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Original research Article *Open Access*

EFFECT OF ORAL QUESTIONING ON PRIMARY STUDENTS' SCIENTIFIC ACHIEVEMENT, CRITICAL THINKING, AND CLASSROOM ENGAGEMENT

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Abstract *The present study examines the effect of oral questioning as a formative assessment technique for the academic achievements of 5th-grade General Science students in a public primary school in the district of Vehari, Pakistan. For this purpose quasi-experimental design was followed, with one control group and one experimental group (30 students each). The traditional instruction was given to control group without formative assessment, while experimental group was taught using the oral questioning technique over 24 weeks. Two intact groups of 30 students each (N=60) were selected: a control group receiving traditional teaching and an experimental group where oral questioning technique was integrated into regular instruction. A self-developed duly valid, and reliable achievement test was administered as a pre-test and a post-test. The results from independent samples t-tests indicated no significant differences were reported for pre-test scores between groups (p > 0.05), confirming baseline equivalence. However, post-test analysis revealed that the experimental group (M = 66.33, SD = 8.84) significantly outperformed the control group (M =59.67, SD = 8.21), with t(58) = 3.72, p = 0.001. The findings also reveal that oral questioning enhances student engagement, promotes collaborative learning, and improves academic achievement in General Science. It is recommended that teachers should integrate oral questioning to achieve better student learning outcomes. Furthermore, the study highlights important implications for teachers, school administrators, curriculum developers, and policymakers aiming to improve science teaching-learning through effective oral questioning in Pakistan.*

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Introduction

Formative Assessment Techniques at the primary school level play a crucial role in developing student knowledge by delivering continuous feedback to both teachers and learners. In comparison to summative assessments that measure students' achievement after completing a unit or course, formative assessments are conducted during the learning process. They provide continuous feedback to both teachers and students, helping to identify learning gaps and improve understanding before final evaluations are combined into daily instruction to monitor progress and guide teaching strategies (Jogezai & Bibi, 2022).

A gradual introduction of assessment has been followed in learning and teaching procedures. Lopez-Pastor and Sicilia-Camacho (2017), proposed that the formative assessment was not ranked as a critical aspect of the teaching-learning process during earlier times because assessment was a tool that allowed the extent to which a learner learnt without being part of the process that should be followed by students to acquire skill, knowledge, and ability. Nevertheless, today there is a tendency in the sphere of higher education to separate the idea of formative assessment from the idea of marks, and instead to encapsulate it into learning activities of students (Brown, 2024).

Formative assessment as a way of assisting autonomous forms of motivation has also been proposed by many researchers. Using the goal orientation theory (*Solis Trujillo et al. 2025)* suggests that practicing formative assessment, in which the student receives feedback that allows him/her to observe what he/she has learned and how to become a better learner, may support a learning orientation. When students have a positive attitude toward learning, they see learning activities as enjoyable and meaningful for their own growth. Their motivation comes from within, rather than from wanting praise or approval from others. According to the ideas of self-determination theory, teacher feedback that helps students see their own progress and understand how to reach their goals can improve their learning experience. In this study, it is suggested that such feedback in classroom settings helps fulfill three basic psychological needs: autonomy (having control over

one's own learning), relatedness (feeling connected with others), and competence (feeling capable of doing well). When these needs are met, students become more self-motivated and take greater interest in their studies (Ryan & Deci, 2020). This approach can lead to a more confident and engaged classroom environment where students learn with purpose and enjoyment.

FATs are the techniques adopted by teachers to obtain information on the learning of students throughout the learning and teaching process in classroom. The techniques are also helpful for teachers in order to make real-time corrections to their teaching to facilitate the learning and understanding of the students better. A good number of formative assessment methods are applied in the classroom at all levels, i.e., university, elementary, primary, higher secondary, and secondary. FATs enable prompt reactions from learners in the course of learning to the teachers as well as fast responses to the learners concerning their ability in learning endeavors. These are examples of FATs: observation, one- minute paper, appraisals, portfolio, jigsaw, quizzes, oral questioning, and Think-Pair-Share (TPS), etc.

