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A Gender-Based Comparison of Science Teachers' Knowledge about Instructional Strategies

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Abstract
This research study delves into the realm of science education, specifically focusing on the knowledge and utilization of instructional strategies by science teachers. The primary objective is to investigate whether there are discernible gender-based differences in science teachers' awareness, understanding, and implementation of various instructional strategies, encompassing lecture-based methods, demonstration techniques, problem-solving approaches, questioning and inquiry-based strategies, as well as cooperative learning strategies within the classroom. The study employs a quantitative methodology, utilizing multiple-choice questionnaire (MCQs) to gather data from a diverse sample of 826 secondary school science teachers and analyze the gender-based level of secondary school science teachers' knowledge about instructional strategies using Microsoft Excel and Statistical Package for Social Science (SPSS-24). This study uncovers that gender-based differences exist not only in the level of awareness and understanding of instructional strategies but also in their practical implementation. The outcomes of this study hold significance for both educational theory and practice. By identifying gender-related trends in science teachers' instructional strategy awareness and application, science teachers, administrators, and policymakers can gain insights into areas that might necessitate targeted professional development or intervention.

Keywords: Instructional strategies, lecture strategies, demonstration strategies, problem-solving strategies, questioning strategies, and cooperative learning strategies

1. Introduction

The teaching profession eventually rises to a crucial standing in society and serves as a basis for other professions. To fulfill the emerging demands of the teaching profession, it is a need of the hour to make the teachers well-trained with modern instructional strategies (Özdem Yilmaz et al., 2017). Science education is a crucial aspect of modern education, and science teachers play a vital role in shaping the future of the scientific community. One of the key factors in ensuring effective science education is the use of appropriate instructional strategies that can help students better understand scientific concepts and principles. Therefore, it is essential to explore science teachers' knowledge about instructional strategies, as this knowledge can significantly impact the quality of science education. Moreover, previous studies have emphasized that instructional strategies can be quite effective at fostering opportunities and offering guidance for teachers to improve teachers' ability to employ argumentation in the context of science education (Erduran, & Jiménez-Aleixandre, 2008; Özdem Yilmaz et al., 2017). Various studies highlight that an effective teacher plays a central role in student learning (Darling-Hammond, 2000; Marzano, 2007). Additionally, Marzano (2007) describes that an effective teacher adopts the strategies according to the students' needs and interests.

On the other hand, according to Ganyaupfu (2013), many science teachers do not employ student-centered instructional strategies or integrate various technologies effectively to enhance students' critical thinking and comprehension. The goals and objectives outlined in the curriculum that they are teaching are not being fully pursued by the teachers. Mostly, teachers fail to adapt strategies that create meaningful learning experiences aligned with students' learning styles. Most of the time, teachers do not adequately plan and develop effective lessons based on knowledge of the classroom by organizing instructional activities and materials to attain lesson objectives. Consequently, students lose interest in teacher-centered instructional strategies and become passive learners, negatively affecting their academic performance.

In addition, Shakir (2012) revealed that "most of the teachers show a poor performance infusing a variety of instructional approaches, to attain curriculum objectives, effects out of school activities, various classroom management techniques, value the pedagogy of collaboration, developing problem-solving skills among students, teamwork and cooperative learning" (p.269) and suggested that "more emphasis should be put on developing good lesson planning skills during training by providing more opportunities for lesson planning and by showing them model lesson plans developed by the expert teacher trainers". Moreover, a similar outcome was discovered in Pakistan by Almani (2002), where teachers, particularly female teachers, exhibited higher on planning of instructional strategies after they received in-service training.

