The Reality of Professional Development Programs for Middle School Science Teachers in Saudi Arabia in light of the Next Generation Science Standards (NGSS)

Naglaa Ali Moustaffa[1,*] & Samaah Hasan Akkash Al-Enazi[2]

[1]Department of Curriculum and Instruction, College of Education in Al-kharj, Prince Sattam bin Abdulaziz University, Al-Kharj 11942, Saudi Arabia

[2]Administration of Education at Al-Kharj, Science Teacher in Primary 39 (Girls) in Al-Kharj, Saudi Arabia

*Correspondence: Department of Curriculum and Instruction, College of Education in Al-kharj, Prince Sattam bin Abdulaziz University, Al-Kharj 11942, Saudi Arabia. E-mail: naglaaeg2007@yahoo.com ORCID: 0000-0002-3314-6757

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Abstract

According to the Next Generation Science Standards, the study sought to determine the reality of professional development programs for middle school science instructors in Al-Kharj Governorate, Saudi Arabia (NGSS). One of the study's most significant findings is that professional development programs for science teachers in the intermediate stage include central ideas according to the next-generation standards NGSS to a high degree, and teachers gain common and interrelated concepts. There are (135) science teachers in middle school schools in Al-Kharj Governorate. One of the most significant recommendations of the study was that professional development programs should be based on teachers' understanding of the foundations and principles of the central ideas. The need to enable the analysis of the critical concepts of geometry and technology is a must and must include activities to implement the principle of causation. Science teachers acquire scientific and geometric practices to a high degree under generation standards. Help them improve their abilities to choose contemporary models for science topics and teach them how to create geometric solutions to real-world science problems.

Keywords: professional development, next-generation science standards NGSS, science teachers, middle schools

1. Introduction

Professional development programs for teachers are important because they advance and improve the educational process, especially those that focus on Next Generation Science Standards (NGSS). It is also characterized by integration because it includes several dimensions and primary domains, the most important of which are familiar concepts, specialized central ideas, and scientific and engineering practice. These programs are designed to clarify the expected performance of students by linking these dimensions to different academic levels. Because of their scientific illustrations, drawings, and equations, science instructor needs these programs. It must use new technologies to appeal to the future generation.

Based on these programs, students can have sufficient science and engineering knowledge upon completing their secondary studies. They can have adequate skills to solve problems in their future lives and are motivated to complete their education outside school, qualifying them to work in engineering and technology-related jobs.

Professional development programs must be founded on teachers' comprehension of the foundations and principles of vital ideas, analyzing the preliminary engineering and technology concepts. They must include different activities to teach cause and effect to scientific and engineering professionals. These programs must contain activities to help instructors invent technical solutions for practical science difficulties and choose modern science models. The education system is one of the essential systems that civilizations want to improve and advance. This interest has grown in recent years due to the rapid and continual changes the world is experiencing, especially at the technical level. Many countries rushed to improve their educational systems, focusing on teacher performance and quality as

critical inputs. It also affects the quality of academic outputs. For this development to occur, it is necessary to prepare the teacher well and provide the appropriate atmosphere and stimulus for his professional development. Many scientific studies confirm this. It is emphasized that the need to support professional development programs for teachers is present. It is considered sustainable professional development that starts from the time they practice the profession until the end of their careers. Teacher development must be balanced and complete. The study also finds it crucial that professional development programs stem from the institution to which the teacher belongs, are based on the teachers' genuine needs, and strive to increase the student's level as an outcome of the educational process (Mousa, 2014). Austin (2006) found that the excellent performance of instructors in the final stage resulted from professional development initiatives. These activities improved student performance in the Knock Seck area of the US. It resulted in excellent student performance and a high degree of cooperation between leaders and teachers in making and implementing joint decisions. It was not only student excellence, as the study indicated that early-career teachers need professional development more than others.

1.1 Research Problem

With the implementation of science standards (NGSS) for the next generation, many prior studies agreed on the significance of providing science teachers with the knowledge and skills necessary to activate the standards in the classroom and their effectiveness. Laxton (2016); Abdel-Karim (2017); Al Rawashdeh (2018); Al Abous et al. (2019); Afifi (2019); Akella (2016); Richman et al. (2019); Al-Ahmed and Al-Muqbil (2016) and Morales (2016) claimed that science teachers require training and support to comprehend science and geometry standards and their implementation in the semester. Al-Juhni (2020) advocates studying in-service science teachers' requirements and providing NGSS-aligned professional development.