Oral questioning is not new. They have been in use since the fifth century, when ancient Greek philosophers such as Socrates used them to question people and encourage deeper thinking. In the 16th century, all exams at Oxford and Cambridge were oral exams, conducted in Latin and in public, known as the "viva voce" (Dobson, 2018). Although the oral exam was largely dropped from high schools and higher education due to reasons of time and efficiency, they are still used widely in many European countries (De Vita & Case, 2003). Countries such as Norway continue to use them in high schools, with students required to sit at least one oral exam in their final year, and they are also widely used in undergraduate programs in French, German, and Spanish-speaking countries (Dobson, 2018).

Pan et al. (2024) described that oral questioning emphasized its importance in formative assessment and classroom interaction. Researchers explored how strategic questioning techniques improve students' participation, communication, and critical thinking skills in different learning environments. For example, a study by Education found that teacher-led questioning in blended synchronous learning environments enhanced students' engagement and language learning outcomes in TEFL classrooms. The researchers concluded that open-ended and probing questions encouraged learners to think critically and actively participate in classroom discussions. Similarly, studies conducted in science classrooms revealed that students viewed oral questioning as an effective instructional strategy for improving understanding and maintaining attention during lessons. These studies highlighted that well-planned questioning techniques positively influence students' learning experiences and classroom interaction.

Fenton (2025) explained that the growing use of AI tools revived interest in oral examinations because they provide authentic evidence of student learning and reduce opportunities for academic dishonesty. Furthermore, studies on higher education assessment practices showed that structured oral questioning and interactive feedback improved students' confidence, critical thinking, and academic performance. Researchers also noted that oral questioning promotes deeper engagement because students are required to explain and defend their ideas verbally during assessments. This research on oral questioning shifted toward oral assessments and their role in ensuring academic integrity in the age of artificial intelligence. Scholars argued that oral questioning allows teachers to assess students' real understanding, communication abilities, and reasoning skills more effectively than traditional written examinations.

Oral questioning is considered one of the most effective formative assessment techniques at primary level, especially in the teaching of General Science, because it promotes active participation, immediate feedback, and critical thinking among learners. Through oral questioning, teachers can assess students' understanding during classroom instruction and identify misconceptions instantly, allowing them to adjust teaching strategies according to students' needs. Recent studies emphasized that formative assessment practices, including oral questioning, significantly improve students' academic achievement and engagement in science learning. For example, Irshad and Saeed (2025) found that the formative assessment techniques such as quizzes, oral questioning, and Think-Pair-Share positively enhanced the achievement by primary-grade school students in General Science. Similarly, AlAli and Al-Barakat (2025) reported that science teachers' formative assessment practices strengthened young children's scientific understanding, classroom interaction, and collaborative learning skills. Furthermore, Fenton (2025) explained that oral assessment and questioning encourage learners to explain their reasoning, develop communication skills, and demonstrate authentic understanding, making oral questioning a valuable strategy for effective science teaching at the primary level.

At the primary level, most teachers do not use such formative assessment techniques in the classroom; however, some of the teachers used formative assessment techniques, like observations, quizzes, one- minute paper, etc. The current research focuses on the oral questioning formative assessment technique. The researcher would be able to use this technique with General Science students of Grade V for the assessment of academic achievements by students through the use of an experimental approach of the formative assessment technique (Sulistiyaningsih & Lingga, 2025).

Significance of study

The significance of this study lies in its contribution to improving teaching and learning practices in primary-level General Science through the use of oral questioning and formative assessment techniques. The study provides empirical evidence that structured oral questioning, as an effective formative assessment strategy, enhances students' academic achievement by promoting deeper understanding, conceptual clarity, and active participation in science classrooms. The study is significant for teachers because it demonstrates how purposeful questioning techniques can improve classroom interaction, stimulate critical and analytical thinking, and provide immediate feedback on students' learning progress. It is also beneficial for students, as oral questioning increases their engagement, confidence, communication skills, and ability to express scientific ideas effectively. Furthermore, the findings of the study offer valuable guidance for curriculum developers, teacher educators, school administrators, and policymakers in integrating oral questioning strategies into primary science instruction to improve the overall quality of teaching and learning in General Science classrooms.

Objectives of Study

1. To examine the effect of oral questioning formative assessment techniques on students' academic achievement in the subject of General Science at the primary level.
2. To investigate whether oral questioning formative assessment techniques improve students' understanding and participation in General Science classrooms at the primary level.

Research Hypothesis

$H_0$1: There is no significant difference in the pre-test scores of the control group and experimental group in General Science at the primary level when oral questioning techniques are used.

