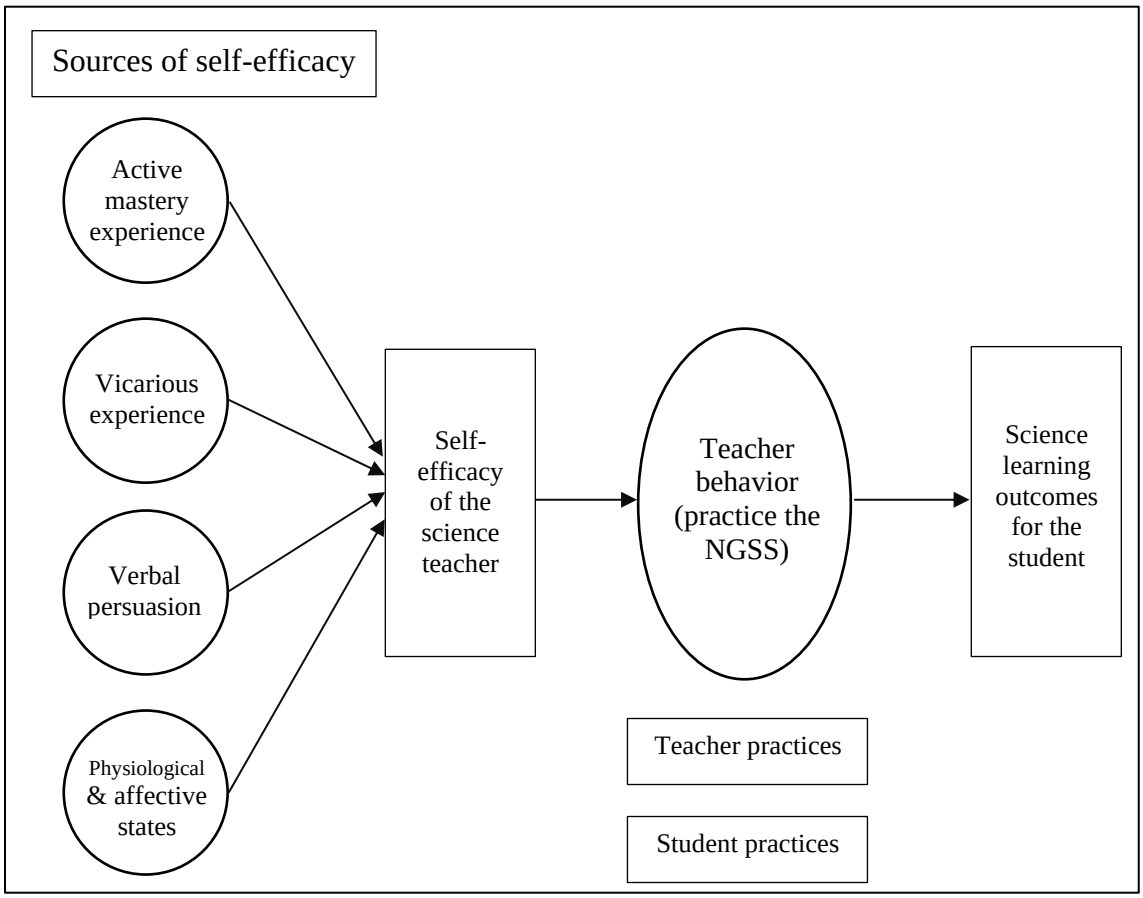

Figure 1: The conceptual framework of the current study

Figure 1 indicates that the science teacher's teaching self-efficacy is shaped by four sources identified in Bandura's social cognitive theory. The first source is active mastery experience, which are performance achievements or actual practice that the teacher succeeds in teaching science and achieving positive results for student learning. The second source is represented in vicarious experience or the science teacher's observation of other teachers who succeed in applying advanced teaching strategies and achieve positive results through them. The third source, verbal persuasion, is the positive feedback that the teacher gets on his/her performance, whether from his/her colleagues or supervisors, which represents an encouragement

to him/her for more effective practices. The fourth source is represented by positive affective states, such as the teacher's sense of a positive teaching climate and close cooperation with other teachers in applying teaching practices necessary to improve student learning outcomes. Based on Figure 1, the current study hypothesizes that there is a close relationship between self-efficacy related to science teaching and its various sources and teachers' practice of NGSS.

Literature Review

The literature review indicates that there are few studies that have examined self-efficacy and NGSS together. The study of Shahat et al. (2022) aimed to reveal the self-efficacy beliefs of pre-service science teachers in the Sultanate of Oman regarding science teaching through the engineering design processes contained in the NGSS. To achieve the objectives of their study, the descriptive approach was used, and a questionnaire was distributed to 73 students from Sultan Qaboos University. The results showed that the participants had a high degree of belief in their success in teaching science through engineering design processes. The results also illustrated that there were no statistically significant differences in the self-efficacy beliefs of the participants according to the variables of gender and academic major. Alebous et al. (2019) revealed the effectiveness of a training program based on NGSS in developing scientific and engineering practices and self-efficacy among female science teachers in Jordan. The study was applied to a sample of 20 teachers using the pre-experimental method. Data were collected from the sample using an observational tool to measure the scientific and engineering practices of female teachers, and a questionnaire to measure their level of self-efficacy. The results showed that there were statistically significant differences in favor of the post-application of the training program, which means that there is a significant effect of the training program on the development of scientific and engineering practices and the self-efficacy of the participants.