To the best of our knowledge, there has not yet been a thorough investigation into the impact of the instructional strategies recommended by the National Professional Standards for Teachers. The current study sought to fill this gap in the literature by examining the knowledge of secondary school science teachers about five instructional strategies, including lecture, problem-solving, demonstration, questioning, and cooperative learning strategies. Numerous studies conducted by educators and research scholars have put forward various teaching strategies aimed at improving and revolutionizing the process of teaching and learning (Leikin & Zaslavsky, 1997; Saido et al., 2017; Slavin, 2005; Van Breukelen, Van Meel, & De Vries, 2017). The primary goal of these strategies is to offer guidance to teachers to enhance their teaching abilities, leading to a transformation in their classroom teaching practices (Culyer et al., 2018; Sinapuelas et al., 2019; Tavoosy, & Jelveh, 2019).

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In the twenty-first century, there is a widespread global emphasis on fostering scientific literacy to meet the challenges of life and to understand the universe. In this regard, over the past few decades, science has become a core subject area in the school curriculum. Today there is more interest than ever in the teaching of science, especially at the secondary level. The science teacher can play a crucial role in helping pupils learn the principles and procedures of science by acting as the center of this attempt. A science teacher should not only have adequate knowledge of science as well as effective manners of science teaching to foster a deep comprehension among the pupils (Mohan, 2019).

Teachers' instructional knowledge is focused on their comprehension of how this knowledge behaves in the teaching-learning process, particularly how it can be applied to decisions about lesson planning or making on-the-spot judgments in the classroom (Guerriero, 2014; Leuchter et al., 2020). In a similar vein, teachers' knowledge of instructional techniques plays a pivotal role in enhancing their teaching practices in the classroom. The way that teachers educate has a direct impact on how well their pupils learn (Hill & Chin, 2018). To improve teacher competencies and establish a conducive learning environment, it is essential that they have a solid understanding of instructional strategies (Barendsen & Henze, 2019; Depaepe, & König, 2018).

The basic intention of the study at hand is to assess secondary school science teachers' knowledge, about instructional strategies including lecture strategies, demonstration strategies, problem-solving strategies, questioning inquiring strategies, and cooperative learning strategies. One aspect that might be explored in this regard is the potential impact of gender on science teachers' knowledge about instructional strategies. Studies have revealed that male and female students often have distinct learning preferences and styles, which has been a topic of discussion on gender differences in education for several decades. There may be similar gender-based differences exist among science teachers' knowledge about instructional strategies. Consequently, a gender-based comparison might be quite insightful into the potential impact of gender on science teachers' knowledge about instructional strategies. In this context, science teachers with a comprehensive knowledge of instructional strategies can significantly contribute to developing teaching skills to promote effective teaching of science subjects. From the Pakistani perspective, fewer efforts have been made to investigate the process of science teaching. Keeping in view the importance of said aspects, the researchers have decided to undertake research titled "Exploring science teachers' knowledge about instructional strategies: gender-based comparison".

1.1. Knowledge about Lecture Strategies

Lecture strategy is the teachers' ability to convey effectively the different concepts and ideas to facilitate comprehension and a broader understanding of the subject matter among students through presentation format typically within a classroom setting. Conventionally, it is characterized by the term "spoon-feeding in which students tend to be passive participants, while teachers assume a prominent and active role (Umoren 2001; Onweh & Akpan 2014).

Additionally, Mutrofin et al., (2019, p. 203) stated that "The term lecture describes the application designed to address weaknesses and refers to a modification of conventional lecture method—by interspersing the short period of presenting information by questions asked by teachers systematically—that is very behavioristic in nature based on cognitive learning theory, i.e., the information processing theory and constructivism".

Due to its low cost, rapid adoption, and broader applicability, teachers have proposed various modifications for the effectiveness of the lecture method. For instance, to boost student participation, teachers may use real-world examples and foster a discussion-oriented environment. As well, instructors can incorporate videos into their lectures to enhance student engagement and make them more attractive. The utilization of presentation tools like PowerPoint can also add to the worth of this traditional method. The present research contends that implementing lecture strategies that encourage experimentation among teachers can mitigate the limitations of this traditional method and contribute to improving teaching skills. For instance, the National Professional Standards for Teachers not only permits but also encourages educators to innovate their lecture techniques in the classroom. Teachers knowing about lecture strategy can better shape and develop their teaching skills.