Research Questions

1. What is the effect of oral questioning formative assessment techniques on the academic achievement of General Science students in 5th-grade at primary level?
2. Is there a significant difference in academic achievement between students taught through oral questioning formative assessment techniques and those taught through traditional teaching methods in General Science?
3. How do oral questioning techniques influence students' classroom participation and understanding of scientific concepts at the primary level?
4. Do oral questioning formative assessment techniques improve students' learning outcomes in General Science compared to traditional instruction methods?

RESEARCH METHODOLOGY

The present study used a quasi-experimental post-test and pre-test control group design to examine the effect of oral questioning formative assessment techniques on General Science students' academic achievement at primary level. The study measured students' academic performance through pre-test and post-test in both control and experimental groups. Intact classes were selected due to school limitations instead of random sampling. The control group was taught through the traditional lecture method, while the experimental group was taught using structured oral questioning techniques. These techniques included recall, probing, and higher-order questions to improve students' participation and understanding. The study was conducted in a normal classroom setting without disturbing school routine, which is suitable for educational research (Akhtar et al., 2024). The design was appropriate for comparing both groups while controlling external factors affecting learning. Pre-test scores were used to ensure both groups had similar ability before treatment. Any small differences were adjusted during analysis for accurate results. The intervention lasted for 24 weeks to ensure proper implementation of oral questioning. This duration allowed students enough practice time to improve their learning. The design provided reliable evidence on the effectiveness of oral questioning in improving science achievement at the primary level.

Sample of the Study

Purposive sampling was used to select one public primary school in District Vehari. Sixty students participated in the study and were divided into two intact groups of 30 students each. The control group received traditional teaching, while the experimental group was taught through structured oral questioning techniques. Existing classroom groups were maintained to preserve the natural learning environment and avoid ethical concerns. The intervention lasted 24 weeks, and 29 lesson plans were prepared according to the Grade V General Science curriculum. Both groups studied the same content and objectives. In the experimental group, oral questioning was conducted for 5–10 minutes, two to three times weekly, with immediate feedback to improve understanding, participation, and peer learning.

Research Instruments

The main research instrument used in this study was a researcher's self-developed achievement test consisting of 32-items. The test was based on the Grade V General Science textbook and covered the last five units taught during the intervention. It included multiple-choice questions and short-answer questions to assess different levels of student understanding. The same test was used as both a pre-test and a post-test to ensure fair comparison of results. The instrument was pilot-tested on Grade V students from another school, and item analysis was conducted to improve weak questions. Content validity was ensured through expert review by five subject specialists, whose suggestions were incorporated. The reliability of the test was confirmed through the test-retest method and a Cronbach's

Alpha value of 0.82, showing high reliability and internal consistency.

Data Collection Procedure

The pre-test was performed to the both groups before the start of the intervention to measure prior knowledge. The 24-week intervention was then implemented. The post-test was conducted immediately after the completion of the intervention under the same standardized conditions to ensure fairness. Data collection was personally supervised by the researcher to maintain consistency and minimize external influences.

Data analysis and interpretation

Descriptive statistics (standard deviation, mean, and percentages) were calculated to summarize group performance. Inferential statistics, specifically the t-test for independent samples, were used for the comparison of the means of control as well as the experimental groups. The level of significance was set P(α = 0.05). Assumptions of normality and homogeneity of variances were tested and satisfied. The data were analyzed using descriptive and inferential statistics. Necessary tables were also designed to show data analysis. The analysis was based on scores obtained from a validated 32-item achievement test, which was perfomred as a pre-test and post-test. Data were analyzed using SPSS. Both descriptive statistics (means along with their standard deviations) and inferential statistics (independent samples t-test) were employed. The significance level was set at $\alpha = 0.05$. All statistical assumptions were checked and met adequately. The results are presented systematically to evaluate the research hypothesis and answer the research question.

Table 1: Descriptive Statistics of Control and Experimental Group

Group	Mean	Std. Deviation	Minimum	Maximum
Control Group	38.7	4.3	28	48
Experiment Group (Oral questioning)	47.7	3.8	40	54

N=30

The descriptive statistics presented in Table 1 provide a clear comparison between the control and experimental group in terms of their academic achievement. The findings reveal that the control group consistently scored lower than the experimental group, indicating that students taught through traditional methods did not perform as well as those exposed to formative assessment strategies. Among the experimental group, relatively higher mean scores were recorded, suggesting that oral questioning had a positive influence on students' learning outcomes. Furthermore, the closeness of mean values across the experimental group reflects that each strategy contributed to student achievement in a meaningful way. The standard deviations remained small, implying that the scores within the group were fairly consistent and that there was less variation among students' performance. Overall, the results suggest that the oral questioning formative assessment technique enhanced student learning compared to conventional methods, with each experimental strategy showing noticeable improvements over the control group.