According to Wilde (2018), despite understanding and using the NGSS, teachers were not using them effectively. Many studies urged teachers to develop lessons that activate the NGSS (Richman et al. 2019). Akella (2016) Suggested that policymakers help teachers implement NGSS. According to the researchers' reality, the Ministry of Education is working to make professional development programs for instructors more relevant and benefit next-generation science students.

Although the literature emphasizes the importance of science teachers providing the knowledge and skills necessary to activate and employ NGSS now, the researchers find that many studies have shown that science teachers need more awareness of the standards of the next generation. Moreover, professional development programs aim to develop their abilities to practice and activate NGSS.

The researchers noted the increasing demand to include science standards for the next generation in science teacher development programs and the lack of recent research on the reality of professional development programs for science teachers according to science standards for the next generation, a new topic in education. The researchers analyzed Science Standards for the Next Generation professional development programs for science teachers.

1.2 Study Objectives

The study was undertaken with the following objectives:

1. To reveal the extent to which the professional development programs for middle-school science teachers include the central ideas according to the next-generation standards NGSS.
2. To Know the extent to which professional development programs offered through the Ministry of Education help middle school science teachers to achieve common concepts according to NGSS.
3. How professional development programs offered through the Ministry of Education help middle-school science teachers achieve scientific and geometric practices following NGSS.

2. Literature Review

2.1 The Concept of Professional Development

There are numerous definitions of professional development for teachers in the literature. Rifai (2015) defines it as a deliberate and planned process that equips employees with the knowledge, information, directions, skills, attitudes, and values to accomplish quality performance and advance in their professional careers.

Wahba (2013) defines professional development as the processes and activities provided to teachers to increase their knowledge, directions, and skills, accomplish ongoing professional growth and enhance their professional performance.

In other words, a teacher's professional development encompasses all efforts made by the educational administration or the instructors to increase knowledge, improve direction, refine skills, and enhance the educational process to enhance his professional level.

2.2 Next Generation Science Standards NGSS

Next Generation Science Standards are the latest US science teaching standards. (Bybee, 2014) defines them as standards based on the National Research Council's (NRC) K-12 theoretical framework for science learning, which contains three components (common concepts, shared ideas, central ideas in the branches of science, and scientific and geometric practices). Teaching science integrates these three dimensions using scientific geometric design, standard concepts, and primary ideas. The Next Generation Science Standards (NGSS) project appeared in 2013 in the US due to several reforms and the necessity to develop science and math teaching under local and worldwide standards. National Research Council (NRC) partners with NAS, NSTA, AAAS, and Achieve. NGSS was established through a collaborative process based on a framework for teaching science from nursery to secondary school. These new educational standards are engaging, integrated, and comprehensive across several topics and academic levels (Abdel-Karim, 2017).

These criteria ensure that all students have a sufficient understanding of science and geometry after secondary school to address life's issues, be motivated to continue science outside of school, and can work in geometry and technology (Al-Ahmed et al., 2018).

They are standards for learning and teaching science effectively in the 21st century, and they integrate the three basic dimensions (common concepts, specialized central ideas, and scientific and geometric practice) to prepare students to meet the challenges of the time. They clarify the expected performance of students by linking these dimensions to different academic levels and topics.

The criterion reflects the expected performance of students and what they should be able to do, integrating all practices, central ideas, and concepts from diverse science areas as they describe student skills (Al-Abous et al., 2019).

These K-12 science standards comprise three dimensions:

2.3 Dimension One: Central Ideas

It focuses on some scientific concepts to explore each concept in depth through scientific study and argumentation and comprehend the provided scientific concepts. It emphasizes the teaching of geometry and science, as well as the integration of knowledge content and geometric and scientific activities with the introduction of investigation and scientific geometric design (Al-Rabiaan & Abeer, 2017). It is defined by central principles for scientific areas that assist the individual in clarifying phenomena. From them, he can connect the concepts to apply them to future scenarios with complete comprehension. (Al-Ahmed et al., 2018).

2.4 The Second Dimension: Common Concepts

It organizes experience, follows perceptions, and ties them to the source. Researchers can easily access them. Education academics stress its importance since it helps pupils understand science effectively, which is essential for comprehension (Zaitoon, 2010). Familiar concepts are important when linking, controlling, and enriching central ideas with scientific and geometric procedures. From here, they increase the student's cumulative learning and highlight the overlap of scientific concepts, patterns, cause and effect, energy, matter, measure, proportion, quantity, systems and systems models, structure and function, stability, and change (Al-Juhni, 2020). Common concepts help students understand scientific and geometric practices and central ideas in geometry and science. Repetition of the image in context is necessary to build knowledge. Concepts grow in different stages. Concepts are comprehensive for all students. Science, geometry, and conceptual judgment are interwoven.

