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Science Teachers' Pedagogical Orientations Versus Students' Preferred Orientations in Pakistan

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ABSTRACT

Previous studies have sufficiently debated science teachers' pedagogical orientations (PO); however, research on students' preferred or desired orientations is scarce. This study determined students' preferred teaching orientations in relationship with their teachers' PO. The sample included 313 grade VIII students and 94 teachers from middle schools in Peshawar-Pakistan. Three vignettes from the Pedagogy of Science Teaching Tests (POSTT) were used to find PO. Data was analyzed using frequency count, means, and t-test. The findings revealed students' and teachers' preferences for didactic direct and active direct orientations. However, the choice of orientation varied with the nature of the topic. The students and teachers showed the least preference for open inquiry orientation. A significant positive correlation existed between teachers' PO and teaching experience, and a negative correlation existed between students' preferred orientations and academic achievement in the general science subject. Interestingly, students with higher test scores preferred teacher-centered instead of student-centered orientations. The study suggests improving teacher education programs to train science teachers in inquiry orientations and its proper integration with science content at all levels.

Keywords: Didactic teaching, education quality, inquiry, pedagogical orientations, process innovation, teaching orientation

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INTRODUCTION

Pedagogical orientations (PO) refer to teachers' preference toward a specific type of instruction or teachers' predisposition toward an instructional approach. It is a critical element of the pedagogical content knowledge (PCK) model for science teaching (Friedrichsen & Dana,

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2005; Magnusson et al., 1999). Anderson and Smith (1987) defined its orientation toward science teaching and learning as the "general patterns of thought and behavior related to science teaching and learning." They identified four teaching orientations: activity-driven teaching, didactic teaching, discovery teaching, and conceptual-change teaching. All these orientations focus on teachers' behavior during science instruction. Some years later, Magnusson et al. (1999) added five more orientations to Anderson and Smith's model: process, academic rigor, project-based science, inquiry, and guided inquiry. Later, Friedrichsen (2002) categorized these orientations into two types: teacher-centered and student-centered orientations. The former relates to didactic and academic rigor, while the latter corresponds to the reform efforts of the 1960s (process, activity-driven, discovery) and contemporary reform efforts and curriculum projects (like conceptual change, project-based, inquiry, and guided inquiry).

The knowledge of PO is helpful to science teachers because it guides their instructional process, assessment procedures, content coverage, and textbook use. These fundamentals can influence teachers' teaching methodologies, classroom management, and student interactions (Revathi & John, 2019). Distinct PO reflects differing perspectives on the essence of knowledge, how acquiring knowledge occurs, and the teacher's and student's involvement in the learning process. Teachers lacking knowledge of PO are more likely to use teacher-centered orientations. Traditional techniques where teachers have primary control in the classroom. They usually incorporate lectures, repetitive learning, and personalized guidance. Students often receive knowledge passively in such settings. In contrast, knowledge of PO will enable a science teacher to choose an appropriate orientation to teach a particular topic. A science teacher may have more than one pedagogical orientation and thus may follow different instructions depending on the nature of the topic and the grade level (Magnusson et al., 1999).

Various factors influence teachers' PO. The first is the teachers' previous job or college experiences (Friedrichsen & Dana, 2005). The teachers would usually adopt a teaching orientation that they are familiar with or have been doing in the past. It also supports the utility of teacher training or taking a science method course. Sahingoz and Cobern (2020) found that teachers who had taken a science method course usually adopted a student-centered orientation. It may be taken with caution as teachers in Pakistan follow teacher-centered pedagogies despite having studied science method courses (Faize et al., 2023). A possible reason for this may be the quality and interaction of science students during classroom instruction. Friedrichsen and Dana (2005) supported this contention that classrooms with passive learners encourage science teachers to use didactic approaches and vice versa. Lastly, science teaching orientation is also influenced by the time available to cover the science syllabus.

Student-centered orientations are time-consuming approaches that science teachers usually avoid completing the course on time.

