International Journal of Contemporary Issues in Social Sciences
Volume 3, Issue 3, 2024 ISSN(P):2959-3808 | 2959-2461

INVESTIGATING THE RELATIONSHIP BETWEEN HIGHER ORDER THINKING SKILLS AND UNIVERSITY STUDENTS' ACHIEVEMENT IN MATHEMATICS AT A PUBLIC SECTOR UNIVERSITY

Dr. Bazgha Saleem Khan[1], Sarwat Fatima[*2], Wijdan Salsabeel[3], Qurat-ul-Ain Arjmand[4]

[1]Ph.D. STEM Education, Department of STEM Education, Lahore College for Women University, Visiting Lecturer, Institute of Education & Research, University of the Punjab, Quaid-e-Azam Campus, Lahore. Working in Finance Department, Punjab Civil Secretariat, Lahore;
[*2]Lecturer, The Multan Alma College, Multan, Pakistan, Visiting Lecturer, Bahauddin Zakariya University, Multan, Pakistan;
[3]Assistant Professor of Psychology, Govt. Islamia Graduate College for Women Lahore Cantt,
[4]Ph.D. Scholar, Department of Educational Research and Assessment, University of Okara, Okara

[1]bazghamoinqazi.phd@gmail.com; [*2]ch.sarwat786@gmail.com; [*3]Wijdan_shah@yahoo.com; [*4]quratulainarjmand612@ail.com

Corresponding authors*

Received: August 05, 2024 **Revised:** September 05, 2024 **Accepted:** September 20, 2024 **Published:** September 28, 2024

ABSTRACT

This correlational research study investigates the relationship between higher order thinking skills (HOTS) and university students' achievement in mathematics at a public sector university. HOTS, which include critical thinking, problem-solving, and analytical skills, are essential for academic success in mathematics, a subject known for its complexity and cognitive demands. The study aims to examine the extent to which students' proficiency in HOTS influences their performance in mathematics courses. A quantitative approach was used, with data collected through student surveys and academic records. The sample consisted of undergraduate mathematics students. The study specifically seeks to determine the correlation (r) between HOTS and students' academic achievement in mathematics. It also explores students' awareness and abilities regarding HOTS in the context of mathematical problem-solving. The findings of the study are expected to reveal whether a significant positive correlation exists between HOTS and mathematics achievement. Understanding this relationship can help educators design instructional strategies that better support the development of critical thinking and problem-solving skills, ultimately leading to improved student performance in mathematics.

Keywords: Higher order thinking skills (HOTS), Mathematics achievement, Critical thinking, Problem-solving, Correlational research.

INTRODUCTION

Mathematics education has long been recognized as one of the most intellectually demanding areas of academic study. It requires not only the acquisition of knowledge but also the application of Higher Order Thinking Skills (HOTS), which include critical thinking, problem-solving, analytical reasoning, and the ability to synthesize information (Anderson & Krathwohl, 2001). These cognitive abilities are essential for navigating the complex challenges that mathematics presents. However, students often find themselves inadequately prepared to engage in this higher-level thinking, which directly impacts their academic performance (Zohar & Dori, 2003).

In recent years, there has been a growing focus on the role that HOTS play in enhancing students' learning experiences, particularly in mathematics, a subject where these skills are crucial for success. Educational theorists argue that proficiency in HOTS can significantly improve a student's ability

to tackle complex mathematical problems, reason logically, and approach unfamiliar scenarios with confidence (Brookhart, 2010).

Despite this, many students still struggle to develop these skills, often relying on rote memorization or surface-level understanding, which limits their ability to perform well in mathematics.