2.5 The Third Dimension: Scientific and Geometric Practices

The applied practice in the standards represents the scientific practice in scientists' behavior, which integrates them into research and the phenomena around them. It also integrates geometric practices engineers use in building and designing models, considering design an essential element in learning science. Ahl (2019) utilized the term practices instead of skills to assure that investigation and scientific research require skill and knowledge. The standards document (NGSS, 2013) defined eight scientific and geometric practices, including asking questions and explaining the problem, using models, planning, analyzing and interpreting data, applying math and quantitative reasoning, designing solutions, gathering and evaluating information, and discovering evidence.

Science teachers must utilize scientific and geometric techniques, standard concepts, and links between fundamental

ideas to apply NGSS standards and design lessons. Curriculum, teacher, administrator, faculty, and policymaker requirements. A scientific teacher must grasp the material, create opportunities for pupils to participate, encourage students' thinking and assist them in designing science-standard products. Al-Baqami (2016) and Kloser (2014) established three prerequisites for the teacher to engage in scientific and geometric practices: a firm grasp of its aims, managing students' conversations, and transferring learning responsibility to the student. Akella (2016) advised recognizing and strengthening science teachers' talents through continual professional development to increase their topic knowledge, self-efficacy, and skills needed to implement NGSS standards and learn new concepts in their regular classes.

Since standards need a dramatic change in teaching methods, teachers must acquire new techniques and specialize in gaining a profound mastery of their subjects. The instructor must have a solid understanding of the NGSS and plan lessons to implement them (Al-Ajmi, 2019). Using scientific and geometric practices needs instructor efficiency (Al-Sheyab, 2019). Implementing NGSS demands instructors to plan and execute, which raises the requirement for a continual professional development program (Richman et al., 2019).

2.6 Professional Development Programs for Middle School Science Teachers According to Science Standards for the Next Generation

Attention and development of in-service middle school science teachers are essential in developing the educational process. The quality of learning and teaching depends on teachers and their scientific practice. Middle school prepares pupils for a successful life by revealing their desires, tendencies, and preparedness. Intermediate science teachers must know and practice next-generation science standards.

Al-Baqami (2016) noted that teachers' ability to activate the learning dimensions of science standards for the next generation depends on their mastery of content, display, and awareness of knowledge and concepts, teaching in the integration of the three dimensions of standards, and providing opportunities for students to actively participate and practice science applications in the classroom (Al-Abous at. al. 2019). Next-generation science standards change teaching from lessons to integrated educational experiences (Bybee, 2013).

The American Research Council emphasized the importance of science teachers being able to take into account students' interests, skills, information, and needs through teaching practices and using teaching methods that develop in students a clear understanding of building an integrated set of ideas in science, increase their ability to make decisions, and give students an apparent experience of building an integrated set of ideas in science. Science students participate and take responsibility (National Research Council (NRC), 2012; Al-Sheyab, 2019). The American Research Council NRC has stressed an educational model that shows how individuals learn and focuses on the integrated learning sequence; teachers must be trained to utilize it in teaching to incorporate NGSS standards, a model based on performance expectations. The educational process is based on performance-based materials.

The application of the NGSS is large-scale professional development for all science teachers in their knowledge and practice to meet these developments in learning and teaching science. Teachers must be supported with professional development programs that keep up with the times to integrate innovations in their classrooms. Afifi (2019) notes that teachers need complete support to comprehend standards and create teaching that leads to achieving standards that lead to coherent and rigorous education and students who can acquire and apply knowledge. Abdel-Karim (2017) said teachers should build NGSS-aligned survey lessons following training. Al-Ahmed and Al-Muqbil (2016) concluded that female teachers must be aware of the next generation's requirements. Abdel-Karim's study (2017) advocated developing professional development and preparation programs for science teachers. Issa and Ragheb (2017) stressed the necessity of preparing and enhancing science teacher professionalism in light of NGSS and linked with curriculum development and student assessment.

Although the literature emphasizes providing science teachers with the knowledge and skills necessary to activate and employ NGSS in their teaching practice, many studies show that science teachers need more awareness of NGSS and that professional development programs aim to develop their abilities to practice and activate these standards.