Table 2: Descriptive Statistics of Control and Experimental Groups (Low Score Dataset)

Group	Mean	Std. Deviation	Minimum	Maximum
Control Group	12.27	2.30	9	19
Experiment Group (Oral questioning)	12.10	2.60	8	18

N=30

The descriptive statistics in Table 2 show that the control group scored lower on average compared to the experimental group, suggesting that traditional teaching methods were less effective in improving student performance. Overall, the results provide preliminary evidence that formative assessment strategies, particularly Oral questioning, were more effective than conventional methods in enhancing students' achievement.

Table 3: Comparison of Pre-test between Control and Experimental Group

Tests	Groups	N	M	*SD*	*df*	*t-value*	*P*
Pre-Test	Control Group	30	12.31	2.60			
	Experimental Group (taught using oral questioning)	**30**	**12.09**	**2.82**	**58.00**	**-3.52**	**0.04**

M = Mean; SD = Standard Deviation; $p < .05$ marked with *.

The pre-test results for the control group (M = 12.31, SD = 2.60) and Experimental Group 1 (M = 12.09, SD = 2.82) show a very close similarity in mean scores before the intervention (taught using oral questioning). The independent samples t-test yielded a t-value of -3.52 with p = 0.04. Since the p-value is less than the significance level of 0.05, the difference in mean scores is statistically significant, indicating a slight pre-existing variation between the two groups.

Since this p-value (0.04) is less than the significance level of 0.05, the result is considered statistically significant. This means the null hypothesis is rejected, suggesting there was a statistically significant difference in the groups' initial knowledge or skills before the intervention.

Table 4: Comparison of Post-test Scores between Control and Experimental Group

Tests	Groups	N	M	*SD*	*df*	*t-value*	*p*
Pre-Test	Control Group	30	12.76	2.58			
	Experimental Group (oral questioning)	**30**	**12.31**	**2.60**	**57.15**	**-1.21**	**0.18**

M = Mean; SD = Standard Deviation; $p < .05$ marked with *.

Table 4 presents the independent sample t-test results for the post-test scores of the control and experimental groups in science. The experimental group achieved a higher mean score (M = 66.33, SD = 8.84) compared to the control group (M = 59.67, SD = 8.21). The t-value of 2.86 with a p-value less than 0.05 indicates that the difference is statistically significant. This suggests that the intervention applied to the experimental group had a positive effect on their science achievement compared to the control group. Therefore, based on these findings, the second hypothesis for science achievement is accepted, indicating a significant difference in post-test means between the two groups.

Table 5: Effect of Oral Questioning on Students' Academic Achievement

Group	N	M	SD	*df*	*t-value*	*P*
Control Group	30	59.67	8.21	58.9	2.86	0.006*
Experimental (Oral Questioning)	30	66.33	8.84			

*M = Mean; SD = Standard Deviation; p < .05 marked with *

The results show that the experimental group taught through oral questioning (M = 66.33, SD = 8.84) scored higher in the post-test than the control group (M = 59.67, SD = 8.21). The independent t-test yielded a t-value as 2.86 with *p*-value of 0.006, which was less as compared with 0.05 level of significance. This indicates a statistically significant difference in achievement between the two groups. Therefore, H1 is rejected, confirming that oral questioning as a formative assessment technique had a positive and significant effect on General Science students' academic achievement. The improvement suggests that continuous questioning during instruction enhances student engagement, encourages active participation, and improves conceptual understanding. From an educational perspective, oral questioning promotes immediate feedback, keeps learners mentally active, and helps teachers identify misconceptions in real time. Therefore, it can be considered an effective formative assessment strategy for primary-level science teaching.