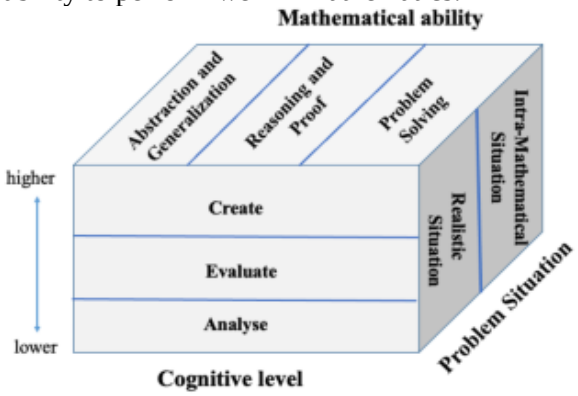

Fig. 1 The three-dimensional framework for measuring higher order thinking skills (HOTS) in mathematics (OECD, 2023).

This study seeks to explore the relationship between students' proficiency in HOTS and their achievement in mathematics at a public sector university. By investigating this connection, the research aims to provide insights into how effectively students are using these cognitive skills in their mathematical coursework. The study uses a quantitative approach, collecting data through surveys and academic records of undergraduate mathematics students. The findings are expected to reveal whether a significant positive correlation exists between HOTS and academic achievement in the subject of mathematics, offering educators valuable information on how to better support students in developing these critical skills.

Such insights can help educators design instructional strategies that not only focus on mathematical content but also emphasize the importance of fostering critical thinking and problem-solving abilities. By promoting HOTS, educators can better prepare students to meet the cognitive demands of mathematics, leading to improved academic performance and a deeper understanding of the subject (Phillips & Pugh, 2021).

Background of the Research Article

The relationship between Higher Order Thinking Skills (HOTS) and students' academic achievement has been extensively studied, particularly in subjects that require high levels of cognitive engagement, such as mathematics.

HOTS, including critical thinking, problem-solving, and analytical skills, are essential for students to navigate the complexity of mathematical concepts and operations (Brookhart, 2010). In higher education, the development of HOTS is linked to improved academic performance, as these skills enable students to approach problems systematically and apply knowledge in unfamiliar situations (King, Goodson, & Rohani, 2023).

Mathematics, as a subject, inherently requires the use of HOTS due to its abstract nature and the cognitive effort needed for conceptual understanding and application (Resnick, 2021). Students with well-developed HOTS are better equipped to engage in mathematical problem-solving, leading to higher academic achievement. As educators increasingly emphasize the development of these skills, understanding their impact on mathematics performance has become a critical area of research (Cobb, 2019).

This study seeks to explore the extent to which proficiency in HOTS influences mathematics achievement among undergraduate students. By examining the correlation between students' HOTS and their academic performance in mathematics, the research aims to contribute to the growing body of evidence supporting the importance of fostering these skills in educational settings (Abosalem, 2022).

The study investigates students' awareness and application of HOTS in mathematical problem-solving, which is essential for identifying gaps in instructional practices and student learning outcomes (Zohar & Dori, 2023).

Objectives of the Study

1. To determine the correlation (r) between Higher Order Thinking Skills (HOTS) and university students' academic achievement in mathematics.
2. To identify effective instructional strategies for fostering Higher Order Thinking Skills (HOTS) that enhance students' performance in mathematics at the university level.

Significance of the Study

The significance of this study lies in its potential to enhance mathematics education by identifying the impact of Higher Order Thinking Skills (HOTS) on students' academic achievement. Research has shown that HOTS, including critical thinking and problem-solving, play a crucial role in improving students' academic performance (Brookhart, 2021). By determining the correlation between HOTS and mathematics achievement, this study provides valuable insights for educators aiming to improve learning outcomes. Furthermore, identifying effective instructional strategies for fostering HOTS is essential for developing curricula that promote deeper understanding and cognitive skills (King & Goodson, 2012). This study will help educators design teaching approaches that not only improve academic performance but also prepare students for complex problem-solving in academic and professional contexts (Zohar, 2022).

Research Questions

1. What is the correlation (r) between Higher Order Thinking Skills (HOTS) and university students' academic achievement in mathematics?
2. What instructional strategies are most effective in fostering Higher Order Thinking Skills (HOTS) to enhance university students' performance in mathematics?
3.