The literature review on PO has focused on either pre-service or in-service teachers while neglecting how science students preferred to be taught. Pre-service science teachers usually prefer didactic orientation (Cansiz & Cansiz, 2016; Feyzioğlu, 2015), while some studies have observed inquiry orientations and orientations that lie between didactic and inquiry (Güven et al., 2019; Sahingoz & Cobern, 2020). These studies observed that the subject matter influenced teachers' PO, selection of objectives for teaching a topic, students' and teachers' roles, grade level, and familiarity with the science method course. Sahingoz and Cobern (2020) found that pre-service science teachers who had studied a science method course opted for guided and open inquiry approaches. In contrast, teachers who had not studied science method courses chose didactic direct orientation. However, the small sample size (N = 20) limited the generalizability of this research. Listiani et al. (2019) explored the PO of 57 pre-service Biology teachers in Indonesia. They found that teachers who had studied science teaching courses had less variation in their PO and would choose inquiry orientations compared to those in their earlier semesters.

In another study, Cansiz and Cansiz (2016) explored the science teaching orientation of eleven pre-service teachers enrolled in an elementary science program. They used the content representations (CoRe) instrument developed by Loughran et al. (2008) to explore the teaching orientations of science teachers based on Magnusson et al. (1999) nine orientations classification. They found that 37% of CoRe reflected didactic orientation as the most preferred teaching orientation. No orientation was observed related to conceptual change and activity-driven approaches. The teachers also had multiple orientations based on the nature of the topic. However, some teachers also exhibited multiple teaching orientations, even for a specific topic. One reason for multiple orientations might be the objectives of teaching a topic mentioned in the national science curriculum. Whether cognitive or psychomotor, the nature of objectives guides the teacher toward a specific teaching orientation.

However, the PO of in-service teachers was influenced by school location, resource availability, and schools' expectations. A study by Ramnarain and Schuster (2014) examined 200 in-service teachers from two locations: township and suburban schools. The Pedagogy of Science Teaching Test (POSTT) explored the PO. The findings revealed different pedagogical orientations due to differences in locality, resources, and schools' expectations. The township teachers were strongly inclined toward active direct teaching, while the suburban teachers exhibited a guided inquiry orientation. Would this also mean that teachers teaching in a suburban school with an inquiry orientation switch to didactic instruction if transferred to a township school and vice versa? The answer is affirmative because Ramnarain and Schuster (2014) concluded

that teaching orientations are influenced by the schools' location and the type of available school resources.

Furthermore, the PO is also influenced by the social context available in a school. By social context, we mean the social environment in the school, the diversity of various cultural and ethnic groups, language differences, and students' socio-economic status. Mavuru and Ramnarain (2018) investigated how this social context influences the pedagogical orientation of in-service teachers in three township schools in South Africa. The students in the three schools had diverse social and cultural backgrounds and socio-economic statuses and spoke different languages, thus providing a rich background for their study. The researchers used semi-structured interviews and classroom observations for data collection. The results indicated that the learner's social and cultural background, beliefs, and experiences influenced science teachers' orientations. They identified only two orientations, process and activity-driven, given by Magnusson et al. (1999), while the remaining seven were not traced. The small sample size and the few observed lesson plans might be a possible reason for this. However, considering the importance of social context in molding teaching orientation, there is a need to overhaul the pre-service teacher training program regarding the social and cultural context and educate prospective teachers to consider these socio-cultural factors during classroom instruction.

Another influencing factor is teachers' beliefs about learning because these beliefs influence teachers' classroom practices. To investigate this relationship, Boesdorfer (2014) observed the classroom practices and beliefs of an experienced Chemistry teacher known for reform-based teaching. The researcher also collected data through interviews and teaching documents (worksheets, lesson plans, handouts, and assessments). The findings revealed that the teacher's belief in science teaching and learning was aligned with her classroom practices, which means that teachers' beliefs are an essential indicator of their teaching orientation. We may question this finding because it was concluded from a single case study of one Chemistry teacher. However, the finding is also supported by Magnusson et al. (1999) model that teaching orientation influences and is influenced by the other areas of PCK, including instructional practices and teachers' beliefs.

