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TEACHING METHODS PREFERRED BY SCHOOL SCIENCE TEACHERS AND STUDENTS IN THEIR CLASSROOM

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Abstract

This study was designed to stipulate an image of occurring science practices in secondary schools. The main objective of this study is to investigate the types of science teaching practices that have been preferred to use by science teachers to teach science subjects. This study delimits the secondary schools of Lahore, which is the second most populated city in Pakistan. The research was conducted on a sample of 60 schools [60 science teachers and 600 students]. The researchers captured the complete list of secondary schools of Lahore from official websites and schools were selected through random technique. The most senior science teacher opted for data collection in case of more than one science teacher availability at a single school. The study adopted a survey research design and data was collected through a newly developed reliable questionnaire with Cronbach alpha = 0.95. The data was entered and analysed by using SPSS. The study result reveals that secondary school science teachers prefer lecture and discussion methods for science teaching. Significantly, science teachers are less interested in using the inquiry method and science project-

based learning in their classrooms. Science teachers should adopt recommended teaching methods to develop a better understanding of science among students.

Keywords

Science Teaching Practices, Secondary Schools, Science Teachers, Science Students, Teaching Methods

1. Introduction

Effective teachers guide to the learners by using their developed set of knowledge and skills. Teachers manage their overall classroom practice as a leader (Soares, 2020), and as a free agent in the classroom, they can accept or reject the changes (Gess-Newsome, 2015) in the teaching. The science teaching and learning in the classroom is influenced by different factors such as students and teachers' beliefs, orientation, prior knowledge, and experience within a context, which plays an important role in students' outcomes (Caleon, Tan & Cho, 2018; Gess-Newsome, 2015; Tufail, Eames, Bunting & Cheng, 2019). The science teachers create a situation of teaching that supports and stimulate students' learning by using an amalgam of different teaching knowledge (Shulman, 1986), encouraging students for learning, developing interest, conceptual teaching, imparting realistic knowledge and practical experience about the world are elements of teaching practices that create a great influence of teachers on their students (Arends, 2012; Wang, 2020).

Science teachers' teaching methods play a vital role in classroom practices if they adopt suitable teaching instructions according to the need of science topics and students. A variety of research-based teaching methods are recommended in the literature for science teachers, teachers may select one, a combination of two or more to suit the needs of science learners to develop the conceptual understanding (Tufail et al., 2019). Moreover, science teaching standards provide a road map to choose teaching methods. Lamentably, education policies of Pakistan (Ministry of Education, 2009; Ministry of Education, 2017) did not pay much emphasis on the quality of science education, therefore, no science teaching standards have been determined yet at any level.

Currently, Pakistan facing many problems in the education sector particularly in the field of science education. For instance, non-availability of teaching materials unequipped and in some cases non-existence of science laboratories, outdated curriculum with little relevance to today's scientific research, unrealistic teacher to student ratio in large class sizes are some of the factors that discourage teachers to adopt discovery and inquiry-based teaching approaches in their classrooms (Memon, 2007) that may make impossible face to face teaching (Chui, 2020). Teachers have limited option to adopt teaching method according to available resources, as result, the lecturing

method is the most commonly adopted teaching strategy by science teachers (Iqbal, Azam & Rana, 2009) whilst encouraging students to rote memorize the science concepts from the textbooks in order to replicate in the examination. Moreover, the lack of trained teachers and the cheating culture in the examinations also contribute to the indicators of the bad quality of education in Pakistan (Ministry of Finance 2002).

In developed countries science teachers have the support of lab assistance and teacher aides to enhance the teaching and learning experience and such assistance develops a positive attitude in teachers toward their teaching (Ualesi & Ward, 2018). On the other hand, the developing countries have only two biotic factors in classrooms that influence teaching practice, i.e., students and teachers (Tufail, 2020). Generally, students develop their scientific understanding in the classroom as well as in a laboratory context where they can have hands-on experience of learning theoretical science concepts. In Pakistan, poor quality or lack of laboratory facilities impede the development of scientific concepts and discoveries, thus leading to rote memorization (Iqbal, Azam & Rana, 2009), which eventually leads to unnourished minds of lacking innovative ideas.