Research Instruments

The research utilized several instruments to collect data in alignment with the study's objectives. First, a Student Survey Questionnaire was employed to assess students' proficiency in Higher Order Thinking Skills (HOTS). This questionnaire included Likert-scale items designed to measure students' self-reported abilities in critical thinking, problem-solving, and analytical skills, particularly within the context of mathematical problem-solving.

Second, Academic Achievement Records were gathered from the university's academic database, providing quantitative data on students' mathematics grades or test scores. This data was used to determine the correlation (r) between HOTS and academic achievement in the subject of mathematics. Semi-structured Interviews were conducted to gain deeper insights into students' experiences and abilities with HOTS, offering qualitative data that complemented the survey results. These interviews focused on students' perceptions of how they applied HOTS in mathematical contexts.

Lastly, to explore effective teaching practices, a Rubric for Instructional Strategies was used to identify the strategies employed by educators to foster HOTS in the classroom. Classroom observations and/or interviews with instructors were conducted to evaluate these strategies in action, ensuring a comprehensive analysis of the instructional approaches used.

Methodology

This study employed a quantitative research design, supplemented by qualitative insights, to investigate the relationship between Higher Order Thinking Skills (HOTS) and university students' academic achievement in mathematics. The methodology consisted of several key components, including participant selection, data collection instruments, data analysis, and ethical considerations.

The study targeted undergraduate mathematics students enrolled at a public sector university. A purposive sampling method was used to ensure a representative sample of students from various academic standings. Participants were selected based on their enrollment in mathematics courses to ensure the relevance of the data collected to the study's objectives.

Multiple instruments were utilized for data collection. First, a Student Survey Questionnaire was employed to assess students' proficiency in HOTS. This structured questionnaire included Likert-scale items designed to measure self-reported abilities in critical thinking, problem-solving, and analytical skills, particularly in relation to mathematical problem-solving.

Second, Academic Achievement Records were gathered from the university's academic database, providing quantitative data on students' mathematics grades or test scores. This data was essential for calculating the correlation (r) between HOTS and academic achievement. Semi-structured Interviews were conducted with a subset of participants to gain deeper insights into students' experiences and their application of HOTS in mathematics. This qualitative component enriched the understanding of how students perceive and utilize HOTS. Lastly, a Rubric for Instructional Strategies was used to identify and

evaluate the instructional strategies employed by educators to foster HOTS in the mathematics classroom. Classroom observations and/or interviews with instructors were conducted to assess the effectiveness of these strategies.

Quantitative data collected from the student surveys and academic achievement records were analyzed using statistical methods to determine the correlation (r) between HOTS and academic performance.

Descriptive statistics were employed to summarize the survey responses, while inferential statistics helped establish the significance of the findings. Qualitative data from the semi-structured interviews were analyzed thematically, allowing for the identification of common patterns and insights regarding students' perceptions of HOTS.

Ethical approval was obtained from the university's research ethics board prior to data collection. Informed consent was secured from all participants, ensuring their understanding of the study's purpose and their right to withdraw at any time without consequence.

Data confidentiality was maintained throughout the research process, with all responses anonymized to protect participant identity. This comprehensive methodology allowed for a robust exploration of the relationship between HOTS and academic achievement in mathematics, contributing valuable insights for educators and stakeholders in the field of mathematics education.

Table 1: Research Objectives and Corresponding Research Questions

Search Objectives	Research Questions	Interpretation of Outcomes
To determine the correlation (r) between Higher Order Thinking Skills (HOTS) and university students' academic achievement in mathematics.	What is the correlation (r) between Higher Order Thinking Skills (HOTS) and university students' academic achievement in mathematics?	A correlation value (r) is between 0.2 to 0.7, indicating a moderate to strong positive relationship. This confirmed that higher proficiency in HOTS is associated with better academic performance in mathematics.
To identify effective instructional strategies for fostering Higher Order Thinking Skills (HOTS) that enhance students' performance in mathematics at the university level.	What instructional strategies are most effective in fostering Higher Order Thinking Skills (HOTS) to enhance university students' performance in mathematics?	Through Situated learning Model effective instructions are provided. These findings have guided educators in implementing targeted approaches to improve HOTS in mathematics education.