While all the above studies are referenced internationally, limited research has been conducted on teachers' pedagogical orientations in Pakistan. For example, some studies have observed that Pakistani teachers tend to have a traditional, teacher-centered orientation, relying on rote learning and lecture methods (Faize, 2011; Zafar et al., 2022). In addition, teachers in Pakistan often lack proper training in pedagogy and may not fully understand the principles of student-centered learning (Dahar & Faize, 2011a). Besides, Pakistan's education sector faces numerous challenges, including low enrollment, high dropout rates, and

a low educational budget. The lack of knowledge about teachers' pedagogical orientations in Pakistan highlights the need for further research and professional development opportunities for teachers. By gaining a deeper understanding of teachers' orientations, policymakers and educators can work towards creating a more student-centered education system and improving student outcomes. Besides, this study also aimed to find students' desired orientation in Pakistan in relation to their teachers' PO. The findings will be helpful to teacher training institutes and science educators regarding the existing educational practices in science education and initiating efforts to improve the learning and instruction of STEM subjects during the rapid technological challenges.

Theoretical Framework

Pedagogical orientations can be assessed through various instruments such as the card-sorting task (Friedrichsen & Dana, 2003), Content Representations (CoRes) (Loughran et al., 2008), and Pedagogical orientations toward science inquiry teaching (POSITT) (Renee'S et al., 2010). However, this study used the Pedagogy of Science Teaching Tests (POSTT) Cobern et al. (2014) developed. POSTT is a tool that has been specifically developed to assess the pedagogical views and behaviors of teachers in relation to the teaching of science. The POSTT framework differentiates conventional, instructor-focused, and modern, learner-centered (or inquiry-based) methodologies. The reasons for choosing POSTT are its reliability in assessing pedagogical orientations, ease of analysis, and the availability of many pool items from different school science areas. Each POSTT item reflects a vignette with four options. The participants are asked to read the vignette and choose one option that best matches their pedagogical choice. The options indicate four types of PO: didactic direct, active direct, guided inquiry, or open inquiry. The details of each variant are elaborated on in Table 1. Some studies that have used the POSTT instrument for assessing PO are Listiani et al. (2019), Ramnarain and Schuster (2014), and Sahingoz and Cobern (2020). This study selected three vignettes from the physical science area of the POSTT instrument (Appendix A). Prior permission was sought from the original authors to use the POSTT instrument for this study.

Table 1
The variant of PO and its description

Fundamental epistemic mode	Variant for each mode	Operationalized description
Science as factual knowledge…	1. Didactic Direct	The teacher presents and explains science content directly and illustrates it with examples or demos. No student activities.
"Ready-made science"	2. Active Direct	The teacher presents and explains science content directly… students actively engage in verification.

Table 1 *(Continue)*

Fundamental epistemic mode	Variant for each mode	Operationalized description
Science as a process of scientific inquiry	Guided Inquiry	Students actively explore phenomena or ideas with teacher guidance toward desired science content.
"Science in the making"	Open Inquiry	Students actively explore phenomena or ideas as they choose…. The teacher facilitates the process but does not prescribe

Source: Cobern et al. (2014)

Research Questions

Q1. What PO is held by science teachers in the sampled schools?

Q2. What are the preferred orientations of science students in the sampled schools?

Q3. Is there any relationship between teachers' PO and students' preferred orientations?

Q4. Is there any relationship between teachers' PO and their teaching experience?

Q5. How is students' preferred orientation related to their academic achievement in science?

MATERIALS AND METHODS

Research Design

This study was descriptive with a survey-type design.