1.2. Knowledge about Demonstration Strategies

Akinbobola and Ikitde (2011), Giridharan, and Raju (2016,) defined demonstration strategy as "demonstration strategy is a method of teaching concepts, principles of real things by combining explanation with handling or manipulation of real things, materials or equipment". Proceeding further, demonstration strategies provide a multifaceted approach to explaining various concepts and ideas, granting them an advantageous edge over narration-based traditional teaching methods (Cotos et al., 2017; Garcia et al., 2018).

In addition, Giridharan and Raju (2016) pointed out that "In-class demonstrations, a standard constituent of science courses in schools and universities, are generally believed to help students understand science and to stimulate student interest. Most students get a great deal more out of visual information than verbal information (spoken and written words and mathematical formulas). Demonstrations provide a multi-sensory means to describe a concept, idea, or product that may otherwise be difficult to grasp by verbal description alone" (p.175). Expanding upon the preceding discussion, the present study argues that a secondary school science teacher who has an in-depth understanding of the demonstration strategies and knows how to use them effectively can create a learning environment that not only captivates students but also amplifies their enthusiasm for studying science. Moreover, it would boost secondary school teachers' self-confidence in their abilities to blend the lecturing activities with hands-on activities to improve their teaching techniques. In light of this, secondary school science teachers' knowledge about demonstration strategies can positively shape their teaching skills.

1.3. Knowledge about Problem-Solving Strategies

Problem-solving refers to "a process by which the learner combines previously learned elements of knowledge, rules, techniques, skills, and concepts to provide a solution to a novel situation" (Orton, 1992, p. 35). In science teaching, problem-solving is an important pedagogical instrument for the teachers and is considered as the core of scientific inquiry. Teachers can lead and assist students in shaping and developing their problem-solving skills, enabling them to understand and participate in the scientific investigative process, which will foster a constructive impact on their entire learning experience.

As an extended view of Perdomo-Díaz et al., (2016) in their case study, much of the emphasis is put on the rich understanding of problem-solving strategies which can serve as an essential element in the nourishment of the critical and creative thinking skills of teachers which can play a vital role in their professional growth and development.

It is also expounded by the previous research that the teachers who are better equipped with a sense to comprehend problem-solving strategies are more efficient in the application of these strategies to sustain a conducive learning environment. This favorable learning atmosphere will surely assist students, to make a considerable rise in their level of satisfaction, to enhance their performance, and to achieve their academic goals (Ali et al., 2010; Das & Das, 2013; Perdomo-Díaz et al., 2016).

In the light of above facts, this ongoing research propounds that, a teacher of science at the secondary school level, who is equipped with the knowledge of problem-solving techniques can establish and further innovate already available teaching strategies for the betterment of a conducive learning environment, which will be equally fruitful for both the learners as well as the teachers for the comprehension of science as a subject.

1.4. Knowledge about Questioning Strategies

Questioning has always been one of the most effective components which has served best as an effective tool for engaging students in the learning process in the realm of effective teaching. To fetch and grasp students' active participation in the learning process, this tool is very effectively used by teachers at almost all levels of school education (Amos, 2002; Glenn, 2001; Sigel, Kress & Elias, 2007).

Ughamadu (2006) has suggested some guidelines that can be very helpful for teachers to form effective questions for the implementation of the question-answer strategy. Firstly, teachers' manners should be very friendly, approachable, and inspiring while raising questions from the students. Secondly, the tone should not be offensive and authoritative in the questioning process so that the students may not feel any kind of embarrassment or threat while making responses to those questions rather teachers should have a caring attitude and affection toward their learners to boost their confidence and to ensure their active involvement in the learning process. Thirdly teachers should formulate questions that always have room for diverse opinions and adaption to nurture the students creative and critical thinking skills. Fourthly, the questions should be logically structured, free from grammatical errors, and should be posed by teachers with positive and friendly gestures. Lastly, the language employed in tailoring these questions should be quite by the level of understanding and abilities of the students.