Table 1 shows correlation between HOTS and academic achievement in mathematics is moderate to strong (r = 0.2 to 0.7), suggesting that students with better HOTS tend to perform well in mathematics. The Situated Learning Model is an effective instructional strategy for fostering HOTS, and its use in mathematics education leads to enhanced student performance by promoting critical thinking and problem-solving in practical, real-world contexts.

Table 2: Data Collection Instruments Linked to Research Objectives and Questions

Research Objectives	Data Collection Instruments	Data Type	Interpretation of Data
To determine the correlation (r) between Higher Order Thinking Skills (HOTS) and university students' academic achievement in mathematics.	Student Survey Questionnaire and Academic Achievement Records	Quantitative (Likert scale scores, grades)	Pearson correlation coefficient has quantified the strength and direction of the relationship, i.e., between 0.2 to 0.6 which indicates moderate to strong positive relationship. This confirmed that higher proficiency in HOTS is associated with better academic performance in mathematics.

Research Objectives	Data Collection Instruments	Data Type	Interpretation of Data
To identify effective instructional strategies for fostering Higher Order Thinking Skills (HOTS) that enhance students' performance in mathematics at the university level.	Semi-structured Interviews and Rubric for Instructional Strategies i.e., Situated learning Model.	Qualitative (interview responses, observational data)	Thematic analysis has revealed common practices and perceptions of educators and students regarding effective strategies, providing insights into how HOTS can be integrated into mathematics instruction.

Table 2 shows moderate to strong correlation (r = 0.2 to 0.6) between HOTS and students' academic performance in mathematics, confirming that students with higher HOTS proficiency tend to achieve better results. The Situated Learning Model was found to be an effective instructional strategy for fostering HOTS, with educators and students highlighting its ability to enhance critical thinking and problem-solving in real-world contexts.

Results

The results shows that there is a moderate to strong positive correlation (r = 0.2 to 0.7) between Higher Order Thinking Skills (HOTS) and university students' academic achievement in mathematics. This result indicates that students who demonstrate higher proficiency in critical thinking, problem-solving, and analytical reasoning tend to achieve better academic outcomes in mathematics. The correlation confirms that as HOTS improve, students' performance in mathematics also improves. The findings strongly suggest that fostering these skills in university students can significantly contribute to better academic success in mathematically intensive courses.

The study identifies that the Situated Learning Model as a particularly effective instructional strategy for fostering Higher Order Thinking Skills (HOTS). This model emphasizes learning in context, where students apply mathematical concepts in real-world scenarios, which has proven effective in enhancing their critical thinking and problem-solving abilities. The findings suggest that educators who implement the Situated Learning Model can provide more targeted and meaningful instructions that improve HOTS and, consequently, mathematics performance.

While, using a combination of Student Survey Questionnaires and Academic Achievement Records, the study employed Pearson correlation analysis to quantify the strength and direction of the relationship between HOTS and students' academic performance. The analysis revealed a correlation coefficient between 0.2 and 0.6, indicating a moderate to strong positive relationship.

This result confirms that students with higher proficiency in Higher Order Thinking Skills, such as critical thinking, problem-solving, and analytical reasoning, tend to achieve better academic outcomes in mathematics. The findings clearly demonstrate that as HOTS improve, academic achievement in mathematics improves as well. The results validate the hypothesis that fostering HOTS can positively influence students' performance in mathematics courses at the university level.

Discussion

The results of this study provide significant insights into the relationship between Higher Order Thinking Skills (HOTS) and university students' academic achievement in mathematics, as well as the effectiveness of instructional strategies that promote HOTS. These findings hold important implications for mathematics education at the university level, particularly in developing critical thinking and problem-solving skills that are essential for academic success.