Selection of Samples

We used a multi-stage sampling technique to collect data from the target sample. The sample included grade VIII students and teachers at the middle school level. During the first stage, we randomly selected twenty-five schools from a list of schools provided by the district education office in Peshawar. In the second stage, all general science teachers in the sampled schools were selected for data collection. The number of teachers ranged from two to five, depending upon the school's strength and the number of sections. The total number of teachers in the sampled schools was 112. However, 94 teachers provided consent to participate in the study. During the third stage, the students of grade VIII were conveniently selected from each school based on their availability and consent to participate in the study. For this purpose, we sought permission from the school headmaster to allow access to the relevant classrooms of grade VIII. The reason for selecting grade VIII students was their prior background with the topics of the vignettes selected for this study. Ethical guidelines were duly followed, and informed consent was taken. The total number of students in the sampled schools was 596; however, 313 students consented to participate. Not participating in the study was due to the student's lack

of confidence and interest in research activities. The number of valid responses was 88 teachers and 162 students. Sadly, most student responses were invalid (151 students) due to multiple or incomplete responses or a lack of understanding of the vignette items and the pedagogical choices.

Research Instrument and Data Analysis

The data were collected through the POSTT instrument and students' achievement in their mid-term exams in the science subject. As the data were collected from 25 government schools, we faced the limitations of a reliable instrument to obtain students' performance. For convenience, we obtained students' achievement in the general science subject in the mid-term examination of grade VIII. However, we ensured that all the selected schools were from the same district and with the same resources.

We selected three vignettes from the POSTT pool, all from the physical science area, to keep the subject domain constant (Appendix A). The teachers took 10 to 15 minutes, while students took 20 to 25 minutes to complete the instrument. The participants were encouraged to read each vignette carefully and choose their preferred response. Each vignette reflected four types of PO: didactic direct (DD), active direct (AD), guided inquiry (GI), and open inquiry (OI), and was assigned a score of one, two, three, and four, respectively for finding the means for each group and statistical difference using t-test.

Results

Participants' responses to the POSTT test were noted for each vignette to find the percentage for each orientation type. The mean, SD, and t-test were calculated using IBM SPSS ver. 27 to conclude the results. The first three figures provide answers to RQ1, RQ2 and RQ3.

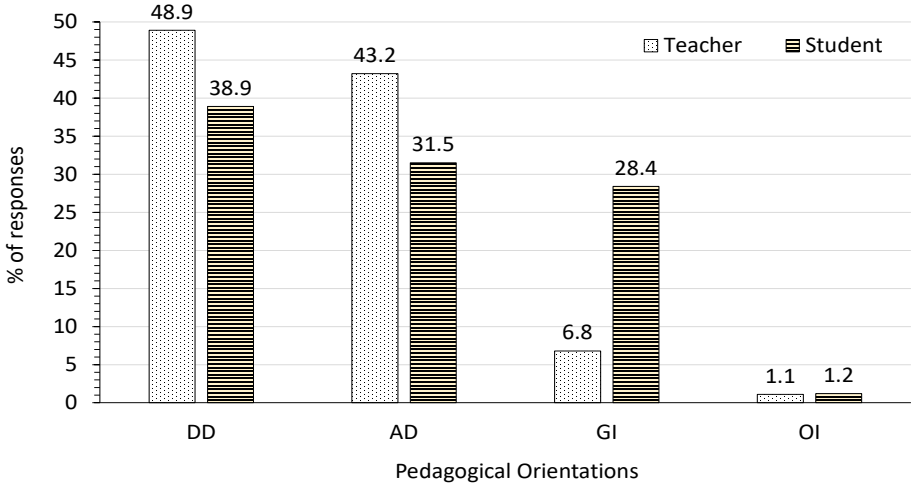

Figure 1. Orientations on Vignette 1 (Air is Matter)
Source: Cobern et al. (2014)

Vignette 1: The topic was 'air is matter.' Both teachers and students preferred DD and AD orientations in vignette 1 (Figure 1). Most participants favored DD (48.9% teachers, 38.9% students) and AD (43.2% teachers and 31.5% students). However, a considerable number of students also preferred GI (28.4%), which accounted for significant differences in teachers' and students' preferred orientation (t (248) = 3.25, p =.001). Generally, the teachers and students preferred teacher-centered approaches (DD and AD); however, students also desired the GI approach for learning about 'air as matter.' Both teachers and students, however, did not opt for OI orientation.