The researchers noticed the growing demand to include NGSS in scientific teacher development programs and the lack of recent research on NGSS-based professional development programs for science instructors. The researchers wanted to examine NGSS-based teacher professional development programs.

3. Research Methodology

The study adopted a descriptive approach for its suitability to the study. The researchers prepared a questionnaire, which was applied to the study sample.

3.1 Study Population and Sample

The study population consisted of all middle school science teachers in Al-Kharj Governorate, numbered (135) male and female teachers, and the study sample consisted of (102) male and female science teachers selected in a simple random way representing (75.6%) of the study population. The following tables show the characteristics of the study sample:

The study sample's characteristics according to gender:

Table 1. Study Sample's Features According to Gender

Gender	Number	Percentage
Male	46	45.1%
Female	56	54.9%
Total	102	100%

The study sample's characteristics according to qualification:

Table 2. Study Sample's Attributes According to Qualification

Qualification	Number	Percentage
Bachelor	88	86.3%
Above Bachelor	14	13.7
Total	102	100%

The study sample's characteristics according to experience:

Table 2. Study Sample's Attributes According to Experience

Experience	Number	Percentage
5 years and less	8	7.8%
6 – less than 10 years	33	32.4%
Above 10 years	61	59.8%
Total	102	100%

3.2 Study Tool

By reviewing previous studies, the researchers designed the study tool, represented by the questionnaire, to achieve the study's objectives. The questionnaire's items were derived from the science standards for the next generation for the intermediate stage—the first of (38) items.

3.3 The Credibility of the Study Tool's Items

First: The structural Credibility (the Credibility of the experts):

To ensure the tool's initial validity, it was submitted to (4) curriculum and teaching technique specialists, who were asked to examine it according to an examination letter. After revisions, the final questionnaire included (30) items.

Second: the internal consistency of the items of the tool:

The tool was applied to an exploratory sample of (30) male and female middle school science teachers to ensure internal consistency. Internal consistency coefficients were extracted as validity indicators by calculating the Pearson correlation coefficient between the degree of each item and the degree of the dimension to which the article belongs.

Table (4) shows that the correlation coefficients for each tool item are positively and statistically significant with the total degree of the dimension to which it belongs at the level of significance ($0.01 \geq \alpha$), indicating that each tool item is appropriate for measuring the size to which it belongs.

Table 3. Pearson's Correlation Values for the Points of Each Item of the Tool and the Dimension It Belongs to

Item	Correlation	Item	Correlation	Item	Correlation	Item	Correlation
Dimension 1: Central ideas according to NGSS							
1	0.937**	3	0.914**	5	0.915**	7	0.697**
2	0.915**	4	0.896**	6	0.898**		
Dimension 2: Providing teachers with the knowledge and skills required to achieve common concepts							
1	10	0.699**	7	0.869**	4	0.707**	0.844**
2	11	0.869**	8	0.858**	5	0.702**	0.900**
3		0.849**	9	0.794**	6	0.834**	3
Dimension 3: Providing teachers with the knowledge and skills required to achieve the standards of scientific and geometric practices							
1	0.540**	4	0.836**	7	0.721**	10	0.684**
2	0.548**	5	0.650**	8	0.893**	11	0.482**
3	0.795**	6	0.739**	8	0.863**	12	0.586**

** Sig. at ≤ 0.01

3.4 Study Tool Reliability

After checking the stability of the study tool, the stability coefficients of the study tool dimensions were extracted using Cronbach's Alpha coefficient, and Table (5) shows these coefficients.

Table 4. Cronbach's Alpha for Study Tool's Reliability

Dimension	NO. of Items	Cronbach's Alpha coefficient
Dimension 1: Central ideas according to NGSS	7	0.952
Dimension 2: Providing teachers with the knowledge and skills required to achieve common concepts	11	0.945
Dimension 3: Providing teachers with the knowledge and skills required to achieve the standards of scientific and geometric practices	12	0.898
Tool's reliability	30	0.960

It is clear from Table 5 that the stability coefficients of the study tool reached the first dimension: central ideas (0.952), and for the second dimension: common concepts (0.945); and the third dimension: scientific and geometric practices reached (0.898), and these coefficients are appropriate and acceptable which indicates suitable stability of the tool.