Robertson (2022) endeavored to identify the effect of analyzing science education standards (including NGSS) on the self-efficacy of science teachers at the primary level in the United States of America. More specifically, Robertson's study examined whether providing formal training in science standards analysis could improve teachers' self-efficacy. The descriptive and predictive method was used, and data were collected from 96 male and female teachers. The results confirmed that receiving training on the analysis of science education standards, including the NGSS, had a positive and statistically significant effect on their self-efficacy. Griffin (2021) investigated the relationship between teacher self-efficacy and NGSS practices in the United States by using a mixed method approach. The participants were 90 science teachers at the secondary level, and the results indicated that there was a relationship between teachers' self-efficacy and their teaching practices of NGSS. The survey study of Akella (2016) aimed to investigate the impact of professional development on the self-efficacy of science teachers with regard to the practice of NGSS, specifically the practice of data analysis and interpretation. The study also sought to reveal teachers' perceptions of the obstacles that negatively affect their self-efficacy in applying NGSS. The study sample consisted of 19 teachers in the United States of America. The results indicated that the professional development sessions helped the teachers to improve their self-efficacy regarding the application of NGSS practices. The professional development sessions also resulted in teachers becoming aware of the many challenges that negatively affect their self-efficacy. Among the most prominent of these are the poor basic scientific and mathematical skills of students, challenges related to professional learning communities and cooperation between teachers, and the prevailing teaching culture. On

the other hand, Dennewitz (2020) attempted to reveal the perceptions of science teachers at the secondary level in the United States about their self-efficacy in planning and implementing lessons that focus on the integration approach in STEM and are based on scientific and engineering practices as one of the dimensions of NGSS. Data were collected from 10 teachers using personal interviews. Participants explained that the NGSS had affected their self-efficacy negatively in some respects due to their inability to bring about the educational transformations necessary to employ scientific and engineering practices. The results of the study also showed that there is a need to provide professional development programs for teachers aimed at bringing about the desired educational transformations for the successful employment of scientific and engineering practices. The results also indicated that teachers preferred to receive direct guidance from expert teachers who model the application of scientific and engineering practices. The study recommended holding workshops and professional development programs to train teachers to employ NGSS and bring about appropriate educational transformations to achieve this.

Methodology

The descriptive research method was used in the current study because it dealt with determining the levels of self-efficacy and practice of the NGSS, describing the correlation between them, and comparing the differences between the subjects under study. According to Calderon (2006), descriptive research is used to identify characteristics of a group of individuals or phenomena, measure trends, make comparisons, and describe relationships between them.

Study population:

Given that one of the main objectives of the Saudi's Vision 2030 is the empowerment of women (Saudi Press Agency, 2021), and in response to the recommendations of several conferences that indicated the importance of increasing research about women in the educational field (First conference for Saudi women's studies, 2018; Second conference of women's vision and ambition, 2020), the current study population was limited to all female middle school science teachers in the city of Khobar, Saudi Arabia, who work in public and private schools.

Study sample:

The sample of the study was chosen by the simple random method, where 67 female teachers voluntarily accepted to participate in this study. The characteristics of the participants with regard to the years of experience variable were as following: nine of them have less than five years of experience in education (13%), 14 of them have between five to 10 years (21%), 44 of them have more than 10 years (66%). The academic major variable of participants was as follows: 23 of them were in chemistry (34%), 35 of them were in physics (52%), and nine of them were in biology (13%).

Instrumentation:

To measure the self-efficacy of female teachers, a survey tool of Akella (2016) was used, which it measures the self-efficacy related to science teaching at both levels, middle and high school. The tool consists of 25 statements that measure teachers' self-efficacy in their ability to implement successful science teaching and influence the learning outcomes of their students. The tool is a five-point Likert scale with the following alternatives (strongly agree = 5, agree = 4, uncertain = 3, disagree = 2, strongly disagree =1). The total score that a female teacher can obtain in this tool ranges from 25 to 125, where the higher score reflects a higher level of self-efficacy beliefs among the female teachers while the lower score reflects a lower level of self-efficacy beliefs among the participants. Akella

(2016) has indicated the validity and reliability of this tool.

To measure the practice of NGSS among female teachers, a survey tool of Hayes et al. (2016) was used, which it measures the science educational practices consistent with the NGSS. This tool consisted of two main axes, one for the educational approaches or practices applied by the female teacher (10 statements) and the other for the practices applied by the female students under assignment or guidance from teachers (21 statements). The tool is a five-point Likert scale with the following alternatives (never = 1, rarely (a few times a year) = 2, sometimes (once or twice a month) = 3, often (once or twice a week) = 4, daily or almost daily = 5). The total score that a female teacher can obtain in this tool ranges from 31 to 155, where the higher score reflects a higher level of NGSS practice while the lower score reflects a lower level of NGSS practice among the participants. Hayes et al. (2016) has verified the validity and reliability of this tool.

Validity:

The content of the two survey tools was translated using a double method. First, the two tools were translated into Arabic. Then the Arabic versions were translated back into English. The two translations were compared, linguistic integrity was checked, and differences were compared. The final version of the two tools was presented to three language experts who are fluent in both Arabic and English for their feedback and guidance. The experts recommended making some minor adjustments for clarity and replacing some vocabulary. All comments have been taken into account.

Pilot study:

A pilot study was conducted on a sample of 30 female science teachers (not the study sample) to verify the clarity of the statements of the two translated survey tools and their linguistic integrity, and to calculate their validity and reliability.

Discriminant validity:

After collecting the data from the pilot study, the discriminant validity of the tool of self-efficacy from the viewpoint of science teachers tool was calculated by arranging the parameter scores in descending order. The female teachers of the upper group were identified, and they included eight participants (27%); the female teachers of the lower group also included eight participants (27%). An independent sample t-test was used to detect differences between the mean scores of the upper and lower groups (see Table 1).

Table 1: Results of the independent sample t-test of the self-efficacy tool

Self-Efficacy Tool	Groups	N	Average	Standard deviation	t	p
Total score	Upper	8	103.714	8.119	10.34	0.000**
	Lower	8	84.50	5.548		

Note. ** p-value is significant at 0.01

Table 1 shows that there are statistically significant differences at 0.01 level between the average scores of the upper and lower groups in favor of the parameters of the upper group ($t = 10.34$, $P<0.01$). This result confirms that the self-efficacy tool has a high degree of discriminant validity.