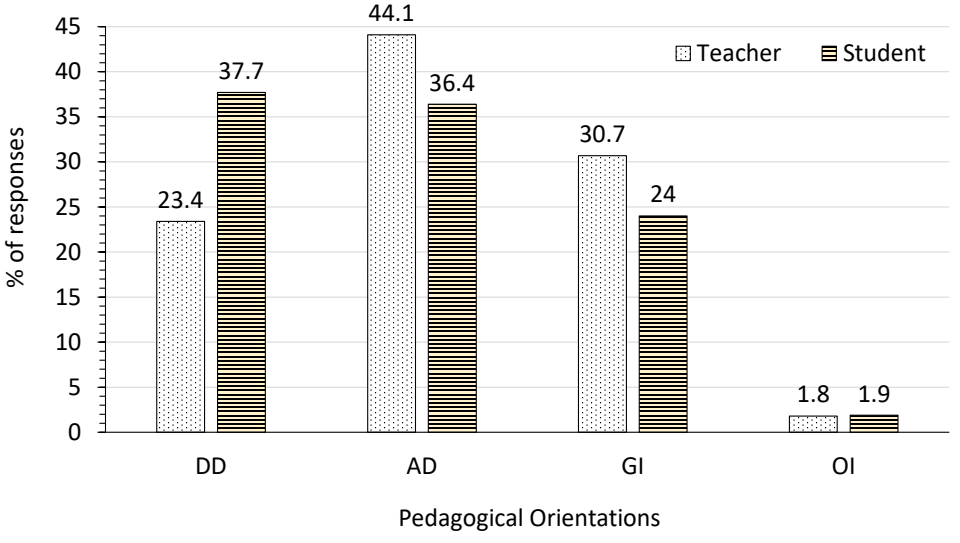

Figure 2. Orientations on Vignette 2 (Reflection of Light)

Source: Cobern et al. (2014)

Vignette 2: Participants' responses to this vignette related to the reflection of light were scattered (Figure 2). Both teachers and students preferred AD orientation (teachers 44.1%, students 36.4%). However, many teachers and students also opted for DD and GI, while both samples did not favor OI. The t-test showed no significant difference in the mean, t (248) = 1.66, p =.098.

Vignette 3: This vignette was about force and motion. The participants' responses were scattered among DD, AD, and GI (Figure 3). The t-test revealed significant differences in participants' preferred orientations (t (248) = 4.91, p = .000). While most teachers preferred GI (58.6%), the students desired DD (47.5%) orientation.

1) Research Question 4: Is there any relationship between teachers' PO and their teaching experience?

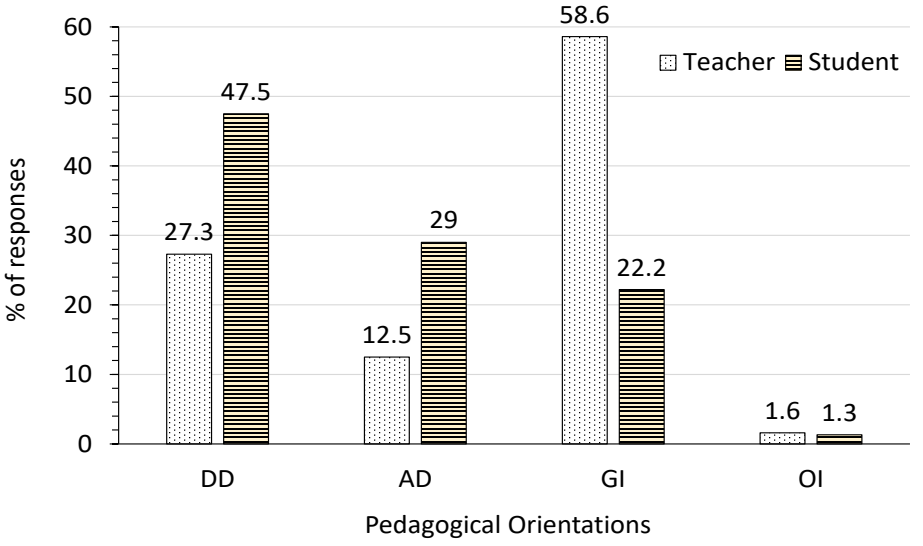

Figure 3. Orientations on Vignette 3 (Force & Motion)
Source: Cobern et al. (2014)

Table 2 shows teachers' POs and their teaching experience. Interestingly, there was a significant positive correlation between teachers' teaching experience and their PO in all three vignettes. However, the correlation coefficient was moderate in all three vignettes.