3.5 Tool Correction Scale, Interpretation of Results

The judging criterion for professional development programs for intermediate science instructors according to the next generation's science standards is a five-year scale based on the questionnaire's categories. The scale included the following: strongly agree and take the value (5), agree (4), and neutral (3), disagree (2), strongly disagree (1), extract the range and length of the category as follows:

- The range is equal to the difference between the highest value of the scale categories and the lowest value of the scale categories = 5-1=4.
- The length of the category is equal to the range divided by some categories of the scale = 4/5 = 0.80

Table 6 shows the criteria for judging the reality of professional development programs.

Table 5. Criteria for Judging the Reality of Professional Development Programs

Mean	The reality of professional development programs
1 – <1.80	Very low
1.80 - <2.60	Low
2.60 - <3.40	Average
3.40 - <4.20	High
4.20 – 5	Very high

3.6 Statistical Processors

To analyze the data, the Social Statistical Package (SPSS) program was used, where the following methods were used:

Frequencies and percentages to describe the characteristics of the sample.

- Cronbach's alpha coefficient to calculate the stability of the instrument.
- Pearson Correlation coefficient to calculate the internal consistency of the tool.
- Statistics are represented by means, standard deviations, and ranks to answer the study's first, second, and third questions.

4. Study Results and Discussion

The first question: To what extent do the professional development programs for science teachers in the intermediate stage include the central ideas according to the Next Generation Standards (NGSS)?

To answer this question, the arithmetic averages and standard deviations of the response of middle school science teachers to the items of the first dimension were calculated: Inclusion of central ideas in professional development programs according to the Next Generation Standards (NGSS), and Table (7) shows these results.

Table 6. Means and Standard Deviations of the Responses of Middle-School Sciences Teachers to the First-Dimension Items: The Inclusion of Central Ideas

NO.	The reality of professional development programs for middle-school science teachers indicates that:	Mean	Standard Deviation	Inclusion	Rank
1	Physics is a primary dimension in professional development programs	3.91	0.960	High	2
2	Biology is a primary dimension in professional development programs	3.87	1.01	High	4
3	Geology and Astronomy are primary dimensions in professional development programs	3.70	0.952	High	7
4	geometry and technology are direct dimensions of professional development programs	3.90	1.06	High	3
5	professional development programs aim to enhance the central ideas of different branches of science	3.87	0.937	High	5
6	professional development programs rely on teachers' understanding of the foundations and principles of the central idea	3.83	1.05	High	6
7	professional development programs include applications that help teachers teach the central ideas	3.97	0.615	High	1
The mean and standard deviation of dimension 1: Central ideas		3.86	0.839	High	

Table (7) shows that professional development programs for science teachers in the intermediate stage include NGSS central ideas to a high degree, with a mean of (3.86), and the highest phrase included was (7), which states that "professional development programs include applications that help teachers teach."

The phrase (3), "Earth and space sciences are one of the main dimensions for these programs," was the least featured in professional development programs connected to Next Generation Standards (NGSS) central ideas, with an average of (3.70) and a high degree of inclusion. Phrase (6) with a mean of (3.83) and a high degree of inclusion: "Professional development programs are based on instructors' comprehension of core themes."

These results indicate the keenness of those responsible for developing the performance of science teachers in Saudi Arabia to provide teachers with the knowledge and skills necessary to integrate and apply third-generation standards in their curricula and education, as it guarantees the professional standards developed for science teachers in Saudi

Arabia. Its standards strongly stressed instructors' expertise with specialized knowledge since it incorporated technical knowledge in 26 of 31 standards for the three domains (physical sciences, biology, and earth science), from standards 6,5,6 through standards 31,5,6. (Education and Training Evaluation Commission, 2020). Standards guide professional licensing exams. The teacher must be familiar with the specialization and be interested in the natural sciences as an epistemological discipline that enables him to present science as a subject and method. He must also have a full understanding and awareness of its scientific content and fields and the theories, principles, laws, concepts, and scientific facts commensurate with the stage he is studying. Nature of specialty, scientific methods used to gather knowledge, integrate biology, physics, chemistry, astronomy, and the environment, and their relationships with other branches of knowledge.

These results indicate that the policies followed in planning and implementing professional development programs in Saudi Arabia are consistent with what many studies have suggested about the importance of aligning professional development and training to the requirements of applying and achieving next-generation standards. These programs and exercises will help teachers understand these practices, including their nature and importance in learning science and the difference between new and traditional science teaching practices and teaching with new standards (Smith and Nadelson, 2017). The results showed that teachers' awareness of the importance of professional development and their convictions in what provides it increased. Developing their teaching approaches to meet third-generation standards is critical.