In addition, the discriminant validity of the NGSS practice tool was calculated by arranging the parameter scores in descending order. The female teachers of the upper group

were identified and included eight participants (27%); the female teachers of the lower group also included eight participants (27%). An independent sample t-test was used to detect differences between the mean scores of the upper and lower groups (see Table 2).

Table 2: Results of the independent sample t-test of the NGSS practice tool

NGSS practice Tool	Groups	N	Average	Standard deviation	t	p
First domain: Students' practices	Upper	8	88.32	7.087	18.304	0.000**
	Lower	8	43.18	10.958		
Second domain: Teachers' practices	Upper	8	47.21	1.475	11.399	0.000**
	Lower	8	28.68	8.477		
Total score	Upper	8	132.79	7.937	15.981	0.000**
	Lower	8	74.50	17.591		

Note. ** p-value is significant at 0.01

Table 2 shows that there are statistically significant differences at 0.01 level between the average scores of the upper and lower groups in favor of the parameters of the upper group ($t = 15.981$, $P<0.01$). This result confirms that the NGSS practice tool has a high degree of discriminant validity.

Reliability:

To verify the reliability of the self-efficacy tool, Cronbach's alpha coefficient was calculated.

Table 3: Cronbach's alpha coefficient of the self-efficacy tool

Tool of self-efficacy from the viewpoint of science teachers	Number of statements	Cronbach's alpha coefficient
	25	0.840

Table 3 indicates that the Cronbach's alpha coefficient of the whole self-efficacy tool was 0.840, which means this tool has a high degree of reliability. Thus, it is suitable for field use.

Moreover, to calculate the reliability of the NGSS practice tool, Cronbach's Alpha coefficient was used.

Table 4: Cronbach's alpha coefficient of the NGSS practice tool

Domains	Number of statements	Cronbach's alpha coefficient
Students' practices	21	0.965
Teachers' practices	10	0.951
Total	31	0.968

Table 4 indicates that the Cronbach's alpha coefficient of the whole NGSS practice tool was 0.968, which means this tool has a high degree of reliability. Thus, it is suitable for field use.

Statistical analysis:

SPSS version 25.0 was used to conduct the statistical analysis of the study data. Table 5 provides the statistical methods that were used to answer the study questions.

Table 5: Statistical methods that used in this study

Study questions	Statistical analysis methods
1. What is the level of self-efficacy of middle school science teachers?	Average, standard deviation, percentage, frequency
2. What is the level of science teachers' practice at the middle school level of NGSS?	
3. Does the level of self-efficacy of science teachers at the middle school level differ according to the two variables (years of experience - academic major)?	One way ANOVA
4. Does the level of science teachers' practice of NGSS at the middle school level differ according to the two variables (years of experience - academic major)?	
5. Is there a correlation between the self-efficacy of science teachers at the middle school level and their practice of NGSS?	Pearson correlation
6. Are there statistically significant differences between middle school science teachers, in regard to high and low self-efficacy in practicing NGSS?	Independent sample t-test

Results and Discussion:

Before presenting and discussing the results, a criterion for judging the results of the two study tools was calculated as follows:

Range = (largest value of answer - lowest value of answer) = 5 – 1 = 4.

Number of levels = 5 level.

Length of level = range ÷ number of levels = 4 ÷ 5 = 0.80

Accordingly, the criterion (0.80) was used (see Table 6).

Table 6: Criteria for judging the mean scores for study tools

Average		Level
From	To	

1	1.80	Very low
1.81	2.60	Low
2.61	3.40	Medium
3.41	4.20	High
4.21	5	Very high

First study question:

To answer the first study question, which stated, "What is the level of self-efficacy of middle school science teachers?" Descriptive statistics of the whole self-efficacy tool were calculated. Table 7 provides the results related to the level of self-efficacy of female science teachers in the middle school stage.

Table 7: Descriptive statistics of the self-efficacy tool

N	Average	Standard deviation	Level
67	3.761	1.022	High

Table 7 shows that the level of self-efficacy of science teachers in the middle school stage was high (average = 3.761). This result means that the female teachers had positive beliefs about their ability to teach science as scientific content, strategies, and procedures for teaching as well as their ability to manage the class and influence the learning of their students.

This result is consistent with Hakami (2019), which showed a high level of self-efficacy among female science teachers for the intermediate stage in Riyadh, and with Alazmy (2019), which showed a high level of self-efficacy among female science teachers for the primary stage in Kuwait. However, the finding of the current study contrasts with Bonet (2021), which showed that most of the American science teachers participating had a low level of self-efficacy beliefs with regard to investigative learning.

Bandura's social cognitive theory can be used to explain the high level of self-efficacy of female science teachers in the current study. Perhaps the active mastery experience experienced by science teachers during and before service through practical and field training, and through their teaching of science via the Internet during the period of the Corona pandemic, has caused an increase in their self-efficacy. This interpretation is consistent with findings from Pehlivan (2022) that mastery experiences were the most powerful contributor to science teachers' sense of self-efficacy. Additionally, the vicarious experience that the participants formed through observing successful female colleagues in the act of teaching may have helped them to enhance their self-efficacy. Furthermore, verbal persuasion that participants obtained during their career might be another source for reinforcing their self-efficacy beliefs, whether the reinforcement was gotten from their supervisors during teaching, or from the trainers who train them during their service. The female teachers may also have obtained verbal persuasion through their interaction with their fellow teachers, positive feedback from their students, or from parents.