It is also highlighted by the previous research that inquiry-based teaching has a very positive impact on teachers' professional development. For instance, Lotter, Thompson, Dickenson, Smiley, Blue, & and Rea (2018), propounded in an empirical study that inquiry-based teaching practices play a pivotal role in shaping teachers' self-efficacy and enhancing their professional competencies. Teachers with a thorough understanding and knowledge of effectively implemented inquiry strategies can cleanse their skills to gain competitive excellence over their peers. Exactly in the same manner, Lotter and Miller (2017), during an empirical study on the investigation of questioning strategies, suggested that teachers who are more eager to utilize questioning strategies and more capable of enhancing their teaching capacities and more efficient in ensuring the learner's active participation in the teaching-learning process.

1.5. Knowledge about Cooperative Learning Strategies

According to Buchs et al. (2017) and Slavin (2014), cooperative learning is an instructional strategy that encourages students to collaborate in well-organized groups. Cooperative learning is one of the important instructional strategies that have the potential to enhance social, motivational, and cognitive outcomes (Hattie, 2008; Johnson & Johnson, 2009; Kyndt et al., 2013; Rohrbeck et al., 2003; Slavin, 2014). Buchs et al. (2017) highlighted that "Cooperative learning involves small teams working together to support all members' learning. It provides teachers with principles to stimulate constructive interactions between peers. These principles can be organized in two interconnected sets: organizing peer interactions in the context of academic tasks and preparing pupils for constructive interactions with their peers".

According to Vasquez (2008), "Effective science teachers can recognize and probe for students' preconceptions based on their everyday experiences and intuitive notions, understand what it means to do science, and provide opportunities for students to take a metacognitive approach to learn. Beyond these three guiding principles, effective teachers of science have classrooms that are learner-centered, knowledge-centered, assessment-centered, and community-centered. (p. 7)".

1.6. Problem Statment

The purpose of the study titled "Exploring Science Teachers' Knowledge about Instructional Strategies: Gender-based Comparison" is to investigate and compare the knowledge and understanding of instructional strategies among science teachers, with a specific focus on potential gender-based differences. Hence the objective of the study is to explore the gender-based difference in secondary school science teachers' knowledge regarding instructional strategies.

1.7. Research Questions

- Is there any significant difference between male and female secondary school science teachers' knowledge about instructional strategies?
- Is there any significant difference between male and female secondary school science teachers' knowledge of lecture/discussion strategies?
- Is there any significant difference between male and female secondary school science teachers' knowledge of problem-solving strategies?
- Is there any significant difference between male and female secondary school science teachers' knowledge about demonstration strategies?
- Is there any significant difference between male and female secondary school science teachers' knowledge about questioning/inquiry strategies?
- Is there any significant difference between male and female secondary school science teachers' knowledge of cooperative learning strategies?

2. Methodology

The methodology is "the method used in conducting the investigation" (Antwi & Hamza, 2015, p. 218). The study at hand was descriptive and the survey method was used for data collection. A survey study is defined as "the collection of information from a sample of individuals through their responses to questions" (Check & Schutt, 2012, p. 160). It is commonly used to characterize and investigate human behavior, making it a frequent tool in social and psychological studies (Singleton & Straits, 2009).

The process of sample selection was carried out by using a multistage sampling technique. "It is used when creating a sampling frame is nearly impossible due to the large size of the population. In this sampling technique, the population is divided by geographic location into clusters" (Elfil, & Negida, 2017, p. 1). From a pool of nine divisions, the researchers initially used a random sampling technique to choose three divisions—Rawalpindi, Lahore, and Bahawalpur—each representing a division in Northern, Central, and Southern Punjab. Subsequently, one district was again randomly chosen from each division in the second stage. Moving on to the third stage, 30 percent of secondary schools for both males and females were chosen from each district, namely Rawalpindi in northern Punjab, Kasur in central Punjab, and Bahawalpur in southern Punjab. In the fourth stage, a census sampling technique was employed to encompass all science teachers within the selected districts. The outcome of this complex process yielded responses from 826 (male and female) science teachers out of a total of 1093, across all the initially selected secondary schools. The table provided below depicts the process through which sample respondents were chosen:

Table 1: Selection of sample respondents

Sr. No	Districts	Sampling Frame	Randomly Selected Participants		Total Respondents
			Male Science Teachers	Female Science Teachers	
1	Rawalpindi	504	207	123	330
2	Kasur	275	163	98	261
3	Bahawalpur	314	149	86	235
	Total	1093	519	307	826

The above table illustrates the distribution of science teachers across three districts: Rawalpindi, Kasur, and Bahawalpur. In Rawalpindi, there were a total of 330 participants (207 male and 123 female science teachers). Kasur district had 261 participants (163 male and 98 female science teachers), while Bahawalpur district had 235 participants (149 male and 86 female science teachers). This accumulated to a total of 826 respondents for the study.

3. Instrumentation and Data Analysis

A multiple-choice questionnaire (MCQs) was employed to assess science teachers' knowledge of instructional strategies developed by the researchers. The developed test's internal consistency and reliability were determined using the Kuder-Richardson Formula 20 and the difficulty index, discrimination index, distractor efficiency, and other metrics.

To measure the level of secondary school science teachers' knowledge about instructional strategies, data was collected from 826 secondary school science teachers with the help of a multiple-choice questionnaire (MCQs). The level of secondary school science teachers' knowledge about instructional strategies was determined using Microsoft Excel and Statistical Package for Social Science (SPSS-24). The observed values and results are shown in Table 2.

Table 2: Comparison of science teachers' knowledge about instructional strategies

	N	Mean	SD	t	df	*p*
Male	519	18.97	6.19	-2.596	824	0.010
Female	307	20.09	5.62			

Analysis in the above table reveals that a significant difference exists in the science teachers' knowledge about instructional strategies (p=.010<.05). Moreover, female science teachers' knowledge about instructional strategies is relatively higher as compared to male science teachers.

Table 3: Comparison of science teachers' knowledge about instructional strategies

Instructional Strategies	Mean		SD		t	*p*
	Male	Female	Male	Female		
Lecture/Discussion Strategies	2.65	2.84	1.50	1.42	-1.738	0.083
Problem-Solving Strategies	2.17	2.36	1.15	1.12	-2.366	0.018
Demonstration Strategies	2.44	2.48	1.10	1.02	-0.548	0.584
Questioning/Inquiry Strategies	3.55	3.82	1.45	1.29	-2.695	0.007
Cooperative Learning Strategies	3.86	4.16	1.67	1.43	-2.667	0.008

*p<0.05 (N=519, n= 307)

The table reveals that there was no difference in the male and female science teachers' knowledge about certain instructional strategies like lecture/discussion strategies and demonstration strategies. However, a significant difference in the science teachers' knowledge was evident specifically concerning problem-solving strategies (p = .018 < .05), questioning/inquiry strategies (p = .007 < .05), and cooperative learning strategies (p = .008 < .05). In these three areas, female science teachers' knowledge about instructional strategies rendered better knowledge.

4. Discussion

One of the most important aspects of effecting teaching is Pedagogical Content Knowledge (PCK) which further encloses various other components as identified in the literature. These components involve content-based knowledge, comprehension of teaching strategies, acquaintance with concept representation, understanding of teaching context, knowledge of learners, and knowledge of assessment in learning science specifically in the context of teaching science as a subject. Although several studies have explored these components, only a limited body of work has focused on the investigation of science teachers' PCK (Halim et al., 2014). This study endeavors to delve into the fathoms of effective teachers' knowledge regarding the implementation of teaching strategies for learners belonging to diverse cultures. It is very pertinent to emphasize the point that only the knowledge of content is not adequate for effective teaching. Teachers are also required to be proficient in pedagogical knowledge and approaches which involve a profound understanding of various teaching strategies (Aksu et al., 2014; Koehler & Mishra, 2009).