The second question: To what extent do professional development programs offered through the Ministry of Education help in the intermediate stage to provide teachers with common concepts according to the Next Generation Standards (NGSS)?

To answer this question, the arithmetic averages and standard deviations of the response of middle school science teachers to the items of the second dimension were calculated: Teachers' acquisition of common and interrelated concepts according to the Next Generation Standards (NGSS), and Table (8) shows these results.

Table 7. Means and Standard Deviations of the Responses of Middle-School Sciences Teachers to the Second-Dimension Items

NO.	The reality of professional development programs for middle-school science teachers in KSA indicates that they enable teachers to:	Mean	Standard deviation	The reality of professional development	Ranking
1	Identify main concepts in Physics	4.22	0.610	High	1
2	Clarify main concepts in Physics	4.21	0.664	High	2
3	Identify main concepts in Biology	4.10	0.759	High	3
4	Explain the main concepts in Biology	4.07	0.785	High	4
5	Identify main concepts in Geology and Astronomy	4.00	0.743	High	6
6	Distinguish the main concepts in Geology and Astronomy	3.87	0.776	High	9
7	Analyze the main concepts in geometry and Technology	3.73	1.05	High	11
8	Understand the foundations and principles of measurement	4.07	0.785	High	5
9	Apply measurement conversions between different measurement systems	3.97	0.890	High	7
10	Professionally apply the cause-and-effect principle in teaching science and geometry	3.80	0.805	High	10
11	Understand the theoretical and mathematical relations between different concepts	3.93	0.740	High	8
	The mean and standard deviation of dimension 2	4.00	0.635	High	

Table (8) shows that the arithmetic mean of the degree of professional development assistance provided by the Ministry of Education in the intermediate stage to provide teachers with common concepts according to the Next Generation Standards (NGSS) was (4.00) and with a high degree, and came in the first order, phrase (1), which states, "The reality of development programs for science teachers for the intermediate stage in the Kingdom indicates..." With a 4.21 average, intermediate science teachers in the Kingdom said it helps them clarify the major physical topics. The third statement (3) states, "The reality of the development programs for science teachers at the

intermediate stage in the Kingdom reveals that they enable teachers to define the main principles of biology," with a high average (4.10).

Table No. 8 shows that item (7), "The reality of development programs for science teachers at the intermediate stage in the Kingdom suggests that they enable teachers to analyze the main ideas of engineering and technology," landed in the penultimate place. Item (10) mentions "the application of cause and effect in teaching science and engineering professionally" with a 3.80 arithmetic average and high degree.

Table 8. Means and Standard Deviations of the Responses of Middle-School Science Teachers to the First-Dimension Items: Providing Teachers with Scientific and Geometric Practices

NO.	The reality of professional development programs for middle-school science teachers in KSA indicates that they:	Mean	Standard Deviation	The degree of professional development	Ranking
1	Enable teachers to understand the principles and foundations of building hierarchal organizations	4.10	0.607	High	4
2	Provide teachers with practical abilities	4.00	0.695	High	8
3	The science teacher can use patterns and concept maps and relate them to geometry.	4.13	0.730	High	3
4	Provide teachers with the skill of asking scientific questions	4.18	0.592	High	1
5	Provide science teachers with the skills to apply geometric problems	3.93	0.740	High	10
6	Enhance the skill of choosing modern modules for the topics of science	3.80	0.805	High	11
7	Provide teachers with the required skills to apply explorative activities.	4.10	0.548	High	5
8	Provide teachers with the skills of data collection	4.03	0.669	High	6
9	Provide teachers with the skills to use mathematics and mathematical reasoning in science	4.03	0.615	High	7
10	Enhance teachers' scientific interpretation skills	4.00	0.830	High	9
11	Provide teachers with the skills to invent geometric solutions in scientific affairs	3.77	0.774	High	12
12	Provide teachers with the skills to analyze and criticize information and data	4.17	0.648	High	2
Mean and standard deviations for the third dimension: scientific and geometric applications		4.02	0.475	High	

The study attributes the sample's high rating to including Next Generation Standards (NGSS) common and interrelated concepts in professional development programs for intermediate science teachers. The policies followed in the Kingdom of Saudi Arabia indicate the adoption of a package of procedures that qualify science teachers and enable them to translate standards in addition to their achievement. These indicators are addressed in their exam items through their knowledge and acquisition of these concepts (Education and Training Evaluation Commission, 2020). This approach is consistent with what many studies have found that professional development for teachers is necessary to bridge the knowledge gap between policymakers and educators in the field, and implementing the NGSS "will be easier if we think of teachers and leaders as co-learners rather than demanding compliance with specific indicators of standards that few people understand well." Determining proper professional development, conducting required research, and realigning professional development resources with NGSS classroom requirements, and that success in implementing these programs depends on school or state financial support (Haag and Megowan (2015); Harris et al. (2015).