Second study question:

To answer the second study question, which stated, "What is the level of science teachers' practice at the middle school level of NGSS?", descriptive statistics of the whole of the NGSS practice tool were calculated. Table 8 provides the results related to the level of female science teachers' practice at the middle school level of the NGSS.

Table 8: Descriptive statistics of the NGSS practice tool

Domains	N	Average	Standard deviation	Level
Students' practices	21	3.523	1.051	High
Teachers' practices	10	4.219	0.895	Very High
Total	31	3.871	0.973	High

Table 8 shows that the level of practice of the NGSS among science teachers in the middle school stage was high (average = 3.871). It is also shown that the level of practice of the NGSS among female science teachers in the first domain was high (average = 3.523), and the level of practice in the second domain was very high (average = 4.219). This result means that there is a high level of practice of NGSS among science teachers at the middle school level, whether in the domain of the practices implemented by teachers or the practices that teachers assign to their students (students' activities). In other words, from the female teachers' viewpoint, there is a high level of application of science teaching practices that are consistent with the NGSS, as reflected in the behavioral manifestations exhibited by teachers and their students.

This result was different from what was reached by Aljohani (2020), which showed a weakness in applying the standards of scientific and engineering practices, and the standards of comprehensive concepts during the teaching of science teachers at the intermediate level. Also, this result differed from the study of Lin (2020), which showed the weakness of the practical application of science teaching practices in the light of the NGSS among American teachers. In addition, there are the results of Alajmi (2019), which showed that the level of scientific and engineering practices in the light of NGSS among chemistry teachers at the secondary level in the city of Riyadh was weak.

Perhaps the reason for the high result of the practice of NGSS among the participants is due to the nature of the recent science curriculum in Saudi Arabia. Saudi Arabia started using a new curriculum in 2010; since then, Saudi Arabia continues to develop the curriculum on a semi-annual basis (Alharbi, 2018). These curricula require teachers to have more student-centered teaching practices and more activation of their active role in learning. Also, students are required to practice higher order thinking skills that are most consistent with what is required by the NGSS. For example, in the science book for intermediate first grade, there is a lesson "Designing a Car", "How Does an Engine Work?", and other topics related to the realities of the students' lives that encourage the application of the practices of NGSS. Additionally, the United Nations Educational, Scientific and Cultural Organization (UNESCO) has issued a book indicating the contribution of the Madrasati platform, which is a platform launched by the Saudi Ministry of Education due to the closures that occurred during the Corona pandemic, in raising the level of professional competence for teachers. The platform provided many educational tools to help plan and implement lessons according to scientific principles (Reimers & Opertti, 2021). The platform may

have had a role in increasing female teachers' practice of NGSS.

Third study question:

To answer the third study question, which stated, "Does the level of self-efficacy of science teachers at the middle school level differ according to the two variables (years of experience - academic major)?", the following two statistical hypotheses were tested:

1. There is no statistically significant difference at the 0.05 level between the average scores of female science teachers at the middle school level in the self-efficacy tool according to the variable of years of experience.

2. There is no statistically significant difference at the 0.05 level between the average scores of female science teachers at the middle school level in the self-efficacy tool according to the variable of academic major.

To answer the hypothesis 1, one-way ANOVA was used to reveal the differences between the mean scores of the participating teachers (see Table 9).

Table 9: Results of one-way ANOVA for the self-efficacy tool according to years of experience (N = 67)

Variance source	Sum of squares	df	Mean square	F	p
Between	37.759	2	108.879		
Within	6975.23	64	108.988	0.173	0.841
Total	7012.98	66			

Table 9 indicates that there is no statistically significant difference at the 0.05 level (F = 0.173, p = 0.841) between the average scores of science teachers at the middle school level on their self-efficacy according to the variable of years of experience. Thus, hypothesis 1 is accepted, which states that "There is no statistically significant difference at the 0.05 level between the average scores of female science teachers at the middle school level in the self-efficacy tool according to the variable of years of experience."

Consequently, this result explains that the difference in the years of experience of the participants did not have a significant effect on enhancing or decreasing their levels of self-efficacy. This finding may contradict with what the literature has shown that teachers' self-efficacy beliefs are strengthened over time in the teaching profession, and that levels of self-efficacy are low among novice teachers compared to more experienced ones (Ibrahim, 2003; Mohammed et al., 2022). Perhaps the reason for this result is that the newly taught teachers have more resources for training and professional growth than their colleagues had in previous times. Also, they have a higher ability to deal with modern techniques in teaching and benefit from them in acquiring many experiences, ideas, concepts, and contemporary trends in teaching science. This may have contributed to creating an equivalence between the more experienced teachers and the newer teachers in the level of self-efficacy.

To answer the hypothesis 2, one-way ANOVA was used to reveal the differences between the mean scores of the participating (see Table 10).

Table 10: Results of one-way ANOVA for the self-efficacy tool according to academic major (N = 67)

Variance source	Sum of squares	df	Mean square	F	p
Between	211.602	2	105.801		
Within	6801.38	64	106.272	0.996	0.375
Total	7012.98	66			

Table 10 indicates that there is no statistically significant difference at the 0.05 level (F = 0.996, p = 0.375) between the average scores of science teachers at the middle school level on their self-efficacy according to the variable of academic major. Thus, hypothesis 2 is accepted, which states that "There is no statistically significant difference at the 0.05 level between the average scores of female science teachers at the middle school level in the self-efficacy tool according to the variable of academic major."

Consequently, this result means that the difference in female teachers' academic major (biology - chemistry - physics) did not have any significant effect on female teachers' self-efficacy beliefs. This finding is consistent with the result of Alqarni and Alahmad (2018), which showed that there was no statistically significant difference in the level of self-efficacy related to the STEM approach of female science teachers at the secondary stage in the city of Riyadh. Because of the work of female teachers at the intermediate level, where there is no significant effect of the exact specialization of each teacher in teaching science, this matter might lead to homogenization of the factors affecting their level of self-efficacy.