Table 2
Relationship between teachers' experience & PO (N = 88)

	Teaching experience	**p**
PO on vignette 1	.308*	.004
PO on vignette 2	.256*	.016
PO on vignette 3	.433*	.002

Note. *Significant at .05
Source: Authors' work

2) Research Question 5: How is students' preferred orientation related to their academic achievement in science?

Table 3 shows the relationship between students' desired orientations and their mid-term exam scores in the general science subject. A significant negative correlation was found for vignette 1 (r (160) = -.298, p = .000) and vignette 2 (r (160) = -.194, p = .013), indicating that students with high scores favored teacher-centered orientations (DD and AD). However, there was no significant relationship in vignette 3 (r (160) = -.033, p = .681).

Table 3
Relationship between students' preferred orientation and science achievement (N = 162)

	Academic performance	p
PO on vignette 1	-.298*	.000
PO on vignette 2	-.194*	.013
PO on vignette 3	-.033	.681

Note. *Significant at .05
Source: Authors' work

Discussion

This study used three vignettes from the POSTT instrument to find science teachers' and students' preferred orientations. We obtained data from 88 science teachers and 162 students conveniently selected from 25 middle schools. Almost 50% of students' responses were excluded due to a lack of familiarity with vignettes and multiple or incomplete responses. The first and second research questions aimed at exploring the pedagogical orientations of teachers and the preferred orientations of students. We found DD and AD orientations by both teachers and students for vignette 1. However, teachers also preferred GI for vignette 2 and vignette 3. Both teachers and students showed the least preference for OI orientation. The third research question inquired if there was a significant difference between teachers' PO and students' preferred orientation. The t-test result revealed a significant difference between teachers' PO and students' preferred orientation for vignettes 1 and 3 and no significant difference for vignettes 2. For the fourth research question, we found a positive correlation between science teachers' pedagogical orientations and their teaching experiences. The last research question inquired about the relationship between students' preferred orientation and their academic achievement, for which a negative correlation was found for vignette 1 and vignette 3, and no significant correlation was found for vignette 2.

Generally, the teachers and the students preferred teacher-centered orientations consisting of DD and AD. Some participants also favored GI, while OI did not receive support from teachers and students in all three vignettes. This finding is aligned with Listiani and Adhani (2023) for science teachers in Indonesia. However, Bansiong (2023) found that Philippine teachers are more inclined towards inquiry orientations, probably due to recent reforms in science education. It was noted that the nature of the topic influenced teachers' choice of PO. While a teacher would choose DD for one topic, the same teacher might choose GI for others. Previous studies have also highlighted that the nature of the topic and subject matter influenced teachers' pedagogical choices due to different teaching objectives to teach a topic (Cansiz & Cansiz, 2016; Sahingoz, 2017). However, teachers tend to shift from didactic instruction to inquiry orientation when trained in science teaching methods (Thornburgh & Brown, 2023).

Most teachers supported GI (58.6%) for vignette 3, which was about force and motion. A possible reason might be the observation and application of force and motion in daily life and the available resources to demonstrate motions; thus, a guided inquiry might be more valuable and applicable. The participants' support for DD and AD in all the vignettes might be attributed to the traditional instructional style inherited as a colonial legacy (Faize, 2015), with the traditional lecture method as the most preferred methodology (Faize et al., 2024).

Another reason for teacher-centered orientations was our sample selection in this study. We collected data from government schools, with most students from slum areas and lower socio-economic status. This also influenced teachers' pedagogical choices toward traditional styles of instruction. The quality of students' classroom interaction, lower motivation, and feedback strongly influence and shape teachers' science teaching orientation. Friedrichsen and Dana (2005) support this contention that classrooms with active learners encourage science teachers to use inquiry approaches.