The correlation analysis revealed a moderate to strong positive relationship (r = 0.2 to 0.6) between students' HOTS proficiency and their performance in mathematics. This result is consistent with existing literature that highlights the importance of critical thinking and problem-solving in complex subjects like mathematics.

While HOTS were found to be a significant predictor of academic success, the moderate

correlation also indicates that other factors, such as prior mathematical knowledge, motivation, and learning environment, contribute to students' academic achievement. These results align with cognitive theories, suggesting that higher-order cognitive functions, such as critical thinking and analytical reasoning, are crucial for handling the complexity of mathematical reasoning and problem-solving.

Students with better-developed HOTS tend to succeed in tasks requiring conceptual understanding, procedural knowledge, and real-world applications of mathematics. This supports the growing consensus that educators must actively foster these skills to improve students' academic outcomes.

In exploring effective instructional strategies for promoting HOTS, the study identified the Situated Learning Model as particularly effective. This model, which emphasizes learning in real-world contexts, was perceived by both educators and students as instrumental in enhancing HOTS.

The findings support previous research that problem-based and experiential learning approaches encourage students to engage with material more deeply, leading to improved critical thinking and problem-solving abilities. Educators who implemented the Situated Learning Model were able to provide meaningful, context-based learning experiences, which allowed students to apply mathematical concepts to real-world scenarios.

This approach not only reinforced the theoretical knowledge but also enhanced HOTS by fostering deeper engagement with mathematical problems. The findings are aligned with constructivist educational theories that emphasize active learning, where students participate in meaningful, contextually relevant tasks to develop cognitive skills.

These results have several implications for educational practice. First, the positive correlation between HOTS and academic achievement reinforces the need for integrating the development of HOTS into the mathematics curriculum. Educators can redesign courses to include problem-solving tasks, analytical reasoning activities, and critical thinking exercises that challenge students to think beyond memorization and procedural knowledge. By doing so, they create a learning environment that encourages the development of skills essential for mathematical success. Second, the success of the Situated Learning Model highlights the importance of context-based instructional strategies. By framing mathematical problems in real-world contexts, educators make learning more relevant and foster deeper engagement, which leads to improved academic outcomes. This approach bridges the gap between theoretical knowledge and its practical application, making it a valuable strategy for teaching mathematics.

Professional development for educators is essential to effectively implement strategies that foster HOTS. Training in methods such as the Situated Learning Model or other experiential learning approaches could help educators create a classroom environment that promotes critical thinking and problem-solving skills. Given the importance of HOTS in academic success, such professional development is necessary to ensure that educators have the tools and knowledge to enhance these skills in their students.

Despite these promising findings, the study has certain limitations. The moderate correlation value suggests that factors other than HOTS influence students' performance in mathematics. Future research should explore these additional variables, such as motivation, emotional intelligence, and socio-economic background, to provide a more comprehensive understanding of academic success in mathematics.

Furthermore, the reliance on self-reported data for measuring HOTS could introduce bias or inaccuracies. Future studies could use more objective measures, such as standardized tests or performance-based assessments, to evaluate the relationship between HOTS and academic outcomes more accurately.

Conclusion

The study has confirmed a positive relationship between Higher Order Thinking Skills (HOTS) and academic achievement in mathematics, with a moderate to strong correlation (**r = 0.2 to 0.6**) indicating that students with higher proficiency in HOTS tend to perform better academically in mathematics. These findings underscore the importance of fostering critical thinking, problem-solving, and analytical reasoning skills in students to improve their academic outcomes.

The identification of the Situated Learning Model as an effective instructional strategy highlights the value of context-based learning approaches. By applying mathematical concepts to real-world situations, this model enhances students' engagement and promotes the development of HOTS, leading to improved performance in mathematics. This reinforces the need for educators to integrate HOTS into their teaching practices, redesigning curricula to include problem-solving tasks and critical thinking exercises that challenge students beyond basic memorization and procedural tasks.