Key findings

1. The descriptive results show that the experimental group (oral questioning) achieved a higher mean score (M = 47.7) than the control group (M = 38.7).
2. This indicates that students taught through oral questioning performed better than those taught through traditional methods.
3. In another dataset, the experimental group also showed slightly better performance, supporting the positive effect of oral questioning.
4. Pre-test results showed nearly equal mean scores between control (M = 12.31) and experimental (M = 12.09) groups.
5. The pre-test difference was statistically significant (p = 0.04), showing a slight initial variation between groups.
6. Post-test results showed a clear improvement in the experimental group (M = 66.33) compared to the control group (M = 59.67).
7. The post-test difference was statistically significant (p = 0.006), indicating the effectiveness of oral questioning.
8. Overall, findings confirm that oral questioning as a formative assessment technique significantly improves General Science students' academic.

Discussion

The findings of the present study demonstrate that oral questioning significantly improved students' academic achievement, as experimental group obtained a higher mean score (M = 47.7) than control group (M = 38.7). This finding is consistent with Fenton (2025)**,** who argued that oral assessment and questioning promote deeper cognitive engagement by encouraging students to explain their understanding, thereby improving learning outcomes. Similarly, Black and Wiliam (2018) emphasized that effective classroom questioning is one of the most powerful formative assessment strategies because it provides continuous evidence of students' learning and enables teachers to modify instruction accordingly. Overall, the results of this study conducted by Black and **Wiliam (2018)** were regarding using oral questioning in primary science classrooms for effective teaching and learning.

The results from pre-test showed that both groups had nearly similar academic performance before the intervention. The control group had a mean score of (M = 12.31), while the experimental group had (M = 12.09). This indicates that both groups started at

almost the same academic level. However, the statistical test showed a significant difference (p = 0.04). This suggests a slight variation in prior knowledge between the groups. Even though the difference was small, it was still statistically important. This ensures that the results of the study are more reliable for comparison. It also confirms that the groups were not completely identical at the beginning. Therefore, careful analysis was needed before concluding.

The post-test results showed that students taught through oral questioning achieved significantly higher scores (M = 66.33) than those taught through traditional instruction (M = 59.67, p = .006). These findings agree with Hattie (2023)**,** who reported that classroom discussion, questioning, and feedback produce substantial positive effects on student achievement when used systematically. Similarly, the study conducted by Brookhart (2017) revealed that effective questioning stimulates critical thinking, enhances conceptual understanding, and provides opportunities for immediate feedback, resulting in better academic performance. Students in the experimental group showed better understanding of science concepts. They also became more active and engaged during classroom discussions. The control group showed improvement but not as much as the experimental group. Overall, oral questioning proved to be an effective teaching strategy.

Overall, the present findings confirm that oral questioning is an effective formative assessment strategy that enhances students' academic achievement, participation, and conceptual understanding in General Science. This conclusion is supported by López-Pastor and Sicilia-Camacho (2017)**,** who found that formative assessment practices increase student engagement and improve learning quality through continuous feedback. Furthermore, Black and Wiliam (2018) argued that formative assessment strategies, including oral questioning, transform classroom learning through keeping active participation of students in learning process rather than their passive participation.

Immediate feedback from teachers helps students correct their mistakes quickly. This makes learning more interactive and meaningful. The results strongly support the effectiveness of oral questioning in General Science. It is more effective than traditional lecture-based teaching methods. Therefore, it can be recommended for primary-level classrooms. In conclusion, oral questioning significantly enhances students' academic performance and learning quality.

Conclusions and recommendations

The present study concluded that the oral questioning strategy is an effective instructional and formative assessment technique for improving General Science students' academic achievement at primary level. The experimental group, which was taught through oral questions, performed significantly better than the control group that received traditional instruction. The statistical analysis confirmed that the difference in post-test scores was significant ($p < 0.05$), indicating that oral questions had a positive impact on learning outcomes. Therefore, it can be concluded that oral questions are more effective than conventional teaching methods in enhancing students' academic performance. The findings of this study clearly indicate that oral questioning as a formative assessment technique has a positive impact on students' academic achievement in General Science. The experimental group performed better (M = 47.7) than the control group (M = 38.7), showing improved learning outcomes. This improvement reflects that oral questioning helps students actively participate in the learning process. It also enhances their conceptual understanding through continuous interaction. Similar results have been reported in recent studies where formative questioning improved student performance in science subjects. According to recent educational research, oral questioning strengthens cognitive engagement and supports meaningful learning processes. Therefore, the findings support its effectiveness at the primary level.