Research in science teaching asserts that teachers' subject matter knowledge, attitude to adopt new teaching methods, and using their teaching skills in classroom practices are central components of their practices (Mavhunga & Rollnick, 2013). According to Ajaja (2007), most of the science teachers do not put their skills into classroom practices, which they have acquired during the teaching certification. Similarly, some deficiencies reported in science teaching in Pakistan (Malik, Farooq, & Rabia, 2016), which are noncompliance with the curriculum, where teachers do not cover the complete syllabus due to time restriction or their lack of knowledge on certain topics. Furthermore, the absence of a mechanism to teacher observations followed by constructive feedback to improve teaching practice, weak lesson planning, and teacher assessment based on student learning outcomes are considered as deterrent factors of science teaching. The study aims to investigate the preferred teaching methods by teachers and students in their secondary science classrooms.

The rest of the paper is structured in five sections: The first section presents a brief review of the related literature. The next section is consisting of the methodology followed by data analysis and interpretation. Finding and discussions are offered at the end.

2. Literature Review

The classical point of view about teaching was simple and considered as a process of transferring knowledge (Warren, 1985). However, recent research suggests that teaching is a

complex and uncertain creative activity which requires teachers to continually adjust their instructional strategies, presentation and representations of ideas, on-the-spot decision making on effective pedagogies, responses to students to meet student needs and to support learning (Park & Chen, 2012; Tufail et al., 2019; Williams et al., 2012). It is clear, there is no facile set of instructions to inform and prepare teachers for the challenges of teacher planning and practice (Barnett & Hodson, 2001). Different teaching and learning elements make effective teaching practices such as teachers' attitudes, skills, subject matter knowledge, organization knowledge, knowledge of student understanding, teacher training, and school context.

Effective science teaching practice is an intellectual work that involves expert judgment to adopt appropriate methods and therefore reflection needs to have a developmental dimension in the educational process. The emphasis should be on effective teaching that helps teachers understand their practice for improvement (Sachs, 2003). In a true sense, science teaching is not only the transfer of the scientific knowledge, content, and curriculum, it also works like an explorer of the hidden knowledge in nature or the mind of the learner. The core of science teaching at the secondary level is to provide students with the foundation of basic science knowledge, which leads them towards further science study in their future, and to understand science applications in their daily lives (Ministry of Education, 2017). This understanding helps students to perceive the world scientifically. During the science teaching-learning process at the school level, students face many problems in understanding scientific ideas in their classrooms and this happens due to inauthentic teaching methods (Darling-Hammond, 2008) used by the science teachers which reduce the student interest in science concepts. The upcoming paragraphs of this subsection offer summary of prevailing teaching methods, which were used in the questionnaire for data collection of this study.

In the lecture method, most of the time teacher stands in front of the students giving information verbally and sometimes using audio-visual aids depending upon their availability to help to explain the concept. Historically, teaching has revolved around the behaviorist approach now termed as 'traditional method' and these traditional teaching practices include lecture and teacher-led activities (Woolfolk, 2013) and mostly, teachers look dominant throughout these practices. The traditional approach assumes the transfer of a planned body of knowledge to the students in prescribed class time. Through traditional methods, teachers facilitate students with the subject matter but it does not enhance the creative habits of students' minds (Neuby, 2010). The lecture method is a one-way flow of information with low student involvement. Contrary to this, the 'discussion method' encourages students' to participate in their learning process by posing probing questions and reflecting on constructed ideas.

The term 'discussion' is generally used in different aspects; firstly, presenting perspectives on a unique idea with another person or a group of people, and secondly, talk or write about some ideas in detail and consider different opinions on it to construct new knowledge. Discussion as a teaching method could be adopted by science teachers in various ways, for example, Kauchak and Paul (2017) argued that science teachers used discussion for exploring prior knowledge of students, uplift students' involvement, evaluation, and development of interest. In this process, students are involved by questioning, listening, and responding to their queries. Students think about the possible answers to a question posed by the teacher, and then discuss the answers with each other. The teacher explains the consensus of this discussion along with the correct science concept to the class. Besides, the teacher helps students' reflection on the discussion process, ask them to write about how the discussion changed their thinking or understanding (Davis, 2001). The discussion method is favorable for evaluating student performance and foster self-confidence and leadership abilities in students (Yoder & Hochevar, 2005). However, the discussion method is limited to elaborate on all the aspects of science learning e.g., students cannot investigate chemical reactions in a laboratory through it.