The third question: To what extent do professional development programs offered through the Ministry of Education at the intermediate stage help science teachers acquire scientific and geometric practices following Generation

Standards (NGSS)?

To answer this question, the arithmetic means and standard deviations of the response of middle school science teachers to the items of the third dimension were calculated: Science teachers' acquisition of scientific and geometric practices according to the Next Generation Standards NGSS and Table (9) shows these results.

It is clear from Table (9) that the arithmetic average of a degree that helps professional development programs offered by the Ministry of Education in the intermediate stage to provide science teachers with scientific and geometric practices according to Generation Standards (NGSS) reached (4.02), and to a high degree, and came in the first order, 4.18 arithmetic average, high degree, second place "Teacher development programs show" science for the intermediate stage in the Kingdom gives teachers the skills to analyze and critique information and data" with arithmetic average (4.18), and a high degree, followed by the third phrase (3) which states "The reality of development programs for science teachers of the intermediate stage in the Kingdom indicates that it enables a teacher to..." The high-degree science of using patterns, concept maps, and geometry.

Table (9) shows that the least appreciated phrase by the survey sample was (11): "The reality of development programs for science teachers at the intermediate stage in the Kingdom reveals that they offer instructors with the abilities to build geometric solutions in practical scientific difficulties." It reached (3.77), with a high degree, and phrase (6) came in penultimate order, stating that "the reality of development programs for science teachers for the intermediate stage in the Kingdom indicates that they develop the skills of selecting modern models for science subjects," with an arithmetic average of (3.80) and a high degree.

Table 9. Means and Standard Deviations for the Sample's Responses about Professional Development Programs' Inclusion of NGSS

NO.	Dimension	Mean	Standard deviation	The reality of prof. development	Ranking
1	Central ideas	3.86	0.839	High	3
2	Common concepts	4.00	0.635	High	2
3	Scientific and geometric practices	4.02	0.475	High	1

The sample's high estimate for including Next Generation Standards (NGSS) scientific and engineering practices in professional development programs for science teachers in the intermediate stage is because the current professional development programs depend on the standards of science teachers recently issued by the Education and Training Evaluation Authority, which confirmed standards 2,5,6 on knowledge of the scientific method. The standard outlines scientific and engineering procedures for the next generation. Standard 4,5,6 covered basic math abilities, data representation, and scientific and engineering methods (Education and Training Evaluation Authority, 2019). This validation of science teachers' standards in the Kingdom helped construct professional development programs that improve these components, and instructors welcome their inclusion.

The study confirms that teachers (the study sample) believe the Ministry of Education's professional development programs give them the skills to apply scientific engineering practices. Still, these results don't agree with Al-Ahmed and Al-Muqbil (2016), who emphasized the need for female teachers to be aware of the next generation's science standards. Some may see that the difference can be attributed to changes in professional development programs over time. Still, the study's results do not agree with a study (Al-Dhubyani and Al-Sufyani, 2021) that confirmed science teachers' activation in the intermediate stage of scientific and engineering practices. In general, it was low, with an arithmetic mean of 2.44 and a standard deviation (.30), and there is a slight discrepancy between scientific and engineering practices in the degree of activation by science teachers at the intermediate stage, as it ranged from a medium activation degree) of 2.96 to a very low degree of activation (1.54), and no practice has achieved a high or very high degree of activation, indicating the need for more studies. The teachers' perspective on the skills and practices they possess may not mean they have acquired them effectively, and what teachers do in the classroom helps students engage in investigative practices similar to what scientists do, confirming the results of students in the Kingdom of Saudi Arabia in international tests, especially tests Excellence, where the Kingdom ranked 35 out of 39 countries in 2019. (Education and Training Evaluation Authority, 2019).