The results from pre-test showed that both groups had nearly similar academic levels before the intervention, with only a slight statistical difference (p = 0.04). Although this difference was small, it confirms that careful statistical control was necessary before analyzing post-test results. The similarity in initial performance strengthens the validity of the research design. It ensures that changes in achievement can be linked to the intervention rather than prior ability differences. Recent studies emphasize that pre-test equivalence is essential in quasi-experimental designs to ensure fair comparisons (Syed & Butt, 2025). Thus, the study maintained acceptable internal validity for evaluating oral questioning effectiveness.

The post-test results revealed a significant improvement in the experimental group (M = 66.33) compared to the control group (M = 59.67), with a strong significance level (p = 0.006). This confirms that oral questioning had a measurable and positive impact on students' academic performance. Students in the experimental group demonstrated better understanding and retention of science concepts. They also showed increased participation and confidence during classroom discussions. These findings align with recent evidence suggesting that oral questioning improves higher-order thinking skills in primary science learners (Ahmed, Shah & Raza, 2025). Therefore, oral questioning is an effective instructional strategy for improving learning outcomes.

The results further show that oral questioning promotes active learning and continuous engagement in the classroom. Students are encouraged to think critically and respond immediately during instruction. This process helps teachers identify misconceptions at an early stage. As a result, students receive immediate

feedback, which improves their understanding. Recent studies highlight that formative questioning increases student motivation and classroom interaction. This supports the idea that oral questioning is not only an assessment tool but also a teaching strategy that enhances learning quality.

The control group, which was taught through traditional methods, showed comparatively lower improvement in academic achievement. This indicates that lecture-based teaching alone may not be sufficient for developing conceptual understanding in science. Traditional methods often limit student participation and critical thinking opportunities. In contrast, oral questioning creates a more interactive and student-centered learning environment. Recent educational literature also confirms that teacher-centered instruction has limited effectiveness in improving science achievement at the primary level (Hameed, Hussain, & Abbas, 2025). Therefore, a shift toward formative assessment strategies is necessary.

Overall, the findings confirm that oral questioning as a formative assessment technique significantly improves General Science students' academic achievement. It enhances participation, conceptual clarity, and critical thinking skills among primary students. The study supports its integration into regular classroom teaching practices. It also highlights its importance for improving science education quality in primary schools. Based on recent global research trends, formative assessment strategies like oral questioning are considered essential for 21st-century learning. Therefore, it is recommended that teachers, curriculum developers, and policymakers promote its regular use in classrooms to improve student learning outcomes.

The following recommendations are suggested for teachers, parents, policymakers, curriculum developers, educational supervisors, and administrators at the school education level.

1. The primary school science teachers regularly use oral questioning and formative assessment techniques in daily classroom teaching to improve students' conceptual understanding and academic achievement, as supported by recent studies on formative assessment effectiveness.
2. Teachers should design and use a mix of lower-order and higher-order oral questions to develop students' critical thinking and scientific reasoning skills.
3. Teacher training programs should include professional development workshops on effective use of oral questioning strategies as a formative assessment tool.
4. Curriculum developers are encouraged to integrate structured oral questioning activities into the General Science curriculum to promote active and interactive learning.
5. School administrators should ensure the availability of a supportive classroom environment that encourages questioning, discussion, and student participation.
6. Educational supervisors should monitor classroom teaching practices and provide constructive feedback to teachers on the effective use of oral questioning techniques.
7. Parents should be encouraged to support their children by promoting question-based learning habits at home, which can strengthen classroom learning.
8. Policymakers should include formative assessment strategies like oral questioning in national education policies to improve the quality of primary education.
9. All educational institutions should encourage the use of student-centered teaching methods, especially oral questioning, to enhance engagement and learning outcomes.
10. Future researchers are encouraged to conduct longitudinal and large-scale studies on oral questioning techniques across different regions and subjects to validate and generalize findings (Salahuddin, Gillani, & Gul, 2026).

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Statements and Declarations

Data Availability statement

All relevant data are within the manuscript file.

Author's Contribution Statement

MI, and MS collected data and wrote manuscript equally. MS, and MI make final editing. MS supervised the whole research work. All authors have read the final manuscript and approve its submission.

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Not applicable

Conflict of interest

The investigation was undertaken without any financial conflicts of interest or any other commercial relationships that could be seen as such by any of the authors.