The limitation of the discussion method can be surmounted by using the inquiry method that enables students to actively investigate their environment by themselves or under the supervision of their teacher. The inquiry method is characterized by students' actions such as investigation, searching, and exploring (Martinello & Cook, 2000) about a part of the context. This method requires a shift in the role of teacher to that of a facilitator rather than an information provider. Different inquiry methods can be adopted by teachers in the science classroom such as open inquiry, guided inquiry, coupled inquiry, and structured inquiry or a combination of them as per the demand of the science concept. Science teachers can develop critical thinking and a deeper understanding of science concepts through inquiry methods (Pratt & Hackett, 1998). This method overlaps some of the features of project-based learning; however, it carries out a clear distinction between their unique features.

The project-based teaching method encompasses specific experiments, recreational field trips, hands-on activities, and student-directed activities. In this learning activity, students usually face problems and challenges; therefore, teachers' involvement is crucial, not only in designing or in choosing the broader theme of the project, but also facilitating students during the project phase to lead them in the right direction. Science students working within a group would improve their characteristics such as team-building relationships, goal setting, developing existing skills, acquiring new skills, and a creative outcome that has a clear benefit to the community. In addition

to this, project-based teaching enhances the students' ability to manage the time and available resources (Schneider, Krajcik & Blumenfeld, 2005) and they can apply to learn to resolve real-world problems (Bell, 2010).

During the above-mentioned teaching methods, many new ideas may strike students' minds, which could remain as imagination until not tested. This calls for an additional approach to teaching science such as learning through experiments (Duit & Tesch, 2010), which gives students a chance to apply theoretical knowledge and ideas into practice. Science teachers' deeper understanding of the scientific process and the use of scientific tools necessary to carry out further studies is witnessed when students are involved in the experiment phase (NRC, 2000). To capture the teaching methods that are preferred by teachers and students in secondary schools; a proper research method was selected that is presented in the following section.

3. Methodology

Since the focus of the study was to measure teachers' and students' perceptions about teaching methods in their classroom, therefore, survey research was adopted for this study. Survey research designs are desirable procedures within the quantitative research paradigm used to describe the opinions, attitudes, beliefs, self-classification, knowledge, behaviors, and characteristics of the population (Creswell & Creswell, 2017; Neuman, 2014) to get a reliable, valid, and accurate data. All secondary science school teachers in Lahore city is the population of this study, 60 science teachers were randomly selected as a sample of this study, 10 students (of grade 9 and 10) randomly chosen from each teachers' class to confirm their claims, total 600 science student were involved. The sampling for this study is shown in Table 1. The sample is representing the population of study which indicating its generalizability (Lincoln & Guba, 1985) and through this sample researcher trying to find teaching practice in reality that increases its validity.

Table 1: Sampling Table

School types	Male		Female	
	Teacher	Students	Teacher	Students
Public school teacher	15	150	15	150
Private school teacher	15	150	15	150
Total	30	300	30	300

The purpose of the sample from the public (male and female) and private schools (male and female) to investigate the clear picture of secondary school practices, that increase the

generalizability. The study employed a newly developed 40-item questionnaire on five points Likert scale [always=5, often=4, sometimes=3, rarely=2, never=1] which were pilot tested before the study on 10% of the total parent sample. Literature in educational research suggests a recommended sample size of 10% of the parent sample for pilot testing (Connelly, 2008). The survey questionnaire has consisted of seven subscales: lecturing, discussion, role-play, inquiry method, scientific activities, project-based, and experiments, with five to six questions in each subscale. The overall Cronbach alpha value of this survey questionnaire 0.95 confirms excellent reliability (Taber, 2018). The responses in this questionnaire are analyzed by using proper statistical formulae, which are reporting in the next subsection with their analysis and interpretation.