In addition, the nature of the curriculum and its content also offers a check on teachers' instructional practices. A curriculum with overloaded content restricts teachers toward teacher-centered instructional practices (Sahingoz, 2017). One reason might be the limited time to cover the loaded content (Zafar et al., 2022) and the lack of classroom resources (Dahar & Faize, 2011b). Indian science teachers also faced difficulty practicing inquiry instruction due to a shortage of time. The teachers complained about the pressure to complete the course within the time frame, making them use didactic approaches (Nargund-Joshi et al., 2011). Ramnarain and Schuster (2014) also supported our findings by concluding that contextual factors like resource availability and class size affect teachers' PO toward teacher-centered approaches.

Teachers' POs were positively correlated with their teaching experience. Teachers with more teaching experience opted for GI, while novice teachers favored DD or AD approaches. Experience enables science teachers to learn from their mistakes, reflect on their classroom practices, and plan effective utilization of available school resources. Hence, as teachers' knowledge and experience increase, their ability to use student-centered approaches also improves (Feyzioğlu et al., 2016). Ramnarain and Schuster (2014) also found that African suburban teachers practiced guided and open inquiry practices because they were more confident and knowledgeable than township teachers.

Sahingoz and Cobern (2020) found that less experienced teachers had less variation in their PO and would choose AD or DD more frequently than inquiry approaches. However, the role and expectations of a school leader are also an influencing factor (Khwaja et al., 2022) in transforming classroom practices. The school principals in Pakistan expect their teachers to complete the course syllabus, thus forcing them to use traditional instructional styles.

For students, a significant negative correlation was found between students' desired orientation and their academic performance in the general science subject for vignettes 1 and 2. Students with higher scores in general science preferred teacher-centered orientation (AD or DD). Considering the traditional instructional styles in Pakistan, where memorization and cramming are the most rewarding in examinations (Faize, 2022), a higher score does not represent higher academic abilities (Dahar et al., 2011). Moreover, students desirous of scoring high preferred an accessible mode of instruction instead of inquiry-based practices (Dahar et al., 2010). As the instruction styles dominate the assessment techniques, the examination questions frequently test memory skills instead of high-order thinking skills (Zaman et al., 2010). Thus, the findings of this study are consistent with the existing practices in Pakistan. This study suggests radical changes and improvements in teachers' preparation programs to train prospective science teachers in modern inquiry practices. The shift from traditional instruction styles to inquiry-based practices would also transform the assessment procedures and students' preferences in favor of inquiry-based orientations (Faize & Akhtar, 2020).

CONCLUSION

Science teachers and students in Pakistan prefer teacher-centered orientations instead of inquiry approaches. This kind of preference is not specific to Pakistan. Rather, similar findings are also reported in other countries, including Indonesia, Turkey, and Germany. The teachers lack knowledge about how to teach through inquiry methods and are familiar with the lecture-based methods. This finding suggests a radical change in teacher education programs by training science teachers in inquiry practices. In addition, the instruction and assessment methods shall be transformed by discouraging memorization and emphasizing learner-centered experiences in developing countries. When analyzing the relationship between teachers' pedagogical orientations and students' desired orientations, it becomes evident that the teaching-learning paradigm cannot be universally applied. Examining the alignment between teachers' pedagogical views and practices and students' preferences highlights a multifaceted interaction that carries significant consequences for the efficacy of classroom instruction, student involvement, and overall educational achievements. It is worth mentioning that classrooms tend to flourish when there is congruence between these orientations, resulting in increased student motivation, enhanced comprehension, and a more cohesive educational atmosphere.

