

Advancing Mathematical Thinking in Higher Education: Challenges and Innovations

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Currently, she is further advancing her academic qualifications by pursuing a Doctor of Education degree at Pangasinan State University, Urdaneta Campus. With 13 years of experience in mathematics instruction, Ms. Pascua has developed effective strategies to enhance students' understanding and appreciation of mathematics while integrating innovative, research-based teaching practices in the classroom. At DMMMSU-NLUC, she continues to inspire and mentor students through her dedication to academic excellence, educational research, and student success. Her professional journey reflects a strong commitment to lifelong learning and a passion for advancing mathematics education.

Introduction

The ability to understand, analyze, and solve problems using mathematical concepts and methods is referred to as mathematical thinking. Mathematical reasoning is a fundamental building block in many fields within higher education, including the sciences, social sciences, and the development of critical thinking skills. Through the development of mathematical reasoning, learners are prepared to face the increasing complexity of modern work, as the demand for analytical and data-driven reasoning continues to grow.

In recent years, trends in higher education regarding the enhancement of mathematical reasoning have focused on innovative instructional

strategies and the integration of technology. In addition to the use of newer technologies and instructional methods, collaborative learning environments have provided learners with more opportunities to interact with their peers, fostering a deeper understanding of mathematical reasoning.

Online platforms and interactive tools have made it possible for learners to engage with mathematical reasoning by visualizing an underlying problem and providing immediate feedback, fostering exploration of mathematical concepts.

Despite innovations in mathematics education, significant challenges remain to the effective teaching of mathematics. Many students struggle to understand fundamental mathematical concepts because the more traditional methodologies used to teach mathematics do not accommodate the various learning styles of many students. It is critical that the gaps that prevent all students from experiencing and benefiting from the enjoyment of mathematical reasoning be addressed in order to facilitate the development of more effective methods of instruction and to create a more equitable learning environment in higher education for the study of mathematics.

Implications of Teaching Mathematics and Challenges in Learning Mathematics

There are many challenges associated with teaching and learning mathematics in higher education that can hinder student engagement and success. A primary barrier to student participation in mathematics is anxiety; this feeling generates negative perceptions about the subject by reinforcing the thought that math is too difficult and/or complex. An example of how strongly students believe this is when they think of themselves as "not a math person." In many cases, this predetermined belief can affect the student's ability to read, write, compute, and/or communicate in mathematics through participation in various mathematical settings; whether the student is in the classroom or outside

of the classroom, this belief can affect the way they choose to participate in discussions or engage with the content being taught in the class.

A second major factor affecting how students experience anxiety in math is the difficulty of the curriculum. A rigorous mathematics curriculum is designed to equip students with the fundamental skills needed to develop and advance their mathematical abilities. However, when a curriculum is overly rigorous or too fast-paced, many students feel overwhelmed, insecure, and anxious about their ability to succeed in math. Additionally, students without adequate foundations to build upon may feel frustrated and lose confidence as they cannot keep up with or understand more advanced concepts and/or applications. This represents a schism and demonstrates the need for an appropriate balance between curriculum development and providing students with access and opportunity to succeed at this level of curriculum rigor.

Lastly, there are also challenges associated with the resources available to assist students as they work to overcome their classroom challenges. Many schools provide limited educational resources to assist their students with their learning challenges. For example, there may not be enough educational resources, such as tutoring, study guides, and technology tools, available to assist students in learning mathematics effectively. In light of this resource deficit, educators must find and use innovative, student-centered strategies to create supportive and engaging learning experiences for their students. The needs of each student should drive the choice of instructional strategies. So, by being persistent in developing an innovative math instructional method, students will be prepared for their future careers. Innovative teaching techniques are important in post-secondary education, especially in mathematics, where traditional approaches do not effectively engage students. One example of an effective, active teaching technique is active learning - getting students involved with their own learning by engaging in group discussions, doing problem solving, and doing hands-on activities that create a specified type of interaction and help students see how

mathematical concepts relate to real-world scenarios, ultimately decreasing their anxiety and increasing their self-confidence.

Another innovative teaching approach is collaborative learning, which encourages teamwork between students. Working in small-group settings helps students understand the mathematical concepts they are studying from multiple points of view, fosters discussion about how to approach and solve problems, and provides support to one another when faced with difficulties. In addition to developing an understanding of mathematical concepts, students develop communication and interpersonal skills through collaboration, which will transfer from the academic setting to the world of work.