3.1 Analysis and Interpretation

The respondents were required to respond to each statement on five points scale from always to never. Numerical values of the responses were ‘always 5, often 4, sometimes 3, rarely 2, never 1’. The data was entered and analysed by using the Statistical Package for Social Sciences (SPSS) software. Mean Response Values (MRVs) and Chi-square test were applied to find out the results: MRV’s indicated the extent of prevalence of science teaching practices and it showed that what practices were the most and the least common while, Chi-square test was employed to see the significant differences among the responses of different categories. In addition to this, the collected data were analysed by cross tabulating the percentages of teachers’ and students’ responses obtained through the questionnaire. The percentage of responses in crosstabs showed the degree of occurrences of science teaching practices as responded by teachers and observed by students in their classes. MRV aggregates the responses representing the degree of occurrences of science teaching practices. A higher degree of MRV is considered the most common practice.

Following criteria were developed for interpreting the results:

- $1 \leq MRV < 1.5$: the absence of practice or never adopted by the teacher
- $1.5 \leq MRV < 2.5$: rare frequent practices
- $2.5 \leq MRV < 3.5$: practice being used sometimes
- $3.5 \leq MRV < 4.5$: often used practices
- $4.5 \leq MRV \leq 5$: always used practice

MRVs of students’ and teachers’ responses and interpretation of these values as per set criteria as shown in Table 2.

Table 2: Mean Responses on Prevalence of Most Common Science Teaching Practices

Teaching Practices	<u>Students’ Responses</u>	<u>Teachers’ Responses</u>
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	MRVs	Interpretation	MRVs	Interpretation
Communicating in a clear and respectable way with students.	3.48	Often	3.62	Often
Engaging students in peer learning	3.48	Often	3.63	Often
Summarizing the topic at the end of the lecture.	3.47	Often	3.83	Often
Responding to a student's question.	3.42	Sometimes	3.45	Sometimes
Delivering a lecture to the whole class for providing information to the students.	3.39	Sometimes	3.65	Often
Asking students to memorize Science definition and scientific facts.	3.36	Sometimes	3.5	Often
Using white/blackboard during the lecture.	3.32	Sometimes	3.47	Sometimes
Assessing student's pre-requisite knowledge.	3.31	Sometimes	3.6	Often
Give examples from the local scenario, such as society classroom, etc.	3.29	Sometimes	3.9	Often
Self-learning through engaging students in solving textbook exercises.	3.28	Sometimes	3.38	Sometimes

According to the highest MRV, students and teachers perceive clear communication as a part of lecturing, peer learning, and recap through lesson summary as often-adopted practices in the science classrooms. Students and teachers both agree on the opinion that teachers *sometimes* respond to the students' questions in the classrooms, use white/blackboard to explain the concepts during the lecture, and students also self-learn through engagement in solving textbook exercises during the sessions.

MRVs of teachers' and students' responses show a slight difference of opinion in delivering a lecture to the whole class and memorization of scientific facts, where teachers claimed to practice lecturing techniques and used rote memorization more frequently. Similarly, a difference of opinion was also found on teachers' assessment of students' pre-requisite knowledge and giving examples from real-world scenarios

The overall results of MRVs most adopted practices show a mixed trend of learning theories, where behaviorism and constructivism are taking precedence over cognitivism, and these trends are shown in the following Figure 1.