Fourth study question:

To answer the fourth study question, which stated, "Does the level of science teachers' practice of NGSS at the middle school level differ according to the two variables (years of experience - academic major)?", the following two statistical hypotheses were tested:

3. There is no statistically significant difference at the 0.05 level between the average scores of female science teachers at the middle school level in the NGSS practice tool according to the variable of years of experience.

4. There is no statistically significant difference at the 0.05 level between the average scores of female science teachers at the middle school level in the NGSS practice tool according to the variable of academic major.

To answer the hypothesis 3, one-way ANOVA was used to reveal the differences between the mean scores of the participating teachers (see Table 11).

Table 11: Results of one-way ANOVA for the NGSS practice tool according to years of experience (N = 67)

Domains	Variance source	Sum of squares	df	Mean square	F	p
Students' practices	Between	1391.6	2	695.798	2.749	0.072
	Within	16197.4	64	253.084		
	Total	17589	66			
Teachers' practices	Between	78.238	2	39.119	0.802	0.453

	Within	3120.24	64	48.754		
	Total	3198.48	66			
	Between	1816.45	2	908.226		
Total	Within	28209.4	64	440.772	2.061	0.136
	Total	30025.9	66			

Table 11 indicates that there is no statistically significant difference at the 0.05 level (F = 2.061, p = 0.136) between the average scores of science teachers at the middle school level with regard to the practice of NGSS in a whole tool or in one of its domains according to the variable of years of experience. Thus, hypothesis 3 is accepted, which states that "There is no statistically significant difference at the 0.05 level between the average scores of female science teachers at the middle school level in the NGSS practice tool according to the variable of years of experience."

Consequently, this result explains that the difference in the level of teaching experience of the participating teachers had no effect on their ability to practice NGSS. This finding is consistent with Alajmi (2019) and Alshiyab (2019), which indicated that there were no statistically significant differences in the level of science teachers' practice of some NGSS standards due to the variable of years of experience. On the contrary, this finding differs with Alshurman (2021), which showed that there were significant differences in the level of practice of some NGSS standards of male and female science teachers in the secondary stage in Jordan, according to the variable of years of experience. Therefore, the result of the current study might be explained by the fact that the most recent female teachers were familiar with the developed science curricula and their teaching methods, whether at the pre-service stage or at the beginning of their work. They have undergone training on these curricula and the best ways to teach them. On the other hand, the more experienced teachers were at the beginning of their learning of the new curricula but still benefitted from their training on the old curricula. Perhaps this is why the different years of experience did not make any significant impact on the practices of NGSS.

To answer the hypothesis 4, one-way ANOVA was used to reveal the differences between the mean scores of the participating (see Table 12).

Table 12: Results of one-way ANOVA for the NGSS practice tool according to academic major (N = 67)

Domains	Variance source	Sum of squares	df	Mean square	F	p
	Between	238.831	2	119.415		
Students' practices	Within	17350.2	64	271.096	0.44	0.646
	Total	17589	66			
	Between	33.466	2	16.733		
Teachers' practices	Within	3165.01	64	49.453	0.338	0.714

	Total	3198.48	66			
	Between	332.09	2	166.045		
Total	Within	29693.8	64	463.965	0.358	0.701
	Total	30025.9	66			

Table 12 indicates that there is no statistically significant difference at the 0.05 level (F = 0.358, p = 0.701) between the average scores of science teachers at the middle school level with regard to the practice of NGSS in a whole tool or in one of its domains according to the variable of academic major. Thus, hypothesis 4 is accepted, which states that "There is no statistically significant difference at the 0.05 level between the average scores of female science teachers at the middle school level in the NGSS practice tool according to the variable of academic major."

Consequently, this result demonstrates that the difference in the female teachers' academic major (chemistry - physics - biology) did not have any significant effect on their practice of NGSS. This finding is consistent with the result of Alosaimi (2020) and Alahmad et al. (2018), which showed that there were no statistically significant differences in the mean scores for practicing some NGSS in the performance of science teachers at the intermediate level in Saudi Arabia according to the variable of academic major. Perhaps the explanation for the appearance of this result is that the participants teach at the middle school level, where there is a balance between the topics of physics, chemistry, and biology within the textbook. That makes the prominence of the effect of one major compared to the other weak, which explains the absence of significant differences between female teachers with academic major in the practice of NGSS.

Fifth study question:

To answer the fifth study question, which stated, "Is there a correlation between the self-efficacy of science teachers at the middle school level and their practice of NGSS?", the following statistical hypothesis was tested:

5. There is no statistically significant correlation at the 0.05 level between the self-efficacy of middle school female science teachers and their practicing of NGSS.

A Pearson correlation coefficient was used to test the hypothesis (see Table 13).

Table 13: Pearson correlation coefficient's Results

Practicing of NGSS / Self-efficacy	First domain: Students' practices	Second domain: Teachers' practices	Total score
Total score	0.477**	0.362**	0.483**

Note. ** p-value is significant at 0.01

Table 13 indicates the following: (1) there is a positive statistically significant correlation at the 0.01 level between the total scores of the self-efficacy of female science teachers and their scores in the first domain, which is students' practice, (2) there is a positive statistically significant correlation at the 0.01 level between the total scores of the self-efficacy of female science teachers and their scores in the second domain, which is teachers' practices, and (3) there is a positive statistically significant correlation at the 0.01 level between the total

scores of the self-efficacy of female science teachers and their scores in the whole tool, which is their practice of NGSS. Thus, hypothesis 5 is accepted, which states that "There is positive statistically significant correlation at the 0.05 level between the self-efficacy of middle school female science teachers and their practicing of NGSS."