Furthermore, the integration of technology provides additional ways to enhance the two teaching strategies above. The use of technology, such as online simulations, educational software, and interactive web platforms, provides students with a more engaging and interactive learning experience. For example, if a student uses graphing software, he/she can visualize complex mathematical functions and see how they are used in real-world applications, potentially reducing the student's anxiety and improving his/her self-confidence in his/her mathematical abilities. Technology can also offer opportunities for students to collaborate on projects and maintain their team relationships, even if working from remote locations (Zappatore, 2023).

As educators incorporate innovative teaching techniques, they create an engaging, more effective learning environment. The emphasis on active involvement in and the use of technology in mathematics will not only help develop students' mathematical reasoning but also prepare them for the digital skills needed for success in 21st-century careers. This also leads to further discussions regarding how the increasing role of technology could help students make sense of and understand mathematics.

Technology is changing the way that people teach and learn mathematics in higher education. Students now have many opportunities to work with different types of technology and engage with difficult concepts (i.e.,



engagement), especially through online technology, which is often accessed via the Internet, providing access to courses and resources for students to complete at their convenience. With the flexibility to learn, students can use their preferred mode and get help when needed, making it easier to understand mathematical concepts.

Simulated environments for learning about mathematics and using mathematical software have greatly enhanced students' ability to understand mathematics. Software such as GeoGebra and MATLAB enables students to gain a better understanding of mathematical concepts through visualizations and data interaction, allowing them to see the immediate impact of their calculations. As a result, students often gain greater confidence and develop greater interest in mathematics by experiencing and exploring mathematical concepts through simulation-based learning.

As technology continues to evolve, so must the ways we assess students' mathematical reasoning. Educators will face both difficulties and benefits from including these educational tools in the classroom; they could help develop new ways to assess student progress, an important part of making assessment of learning meaningful in a rapidly changing world.

Learning Assessments in Mathematics

Learning assessments for higher education in mathematics have continued to evolve, as educators seek better methods to gauge how well students are learning and how engaged they are in the classroom. Most summative assessments (such as midterms and final exams) focus on memory (or recall) of mathematical principles and create anxiety in students. Formative assessments provide students with regular assessments of their progress toward course objectives, fostering a growth mindset and helping them understand where they need to improve.

Performance-based assessments have been an innovative approach to assessing mathematical thinking; by engaging in authentic mathematical

tasks (e.g., solving real-world word problems), students can demonstrate their understanding of and ability to use mathematical concepts. Performing these tasks in a context that is both relevant to the student and representative of real-life situations helps to reinforce the applicability of what they have learned and encourages continued motivation to learn mathematics.

Additionally, peer assessment has become increasingly popular in mathematics education. This fosters collaboration and communication skills by allowing students to provide feedback on each other's work. The peer feedback a student provides to a classmate can offer diverse perspectives and promote a sense of community in the classroom; giving students ownership of their learning experience contributes to the success of their peers. Students' experience with mathematics can be greatly impacted by their emotional and social factors. For students from many cultural identities, these experiences impact how they view the mathematical process.

A case study following a Hispanic student from a low socio-economic, urban area who struggled in school because of his lack of connection with the teacher and the classroom experience illustrates this point. Due to the student's background, his family never completed high school, and his past experience left him believing he would not succeed at school.

The educator became aware of the student and invested time outside of school, learning about the student's culture and life experiences before returning to school, positively impacting the student's success in mathematics and creating a sense of belonging in the classroom and the school.

This example highlights the impact of cultural/social factors on how students learn mathematics and how educators, by recognizing these factors, can foster a more positive attitude toward mathematics, develop a sense of belonging in the classroom, and encourage motivation to learn mathematics.

In summary, many factors outside the emotional domain significantly influence students' educational success through cultural and social experiences. Educators must be aware of these factors and consider their interactions when working with students from diverse cultural backgrounds. Recognizing and valuing student cultural/social factors will support student success in higher education, particularly in mathematics education.

Educators must be aware of the cultural/social factors that influence students' attitudes toward mathematics and how these factors also affect students' learning and success in mathematics education.

References

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