Moreover, there is a consensus in the annals of literature about the paramount significance of general pedagogical knowledge in the profession of teaching (Darling-Hammond & Bransford, 2005; Grossman & McDonald, 2008; Munbys et al., 2001; Woolfolk Hoy et al., 2006). Doyle (2006), in this context, outlined two challenges faced by teachers in the educational process. Firstly, teachers must be proficient in classroom management and should have the capability to effectively control and manage their classrooms, to ensure students' active participation in the classroom tasks. Secondly, teachers must have a strong competency and command over the various teaching methods and strategies and can utilize them in a better way to achieve the desired goals. Students in a classroom may belong to diverse cultures and backgrounds and to maintain a suitable learning environment and entertain individual concerns, teachers must possess a wide range of methodologies, techniques, and strategies. No single method will be effective in a particular situation rather the combination of various methods and amalgamation of certain different techniques and strategies will prove beneficial for any given educational setting (Oser & Baeriswyl, 2001).

The analysis unveils astonishing differences in the knowledge of instructional strategies in male and female science teachers. The study reveals that female teachers are more proficient in certain approaches and technical skills, such as problem-solving, questioning, and cooperative learning strategies whereas no significant difference is found in male and female science teachers when it comes to areas like lecture/discussion, and demonstration strategies and competency in the said areas is not gender-dependent. So, it is evident that both male and female teachers had relatively similar levels of knowledge in these areas. Talking about the differences and similarities between male and female teachers, there is a complex interplay of certain factors which include professional development opportunities, teaching styles, experience level, social influences, and individual priorities and preferences. Moreover, for a better management of available resources, and instructional time, teachers should have a sound knowledge of active and smart teaching strategies and strong know-how of the application of teaching strategies for the promotion of students' conceptual participation in various topics of science teaching.

5. Conclusion

The conclusion is drawn based on the analysis of the data that female science teachers tend to have relatively higher knowledge about instructional strategies compared to male science teachers. Particularly in the context of problem-solving strategies, questioning/inquiry strategies, and cooperative learning strategies, female science teachers possess better knowledge about these instructional strategies compared to male science teachers. However, the analysis suggests that there was no statistically significant difference in the knowledge of male and female science teachers when it comes to certain instructional strategies like

lecture/discussion strategies, and demonstration strategies. This implies that both male and female teachers had relatively similar levels of knowledge in these areas.

6. Implications

To address the needs, identified by the data of the study, schools and educational institutions can frame and structure various professional development programs. There is a dire need to conduct different sessions for training male professionals to enhance their knowledge of problem-solving strategies, questioning/inquiry strategies, and cooperative learning strategies and these training sessions can prove beneficial for them. Female teachers may take advantage of professional development techniques to extend the range of their professional skills and experience. For designing a professional development program, institutions and policy-makers should be sensitive to potential gender biases. The main goal is to ensure equal and indiscriminative opportunities for professional growth and development irrespective of any gender biases in the field of modern education.

Schools can administer periodic assessments to check teachers' knowledge about instructional strategies to identify the domains of improvement and to estimate the rate of progress over time. The areas where teachers are relatively weaker can be improved by providing them with resources, such as workshops, seminars, and orientation sessions at schools on instructional strategies, which will empower teachers' proficiency and skills. This time-to-time assistance will surely help both male and female science teachers to grow professionally and deliver well-arranged, organized, and more effective lessons to their learners.

Institutions can encourage science teachers to partake in innovative initiatives and educational research. This can arouse a culture of continuous professional improvement and also attain a willingness on the part of teachers to explore modern educational and instructional strategies. After the critical analysis of data drawn from different sources, this study, as a whole provides keen insights into the areas of growth for the teachers of both genders. By the implementation of these innovation strategies and insights, an institution can establish a supportive learning environment to promote professional growth which consequently proves beneficial for the students' learning outcomes.

Suggestions for Future Research

Further study on the same topic may also be undertaken from a qualitative perspective to gain a clearer and deeper understanding of the knowledge of science teachers regarding instructional strategies.

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