Thus, the result of the fifth study question revealed the existence of a statistically significant positive correlation between the self-efficacy of female science teachers at the middle school level and their practice of NGSS in both domains (students' practices and teachers' practices). This result means that the higher level of self-efficacy among female teachers, the greater their ability to practice NGSS. This result differs with the result of Dennewitz (2020), which indicated that the application of teaching practices in accordance with NGSS had a negative impact on the self-efficacy of a sample of science teachers in the United States due to their inability to bring about the educational transformations necessary to employ scientific and engineering practices.

Sixth study question:

To answer the sixth study question, which stated, "Are there statistically significant differences between middle school female science teachers with high and low self-efficacy in NGSS practice?", the following statistical hypothesis was tested:

6. There is no statistically significant difference at the 0.05 level between the average scores of female science teachers with high and low self-efficacy in NGSS practice.

An independent sample t-test was used to test the hypothesis after arranging the participants' scores in the self-efficacy tool in descending order, where the high self-efficacy group included eight teachers (27%) and the low self-efficacy group included eight teachers (27%) as well (see Table 14).

Table 14: Results of independent sample t-test for examining differences between high and low self-efficacy parameters in NGSS practice (N = 67)

Domains	Groups	N	Average	Standard deviation	t	p
Students' practices	High self-efficacy	8	84.00	12.542	3.589	0.00**
	Low self-efficacy	8	68.33	13.630		
Teachers' practices	High self-efficacy	8	45.90	3.445	3.176	0.00**
	Low self-efficacy	8	41.17	5.283		
Total	High self-efficacy	8	129.89	13.069	4.183	0.00**
	Low self-efficacy	8	109.50	16.027		

Note. ** p-value is significant at 0.01

Table 14 indicates that the t values ranged between 3.176 to 4.183, which are statistically significant values at the 0.01 level. This result means that there are statistically significant differences between participants with high and low self-efficacy in NGSS practices in favor of the higher self-efficacy scorers. Thus, hypothesis 6 is rejected and the alternative hypothesis is accepted, which states that "There is statistically significant difference at the 0.05 level between the average scores of female science teachers

with high and low self-efficacy in NGSS practice."

Consequently, this result explains that there is a positive effect of female teachers' self-efficacy beliefs in their practice of NGSS. This finding is consistent with the result of Griffin (2020), which indicated that there is a positive relationship between the self-efficacy of high school science teachers in the United States on their educational practices of the NGSS.

This result might be explained based on Bandura's social cognitive theory, where the triadic causation reciprocal model suggests that behavior (in this case female science teachers' practice of NGSS) is influenced by the teachers' internal personal factors (including their own self-efficacy beliefs) in their interaction with the environment (the classroom environment and what it includes of interactions between teachers and students) (Mabogunje et al., 2016). In addition, based on the impact of self-efficacy on performance, which was confirmed by Bandura (1995), the self-efficacy beliefs of female teachers in the current research have contributed to the development of NGSS practices through cognitive processes (Teachers' awareness of the procedures and steps needed to apply NGSS), motivation (motivating female teachers to teach effectively in accordance with modern standards), and emotional factors (increasing the ability of female teachers to overcome difficulties and frustrations that they may encounter while applying NGSS practices).

Conclusion:

This study aimed to reveal the level of self-efficacy of science teachers at the middle school level, the level of their practices for teaching science in the light of NGSS, to determine whether there is a statistically significant relationship between the level of self-efficacy and the level of practice of teaching science in the light of NGSS. The results of the study showed that there is a high level of self-efficacy among science teachers at the middle school level, and the level of their practices for teaching science in the light of NGSS. The results also confirmed the existence of a positive correlation between the two variables, and the existence of a significant effect of self-efficacy on science teaching practices according to the NGSS. The results of the study may carry many important implications, whether for teacher training programs according to modern standards for teaching science and identifying their training needs in this field, programs for developing teachers' self-efficacy beliefs, or developing science education curricula in the light of contemporary standards. This study recommends that the Saudi Ministry of Education continue to provide support for the development of self-efficacy of female teachers because of its impact on their practices of NGSS, provide training courses on the usefulness of NGSS in teaching science at the middle school level, and provide applied programs for science in-service teachers to develop their abilities to employ NGSS in their teaching.

References

1. Akella, S. (2016). The impact of next generation science standards (NGSS) professional development on the self-efficacy of science teachers (Publication No. 10090298) [Doctoral dissertation, Southern Connecticut State University]. ProQuest Dissertation and Theses Global.
2. Alahmad, N., Alshehri, J., Alturki, K., Albaqmi, M., & Aldosary, N. (2018). The perceptions of the science female teachers of the intermediate schools towards the nature of science (nos) according to the next generation science standards (ngss). Journal of Scientific Research in Education, 4(19), 471–495. https://doi.org/10.21608/JSRE.2018.22974
3. Alajmi, N. (2019). Level of knowledge and implementation of science and engineering practices by high school female chemistry

teachers according to NGSS standards [Master's thesis, King Saud University]. King Saud University Digital Archive. http://search.shamaa.org/PDF/Dissertation/SaKSU/ksu_tarb_2019_270187_aajamin_authsub.pdf