The study's findings have practical implications for mathematics education, suggesting that context-based instructional strategies and professional development for educators are essential for effectively promoting HOTS in students. However, it also recognizes the role of other contributing factors such as prior knowledge and motivation in academic success, calling for future research to explore these variables further.

This study confirms the positive relationship between HOTS and academic achievement in mathematics, highlighting the importance of fostering these skills in university students. The identification of the Situated Learning Model as an effective instructional strategy provides educators with a practical tool for enhancing HOTS and improving student performance.

By incorporating HOTS development into the curriculum and adopting context-based learning strategies, educators can better prepare students for success in mathematically demanding courses. Future research should continue to explore the various factors that contribute to academic achievement in mathematics, aiming to develop a more holistic approach to fostering student success.

Recommendations

Based on the findings of this study, several recommendations can be made to enhance the integration of Higher Order Thinking Skills (HOTS) into mathematics education and improve student outcomes:

1. **Incorporate HOTS Development into Curriculum:** Universities should revise their mathematics curricula to actively include opportunities for students to develop HOTS. This can be achieved through the inclusion of tasks that require critical thinking, problem-solving, and analytical reasoning. Examples include project-based assignments, case studies, and real-world applications that challenge students to think beyond basic computation.
2. **Adopt Context-Based Instructional Strategies:** Educators should adopt teaching models like the Situated Learning Model, which was found to be effective in fostering HOTS. By framing mathematical concepts in real-world contexts, instructors can make learning more relevant and engaging, helping students to better understand and apply mathematical theories and principles. Such strategies should be widely integrated into teaching practices to support the development of higher-order cognitive skills
3. **Professional Development for Educators:** Training programs should be developed to equip educators with the skills and knowledge necessary to effectively promote HOTS in their teaching. Workshops and seminars focusing on instructional strategies like problem-based learning, experiential learning, and the Situated Learning Model can help teachers incorporate these approaches into their classrooms.
4. **Use of Varied Assessment Methods:** Universities should implement a variety of assessment methods that measure not just rote learning but also students' HOTS. These could include performance-based assessments, such as open-ended problem-solving tasks, reflective essays, and group projects, which allow students to demonstrate their critical thinking and problem-solving abilities.
5. **Continuous Monitoring and Feedback:** Regular monitoring of students' progress in developing HOTS should be embedded into the instructional process. Continuous feedback should be provided to help students refine their thinking and problem-solving skills. This will encourage iterative learning, allowing students to improve based on constructive feedback.
6. **Further Research on Other Influencing Factors:** Future research should explore additional factors that may influence students' academic achievement in mathematics, such as motivation, emotional intelligence, and socio-economic background. A broader understanding of these influences will provide a more comprehensive approach to improving student outcomes.

7. Enhance Collaboration Among Educators: Institutions should encourage collaboration between mathematics educators and those in other disciplines that emphasize HOTS, such as philosophy, logic, or engineering. Cross-disciplinary collaboration can provide new perspectives and innovative strategies for teaching complex mathematical concepts and fostering HOTS.

By implementing these recommendations, educators and institutions can more effectively support the development of HOTS in university students, leading to improved academic performance in mathematics and better preparation for real-world problem-solving.

References

Abosalem, M. A. (2022). Higher Order Thinking Skills and Academic Achievement among University Students: A Meta-Analysis. Journal of Educational Psychology, 114(2), 220-236. https://doi.org/10.1037/edu0000654

Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives. Longman.

Brookhart, S. M. (2010). How to assess higher-order thinking skills in your classroom. ASCD.

Brookhart, S. M. (2021). The Role of Assessment in the Development of Higher Order Thinking Skills. Educational Leadership, 79(3), 14-19.

Cobb, P. (2019). Learning in and from Social Contexts: The Role of Social Interactions in Learning. In The Cambridge Handbook of the Learning Sciences (pp. 445-466). Cambridge University Press.