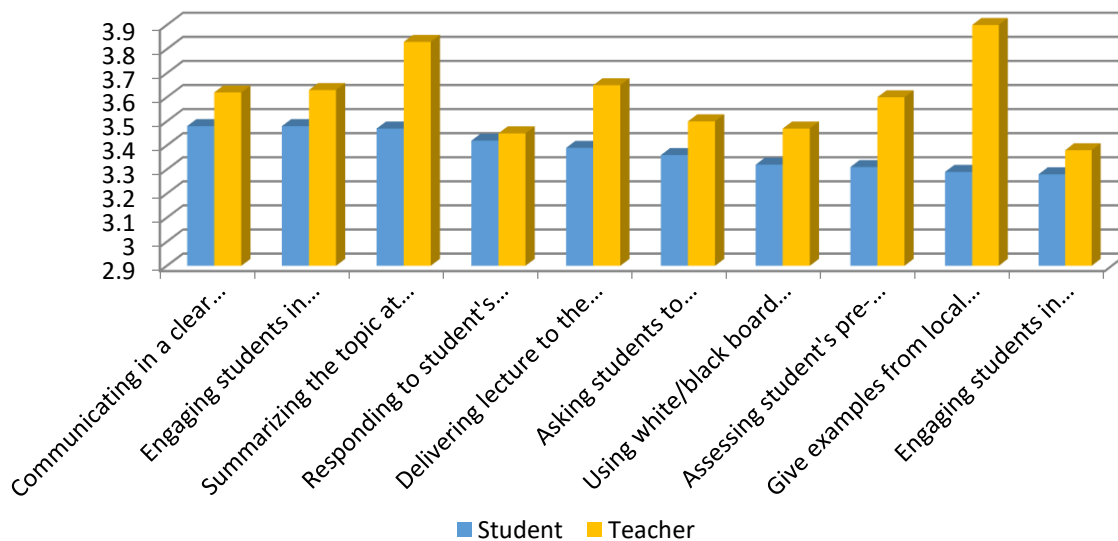


Figure 1: Students' and Teachers' Responses about the Most Common Science Teaching Practices

Figure 1 shows the comparison of most common science teaching practices from students' and teachers' perspectives. Aggregated MRVs of students' responses are lower as compared to the teachers' responses against all questions. The biggest difference of opinion is found on the use of local scenarios in the classroom, where students aggregated MRV is equivalent to 3.3, and teachers' responses equate to 3.9. Similarly, the other major difference among opinions is found on the summarization of the ideas at the end of the session, where students' MRV aggregated to 3.5 and teachers to 3.8. On the other hand, teachers and students almost agreed to answer students' questions in class with teacher aggregate MRV = 3.45 and students MRV= 3.42.

Table 3, indicates the least common science teaching practices adopted by science teachers in their classes according to captured data.

Table 3: Mean Responses on Prevalence of Least common Science Teaching Practices

Teaching practices	Students' Responses		Teachers' Responses	
	MRVs	Interpretation	MRVs	Interpretation
Engaging students in writing about their science experiments or science activities.	2.89	Sometimes	3.3	Sometimes
Involving students in activities to enable the understanding of scientific concepts.	2.88	Sometimes	3.15	Sometimes
Conduct whole class discussion at the end of the activity.	2.87	Sometimes	3.25	Sometimes

During the discussion, asking probing questions such as "why do you so think so"?	2.85	Sometimes	3.17	Sometimes
Using visual aids (charts, pictures etc.) to explain the concepts.	2.8	Sometimes	3.22	Sometimes
Organizing field trips for increasing the information of the students.	2.72	Sometimes	3	Sometimes
Encouraging students to role-play for explaining Science concepts.	2.69	Sometimes	3.05	Sometimes
Using different techniques during activities such as flashcards etc.	2.69	Sometimes	3.3	Sometimes
Inviting guest speakers (Science subject experts) in class.	2.64	Sometimes	2.92	Sometimes
Engaging students in learning from various sources other than the textbook (CDs, magazines, etc.)	2.57	Sometimes	2.53	Sometimes

It can be easily observed in the table that the aggregate of all student responses is below the mid-point ($2.5 \leq MRV < 3.5$) of the range identified for practices adopted sometimes in the classroom teaching, whereas, majority of teachers have acclaimed to practice these methodologies above the mid-point of the MRV range ($2.5 \leq MRV < 3.5$: practice being used some time). It is interesting to note that majorly all the least commonly adopted practices belong to the constructivist approach to teaching. A comparison of students' and teachers' perceptions are presented in figure 2.