Implications of the Study

The instructional techniques science teachers use have a significant role in students' understanding and academic performance. Interactive teaching and student-centered classrooms create a more conducive learning environment and help improve students' academic achievements. This study highlighted the pedagogical

choices of science teachers in Pakistan, which were mostly teacher-centered. It is a concern for our teacher educators, educationists, and policymakers. There is a major shift worldwide towards student-centered teaching. The findings of this study are an eye-opener for our policymakers and teacher training institutes to focus on training prospective science teachers in student-centered pedagogical orientations. Furthermore, science students preferred teacher-centered approaches over inquiry. Rather, there was a negative correlation between students' academic achievement and pedagogical orientations. This means that students with higher grades prefer a teacher-centered orientation. A possible reason for this choice is that inquiry orientations require greater effort and work on the part of students, which students do not welcome. The students used rote learning to get good grades. This approach needs to be changed by discouraging rote learning and giving credit to creativity and critical thinking in science assessment. The researchers hope the revised science curriculum will focus on reforming the science teaching and assessment techniques, thereby creating students' interest in innovative thinking, knowledge generation, and its application in everyday life.

Limitations and Recommendations for Future Research

This study is not without limitations. First, we used a quantitative approach to explore PO, which provided a limited understanding of the reasons for choosing that specific orientation. Conducting a semi-structured interview to explore the reasons for choosing a specific orientation will provide a greater understanding of the pedagogical choices. Secondly, we relied on students' scores in the mid-term examination in the sampled schools. This again has limitations due to variability in teachers' quality, test items, available resources, and mental abilities. Future studies may consider these limitations for a more reliable relationship between the quantitative variables. Lastly, we collected data from middle schools in the Peshawar district, a developing district. Future researchers may conduct similar studies at the secondary level or college level and also in the advanced urban areas of Pakistan to further explore teachers' POs and students' desired orientations.

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Appendix A: Vignettes of the POSTT instrument

1. Air is matter

Your teacher wants to teach the topic of air matter. She is planning to introduce the topic by asking questions in the class. As a student, which of the following is your preferred choice for your teacher to teach this topic?

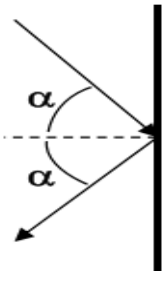
A. The teacher shall ask us to think up ways to test if the air is a matter using whatever equipment we have in the classroom. She should then allow us to go ahead and try other ideas ourselves. (4)

B. The teacher should help us develop ways to test whether air is matter, allow us to investigate with fans, and then use our findings to conclude whether it is a matter. (3)

C. The teacher should tell us directly whether air is a matter and how we can feel it. The teacher can ask us to use fans in our classroom to find evidence about whether air is a matter. (2)

D. The teacher should tell us directly whether air is a matter or not and how we can feel it. The teacher shall demonstrate to us whether it is a matter or not. (1)

2. Light reflection



Your teacher wants to teach the reflection of light and its bending from the surface of a mirror. Which ways do you prefer to be taught this topic by your teacher?

A. The teacher should write about reflection on the board and then illustrate with a diagram. Next, the teacher shall show us a real example using a light ray source, mirror, and protractor. (1)

B. The teacher should ask us to investigate ourselves about light behavior around mirrors. The teacher shall provide us with the relevant items to conduct this investigation. Afterward, we would tell the teacher what we did and found. (4)

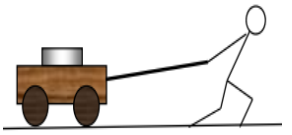
C. The teacher shall ask us questions about light reflection. Then, we should be allowed to investigate ourselves in the reflection of light. The teachers shall conclude the topic by giving us a summary. (3)

D. The teacher shall write the law of reflection on the board and illustrate it with a diagram. Then, the teacher shall allow us to verify the law by providing relevant resources. (2)

3. Force and motion

The teacher wants to teach the relationship between force and motion. There is a law about this relationship. The classroom has a loaded wagon to which a pulling force can be applied. What is your preferred way to be taught this topic?

A. The teacher shall ask us questions about any relationship between force and motion. Then, we shall be allowed to freely use the available items to explore the relationship between force and motion. (4)



B. The teacher shall write the law on the board and explain it carefully. The teacher shall then give us the loaded wagon to verify the law ourselves. (1)

C. The teacher shall ask us questions about motion and force. Afterward, the teacher shall guide us to explore this safely in the lab, followed by a class discussion of our findings. (3)

D. The teacher shall write the law on the board and explain it carefully. The teacher shall then demonstrate the law to us for our understanding. (2)