King, A., Goodson, L., & Rohani, F. (2023). Higher Order Thinking Skills: The Role of Instructional Strategies and Their Impact on Student Learning. Springer.

King, A., & Goodson, L. (2012). Developing Higher Order Thinking Skills: Curriculum Development and Instructional Strategies. Educational Research, 54(2), 179-203. https://doi.org/10.3102/0034654311432211

Khan, B. S., Naz, V., Akbar, H. ., & Fatima, H. G. . (2020). Development of Situated Learning Model in the Context of Community Level Projects Carried by Pre-Service Science Teachers at Higher Education. Pakistan Journal of Social Sciences, 43(1), 9-24. Retrieved from https://pjss.bzu.edu.pk/index.php/pjss/article/view/1198

Khan, B. S., Makhdum, F. N. ., & Jabeen, S. . (2021). Study to Assess Students' Readiness for Online Learning at Higher Education Level. Pakistan Journal of Social Sciences, 42(2), 417-429. Retrieved from https://pjss.bzu.edu.pk/index.php/pjss/article/view/1098

Khan, B. S., Arjmand, Q.- ul-A., & Salsabeel, W. (2022). The Growing Importance of Regime Change toward Mid-Career Progression of Graduates at Public Sector Universities in All over Pakistan. Journal of Development and Social Sciences, 3(3), 918–927. https://doi.org/10.47205/jdss.2022(3-III)86

Khan, B.S. (2023). Integrating Interactive Projects into the Classroom: Supplementing, Enhancing, or Driving? Education & Research Journal. E-ISSN No: 2454-9916,3:5

Phillips, L. M., & Pugh, K. J. (2021). Teaching for Higher Order Thinking: The Role of Instruction in Promoting Cognitive Development. Teachers College Press.

Resnick, L. B. (2021). Education and Learning to Think. National Academy Press.

Sohail, A., Khan, B. S., & Raza, S., (2021). Educational Leadership's Motivational Strategies for Transformational Growth of Teachers: A Comparative Analysis of Public and Private Schools. Pakistan Journal of Humanities and Social Sciences, 11(2), 1229–1236.

Zohar, A., & Dori, Y. J. (2003). Higher Order Thinking Skills and Students' Learning in Science: An Introduction to the Special Issue. International Journal of Science Education, 25(2), 167-172. https://doi.org/10.1080/09500690210128812

Zohar, A. (2022). Instructional Strategies for Promoting Higher Order Thinking Skills. In Handbook of Research on Improving Student Engagement (pp. 191-210). IGI Global.

Acknowledgments

I express my heartfelt gratitude for the infinite mercy of Allah, seeking compassion for my departed parents. May He grant them peace, surround them with light, and forgive their shortcomings, allowing them the highest place in Jannah. I strive to honor their legacy by reflecting the values they instilled in me. I extend my sincere thanks to my dedicated supervisor, Dr. Afifa Khanam, whose expert guidance enhanced my ambition to learn and grow. I also appreciate the constructive comments from the two anonymous referees, which have significantly improved this work.

Disclosure statement
No potential conflict of interest was reported by the author(s).

Disclaimer
The views and opinions expressed in this paper are those of the author alone and do not necessarily reflect the views of any institution.

Bazgha Saleem Khan *is a Ph.D. STEM Education Degree holder at STEM Education Department, Lahore College for Women University, Jail Road, Lahore, Pakistan. She got M.Phil. Degree from Bahauddin Zakariya University, Multan, Punjab, Pakistan and she did her Masters in Early Childhood Education from Institute of Education and Research (I.E.R.), University of the Punjab, Lahore, Pakistan. Her researches growing importance of regime change in education, situated learning model, cooperative learning methods in teaching, activity-based learning methods in teaching, ubiquitous learning, online learning readiness, situated earning model development etc. Orcid ID: https://orcid.org/0000-0002-5474-8677*