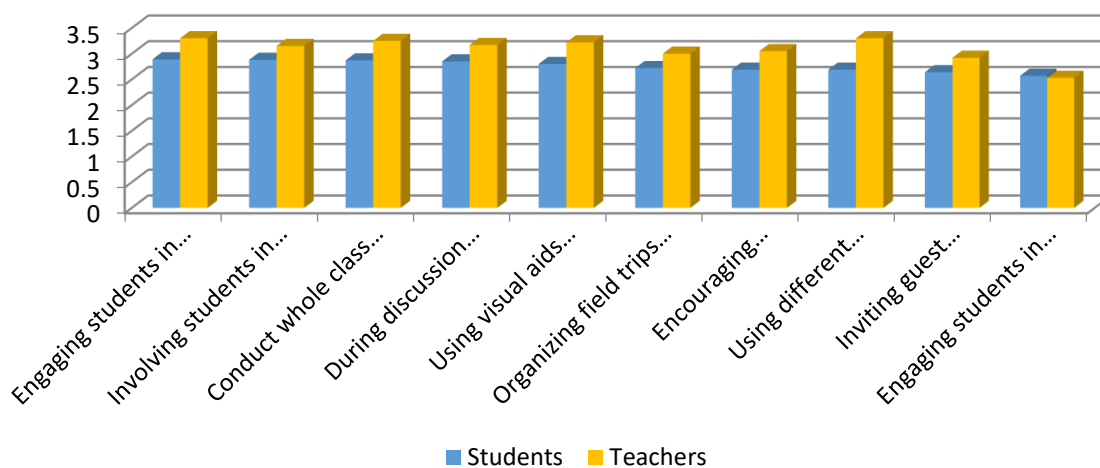


Figure 2: Student and Teacher Responses about least Common Science Teaching Practices

This figure illustrates the comparison of students' and teachers' responses against the same question item. MRV of student responses against all statements lower than teachers' responses except this statement 'Engaging students in learning from various sources other than the textbook (CDs, magazines, etc.)'. This confirms an agreement between students and teachers in using resources other than textbooks in classroom teaching.

To sum up, there are noteworthy differences between teachers' and students' perceptions of science teaching. Teachers' responses claim to deliver a high-level of science teaching practices in the classrooms in contrast to students' perceptions. The upcoming section subscribed to the discussion of the key findings of this study with some recommendations and suggestions for future study.

4. Discussion

The findings of this study showed that traditional methods and its associated practices are relatively more common among students and teachers for science teaching, for instance, rote memorizing from the textbooks and enhancing science concepts through lecturing. These results reflect those of Ajaja (2007), who also found that science teachers used a lecture method to deliver science concepts instead of recommended teaching methods for teaching science.

This study also highlights the difference between students' perceptions of teaching and teachers' responses to their teaching. The science teachers believed to adopt constructive teaching methods, but their students did not support their claims. This also accords with earlier observations in research, which showed that science teachers who claimed to use constructivist teaching methods were found to be practicing traditional methods during the classroom observations (Mansour, 2013). This shows a gap in teachers' beliefs where they are unable to turn their teaching claims into successful practice. Another explanation of the difference between students' and teachers' perceptions; might be the students' preferred teaching methods are different from teachers'. Overall, teachers and students like those activities which are based on traditional methods. A study by (Qualters, 2002) also found that students show less interest in active learning teaching methods because of their fear of wasting time, not being able to complete the syllabus, and possibly feel anxious about changing traditional classroom culture. The finding of this study about students' preferred methods is lecturing followed by discussions is supported by other researchers (e.g., Casado 2000; Carpenter 2006; Gillies & Kim 2015).

The study also indicated that the inquiry method and its associated practices were less commonly used for science teaching in secondary schools. Finding in the present study is consistent

with the findings of Eltanahy and Forawi (2019), they found that the inquiry method is not much-preferred in the classroom as compared to the textbook method. Inquiry-based teaching requires a highly structured approach to pose the inquiry at the students, therefore, teachers who do not feel confident or have no formal training in using inquiry-based teaching struggle to implement this approach in their classrooms (Gillies & Kim, 2015). Science teachings demand teachers to use teaching methods recommended by the experts (Bell, 2010; Duit & Tesch, 2010; Pratt & Hackett, 1998) for a better understanding of scientific concepts. Tseng, Tuan, and Chin (2013) study also concluded that teachers who have been successful in implementing effective inquiry-based teaching in their classes are those who have been taught using the same technique by their teachers.

The new teaching techniques should be included in teacher training, refresher courses for in-service teachers, and teaching educators. It is also asserted by some studies, [e.g., Chui 2020; Malik et al., 2016] teacher educators should receive up-to-date training on using modern teaching methods and techniques to support 21st-century learning. The use of innovative technologies should also be made part of teacher training courses to enable teachers to exploit such technologies to impart more student-centered pedagogies in their sessions (Bell, 2010). Moreover, science teachers should be able to relate their teaching to real-world scenarios through project-based learning, thus enabling students to implement their learned knowledge and acquired skills in real-life situations.

The present study adopted a survey design to gather students' and teachers' responses to the methods of science instruction. Future research could benefit from using qualitative research designs or quantitative research in another context to get further insights into the difference of students and teachers' opinions regarding the use of teaching practice as indicated by the present study.

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