4. Alazmy, A. (2019). The extent of primary grades science teachers using differentiated education strategies and its relation to their perceived level of self-efficacy [Unpublished Master thesis]. World Islamic Sciences & Education University.
5. Alebous, T., Alrawashdeh, S., Alkhawaldeh, M. (2019). The effect of training program for science teachers based on next generation science standards (NGSS) in the developing of science and engineering practices and self-efficacy among them in Jordan. Dirasat: Educational Sciences, 46(2), 187–203. https://journals.ju.edu.jo/DirasatEdu/article/view/101332
6. Alharbi, A. (2018). The development of science curricula in in the middle school in the light of scientific concepts included in the vision of Saudi Arabia 2030. Journal of Education and Psychology, (61), 109–132. https://doi.org/10.33948/0059-000-061-006
7. Alhomairi, A. (2018). A proposed perspective for developing science curriculum for the upper primary grades in accordance to Saudi Arabia's vision for 2030: An analytical and descriptive study according to delphi method. International Journal of Higher Education, 7(1), 69–86. https://doi.org/10.5430/ijhe.v7n1p69
8. Aljohani, A. (2020). The reality of practice of science female teachers in the intermediate stage for the next generation science standards (NGSS). Faculty of Education Journals - Port Said, (30), 94–118. https://doi.org/10.21608/JFTP.2020.24169.1030
9. Alosaimi, H. (2020). The degree of availability of scientific and engineering practices aligned to NGSS in the performance of science teachers of intermediate stage. Journal of Faculty of Education-Benha University, 5(122), 315–361. https://doi.org/10.21608/JFEB.2020.165441
10. Alqarni, N., & Alahmad, N. (2018). Female high school science teachers' self-efficacy to teach in light of stem approach. International Interdisciplinary Journal of Education, 7(11), 15–29. https://doi.org/10.36752/1764-007-011-002
11. Alshiyab, M. (2019). Possession level of scientific and engineering practices in the light of the next generation science standards "ngss" by secondary stage science teachers in saudi arabia. Umm Al-Qura University Journal of Education & Psychology Sciences, 10(2), 338–366.
12. Alshurman, S. (2021). The level of employment of secondary school science teachers in jordan for science and engineering practices (sep) of next generation science standards (ngss) during their teaching. Journal of the Association of Arab Universities for Research in Higher Education, 41(3), 181–197. https://doi.org/10.36024/1248-041-003-009
13. Altamimi, R. (2021). The extent of inclusion of Next Generation Science Standards NGSS in the science book for the third grade intermediate. Pathways for Shariah, linguistic studies and humanities, (9), 275–316. https://doi.org/10.1002/tea.21751
14. Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Prentice-Hall, Inc.
15. Bandura, A. (Ed.). (1995). Self-efficacy in changing societies. Cambridge University Press. https://doi.org/10.1017/CBO9780511527692
16. Bandura, A. (1997). Self-efficacy: The exercise of control. Worth Publishers.

17. Bandura, A. (2012). On the functional properties of perceived self-efficacy revisited. Journal of Management, 38(1), 9–44. https://doi.org/10.1177/0149206311410606
18. Bandura, A., Freeman, W., & Lightsey, R. (1997). Self-efficacy: The exercise of control. Journal of Cognitive Psychotherapy, 13(2), 158–166. https://doi.org/10.1891/0889-8391.13.2.158
19. Calderon, J. (2006). Methods of research and thesis writing (2nd ed.). National Bookstore.
20. Christian, K., Kelly, A., & Bugallo, M. (2021). NGSS-based teacher professional development to implement engineering practices in STEM instruction. International Journal of STEM Education, 8(1), 18. https://doi.org/10.1186/s40594-021-00284-1
21. Dennewitz, B. (2020). A case study of science teachers' perceptions of self-efficacy in teaching the science and engineering practices (Publication No. 28156244) [Doctoral dissertation, Southeastern University]. ProQuest Dissertation and Theses Global.
22. First conference for Saudi women's studies. (2018, October 24-25). First conference for Saudi women's studies [Keynote address]. First conference for Saudi women's studies, Riyadh, Saudi Arabia. https://www.pnu.edu.sa/ar/Deanship/Research/ResearchCenter/FCSWS/Pages/Brief.aspx#content
23. Griffin, N. (2020). Examining the relationship between science teachers' epistemology and self-efficacy on science instructional practices and conceptualization of student research experiences rooted in the next generation science standards [Unpublished Doctoral dissertation]. Western Connecticut State University.
24. Hakami, A. (2019). The level of self-efficacy among science female teachers. Faculty of Education Journals - Port Said, (25), 807–821. https://doi.org/10.21608/JFTP.2019.42695
25. Hassanein, B. (2016). Next generation science standards. Journal of Education-Sohag University, 46(46), 398–439. https://doi.org/10.21608/EDUSOHAG.2016.125612
26. Hayes, K., Lee, C., DiStefano, R., O'Connor, D., & Seitz, J. (2016). Measuring science instructional practice: A survey tool for the age of NGSS. Journal of Science Teacher Education, 27(2), 137–164. https://doi.org/10.1007/s10972-016-9448-5
27. Ibrahim, A (2003). Design and initial validation of an instrument for measuring teacher beliefs and experiences related to inquiry teaching and learning and scientific inquiry (Publication No. 3124086) [Doctoral dissertation, Ohio State University]. ProQuest Dissertation and Theses Global.
28. Judson, E. (2022). Variations among next generation science standards and other NRC framework-based science standards: Differences in layout, typography, and what teachers notice. Education Sciences, 12(5), 21. https://doi.org/10.3390/educsci12050330
29. Kaya, F. (2020). How a science methods course changes secondary preservice science teacher? self-efficacy beliefs about science and engineering practices (Publication No. 28163916) [Doctoral dissertation, Kent State University]. ProQuest Dissertation and Theses Global.
30. Krajcik, J., Codere, S., Dahsah, C., Bayer, R., & Mun, K. (2014). Planning instruction to meet the intent of the next generation science standards. Journal of Science Teacher Education, 25, 157–175. https://doi.org/10.1007/s10972-014-9383-2
31. Lilly, S., McAlister, A., Fick, S., Chiu, J., & McElhaney, K. (2022). Elementary teachers' verbal supports of science and engineering practices in an NGSS-aligned science, engineering, and computational thinking

unit. Journal of Research in Science Teaching, 59(6), 1035–1064. https://doi.org/10.1002/tea.21751