Table (10) shows that the Ministry's professional development programs included science standards for the next generation to a high degree. The acquisition of scientific and geometric practices ranked first, with an arithmetic mean of 4.02 and a standard deviation of 0.475, followed by teachers' addition of familiar concepts with an average of 4.00 and a standard deviation of 0.635. The professional development of the central ideas is also high, with an

arithmetic mean of 3.86 and a standard deviation of 0.839. From this, it became clear that the development programs provided to science teachers in the Kingdom of Saudi Arabia include science standards for the next generation and scientific practices. The nature of science requires scientific practices and the use of models and procedures. Experiments and this study agreed with Al-Abous et al. (2019) but not with Al-Ahmed and Al-Muqbil (2016), which underlined the necessity for female teachers to know science standards for the next generation. The difference between the two studies may be due to time and the development of professional development programs presented by the Ministry of Education to keep pace with the vision of 2030 and to adopt the standards of science teachers issued by The Education and Training Evaluation Authority on available international and Arab experiences.

Thus, we can summarize the result as follows:

The results of the first question showed that the professional development programs for science teachers in the intermediate stage included the central ideas according to the next-generation standards NGSS to a high degree, with an arithmetic average of (3.86), and the highest phrase was the phrase (7). It states, "Professional development programs include applications that help teachers teach central ideas" with a high degree of inclusion (3.97), and that the least included phase in professional development programs related to central ideas according to the Next Generation Standards (NGSS) was the phrase (3). It says, "Earth and space sciences are significant to these programs," with a mean of 3.70 and high inclusion.

Second-question results: The results showed that the arithmetic average of the degree of professional development assistance provided by the Ministry of Education in the intermediate stage to provide teachers with Next Generation Standards (NGSS) common and interrelated concepts reached (4.00) and with a high degree, and came in the first order. "The reality of development programs for intermediate science teachers in the Kingdom suggests that they enable teachers to identify the main physical ideas," with a 4.22 average and a very high degree, and last rank item (7) states. "Teacher development programs show science at the intermediate stage in the Kingdom allows teachers to analyze geometry and technology to a high degree (3.73 average).

Third-question results: The results showed that the arithmetic average of a degree that helps professional development programs offered by the Ministry of Education in the intermediate stage to provide science teachers with scientific and geometric practices according to Generation Standards (NGSS) reached (4.02) and with a high degree, and came in the first order phrase (4) which states, "The reality of the development programs for science teachers for the intermediate stage in the Kingdom indicates that they provide teachers with the skills to ask questions in practice: with an arithmetic average of (4.18), and with a high degree. The results showed that the least appreciated expression by the study sample was (11), which states the reality of the development programs for intermediate science teachers in the Kingdom shows they offer instructors the skills to innovate geometric solutions in practical science difficulties, with an average of (3.77) and a high degree.

5. Conclusion

This paper aims to determine the reality of professional development programs for middle school science teachers in Saudi Arabia in light of the Next Generation Science Standards (NGSS). In a middle school in Saudi Arabia, the researchers used a descriptive analysis method. The method was applied to the study instrument and its sample, i.e., all 135 science teachers in the middle school in the Al-Kharj governorate. The research has achieved several significant results, the most important of which are:1. In-service training programs for middle school teachers include key ideas according to the standards of the next generation (. 06). a high grade, and an arithmetic average of 3.86.2. The degree of support provided by the professional development programs through the Ministry of Education in the middle stage of teaching teachers the common concepts according to the standards of the next generation was high, and an average arithmetic value was estimated at (4). In the middle stage of teaching science, teachers based their science and technology practices on the next-generation standards, and the professional development programs of the Ministry of Education were of a high level, with an average arithmetic value of 4.02.4: First-order scientific practice was one of the most important professional development programs for science teachers in Saudi Arabia. It included science standards for the next generation. This may be because science requires scientific practices, models, and experiments. This study did not agree with the study by Ahmad and Future (2016), which stressed that teachers need to know the science standards for the next generation. This can also be attributed to the accreditation of science teachers by the Commission for Educational Evaluation and Training based on international and Arab experiences. Based on the results of the study, some recommendations were made.

6. Recommendations

The researchers recommend that departments of education continue to offer professional development programs for science instructors following the science standards for the future generation. They recommend conducting more studies examining the effect of professional development on the implementation of science standards for the future generation by science teachers; conduct a similar investigation to determine the reality of professional development programs for science teachers throughout the provinces and governorates of the Kingdom of Saudi Arabia. They also recommend conducting studies establishing a relationship between Saudi Arabian and worldwide science norms.

7. Suggestions

The researchers propose that future researchers study "The Next Generation Science Standards (NGSS) and examine the relationship between middle school science teachers' professional development programs and their teaching practices." They also propose a study to determine the influence of intermediate-level Next Generation Science Standards (NGSS)-aligned professional development workshops on students' scientific and geometric practices.

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