32. Lin, A. (2020). Making sense of teachers' initial steps with the NGSS (Publication No. 28155652) [Doctoral dissertation, University of Hawai'i]. ProQuest Dissertation and Theses Global.
33. Mabogunje, A., Sonalkar, N., & Leifer, L. (2016). Design thinking: A new foundational science for engineering. International Journal of Engineering Education, 32(3(B)), 1540–1556.
34. McCormick, W. (2019). Self-efficacy and stem career interest in black and latino middle school students: A study on the next generation science standards (Publication No. 13863340) [Doctoral dissertation, Loyola Marymount University]. ProQuest Dissertation and Theses Global.
35. Meiyanti, F., Hardienata, S., & Hidayat, N. (2022). The correlation between self-efficacy and pedagogic competence with teacher teaching effectiveness. Pedagonal: Jurnal Ilmiah Pendidikan, 6(1), 107–119. https://doi.org/10.55215/pedagonal.v6i1.4935
36. Mercadante, K. (2017). From standards to standard practice: A critical look at the perceptions and process of integrating the next generation science standards in the nation's schools (Publication No. 10608975) [Doctoral dissertation, Robert Morris University]. ProQuest Dissertation and Theses Global.
37. Mohammed, S., Mahfouz, R., & Syed, H. (2022). Educational beliefs and their role in achieving the efficiency of primary education teachers. Educational Journal for adult education, 4(1), 291–325. https://doi.org/10.21608/altc.2022.274207
38. NGSS Lead States. (2013). Next generation science standards: For states, by states. The National Academies Press.
39. Nuangchalerm, P., Prachagool, V., Prommaboon, T., Juhji, J., Imroatun, I., & Khaeroni, K. (2020). Views of primary thai teachers toward STREAM education. International Journal of Evaluation and Research in Education (IJERE), 9(4), 987–992. https://doi.org/10.11591/ijere.v9i4.20595
40. Okoro, A., Nwagbo, C., Ugwuanyi, C., & Ugwu, B. (2022). Evaluating the impact of teachers' self-efficacy on students' academic achievement in biology in Enugu State, Nigeria. Webology, 19(3), 161–176.
41. Ozkan, Z. (2022). The effect of STEAM applications on lesson outcomes and attitudes in secondary school visual arts lesson. International Journal of Technology in Education, 5(4), 621–636. https://doi.org/10.46328/ijte.371
42. Pehlivan, M. (2020). A study on sources and consequence of science teachers' self-efficacy [Master's thesis, Middle East Technical University]. Integrated Information Service. https://hdl.handle.net/11511/96343
43. Reimers, F., & Opertti, R. (Eds.). (2021). Learning to build back better futures for education: Lessons from educational innovation during the COVID-19 pandemic. UNESCO International Bureau of Education.
44. Robertson, A. (2022). The impact of analyzing science standards on elementary teacher science self-efficacy (Publication No. 29169330) [Doctoral dissertation, Frostburg State University]. ProQuest Dissertation and Theses Global.
45. Romanillos, R. (2017). Improving science teachers' self-efficacy for science practices with diverse students (Publication No. 13890150) [Doctoral dissertation, Johns Hopkins University]. ProQuest Dissertation and Theses Global.
46. Roza, M., Lufri, L., & Asrizal, A. (2023). Meta-analysis the effect of STEM integrated

problem based learning model on science learning outcomes. Jurnal Pendidikan Matematika dan IPA, 14(1), 16–32. http://dx.doi.org/10.26418/jpmipa.v14i1.51678

47. Saudi Press Agency. (2021, March 8). Women are a fundamental pillar of the Kingdom's Vision 2030. https://www.spa.gov.sa/2197982
48. Scannell, S. (2019). Next generation science standards and physics first: A case study of high school teachers' beliefs and practices (Publication No. 13886036) [Doctoral dissertation, Portland State University]. ProQuest Dissertation and Theses Global.
49. Second conference of women's vision and ambition. (2020, November 17-18). Enhancing the role of Saudi women in the development of society in light of the Kingdom's Vision 2030 [Keynote address]. Second conference of women's vision and ambition, Jouf, Saudi Arabia. https://www.ju.edu.sa/
50. Shahat, M., Al-Balushi, S., & Al-Amri, M. (2022). Investigating pre-service science teachers' self-efficacy beliefs for teaching science through engineering design processes. Interdisciplinary Journal of Environmental and Science Education, 18(4), 15. https://doi.org/10.21601/ijese/12121
51. Shapiro, L. (2018). High school science teachers' receptivity to the next generation science standards: An examination of discipline specific factors (Publication No. 10751507) [Doctoral dissertation, Northeastern University]. ProQuest Dissertation and Theses Global.
52. Shouman, A. (2019). Develop the physics curriculum in the light of the next generation of science education standards and its effectiveness in developing critical thinking among secondary students. Faculty of Education Journal-Tanta University, 74(2), 1110–1237.
53. Siaw, W., Yeboah, A., Konama, A., & Nartey, E. (2022). Effect of junior high school science teachers' self-efficacy on pupils' performance. Journal of Critical Reviews, 9(3), 38–55.
54. Sundberg, D., & Wahlstrom, N. (2012). Standards-based curricula in a denationalised conception of education: The case of sweden. European Educational Research Journal, 11(3), 342–356. http://dx.doi.org/10.2304/eerj.2012.11.3.342
55. Younes, Y. (2018). The relationship between recognized self-efficiency and psychological flexibility for kindergarten pre-service teachers. Journal of Education-Sohag University, 52(52), 557–630.
56. Yulianti, D., Utami, N., Ridloand, S., & Isdaryanti, B. (2021). Measurement of TPACK self-efficacy for pre-service science teachers. Journal of Physics: Conference Series, 1918(5), 5. https://doi.org/10.1088/1742-6596/1918/5/052084