Understanding How Students Perceive Digital Tools: A Review Using the Technology Acceptance Model and the Computer Attitude Questionnaire

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Abstract: Educators and institutions across higher education continue to face challenges motivating students in mathematics courses, particularly in community colleges, where many struggle to see the real-world relevance of College Algebra and Statistics. Students in these settings often disengage from course content and technology-based tools designed to support their learning. Meanwhile, support programs such as tutoring, advising, and mentorship are widely implemented to promote student success, yet their impact on students' engagement with educational technologies remains underexplored. This study examines how students perceive and use digital tools in mathematics and statistics courses through two well-established frameworks: the Technology Acceptance Model and the Computer Attitude Questionnaire. As platforms like RStudio, MyMathLab, and MyOpenMath become more common in higher education, understanding how students experience ease of use, usefulness, support, and confidence is essential. Based on a literature review grounded in educational technology research and validated psychometric models, this proposal lays the foundation for a future empirical study. The review identifies theoretical and methodological trends, as well as gaps in the use of these frameworks for analyzing student experiences in hybrid and digitally intensive learning contexts. It offers insights to guide future research and support more effective integration of educational technologies.

Introduction

The integration of digital tools in higher education has increased the importance of understanding how students interact with technology, particularly in STEM-related courses. In mathematics and statistics education, platforms like RStudio, MyMathLab, and MyOpenMath are becoming common (Chan et al., 2022; Attallah et al., 2018). Researchers often rely on frameworks such as the Technology Acceptance Model (TAM) and the Computer Attitude Questionnaire (CAQ) to evaluate students' perceptions and attitudes toward these tools (Davis, 1989; Knezek & Christensen, 1996). This study seeks to justify the application of these frameworks through planned psychometric analyses that will examine their reliability and validity in a modern academic context (Doğan & Balkaya, 2023; Marikyan & Papagiannidis, 2023).

Purpose

The purpose of this research is to provide a literature-based justification for conducting exploratory and confirmatory factor analyses on survey responses rooted in TAM and CAQ frameworks (Davis, 1989; Knezek & Christensen, 1996). These tools have proven useful in capturing how students relate to digital technologies in learning environments, particularly regarding perceived usefulness, ease of use, and confidence in using technology (Bunz et al., 2020; Noh et al., 2021). We aim to understand how constructs such as institutional support, anxiety, and

computer confidence interact to shape students' acceptance and usage of educational technologies (Reyes et al., 2020).

Literature Review

To better understand how students engage with educational technologies in mathematics and statistics courses, it is essential to examine the theoretical and empirical foundations that support this area of research. This section reviews two established frameworks, the Technology Acceptance Model and the Computer Attitude Questionnaire that offer insight into both cognitive and emotional factors influencing technology use. The following sections explore the historical background, theoretical grounding, key empirical findings, and identified gaps in the literature that justify further investigation.

Background

The Technology Acceptance Model (TAM) and Computer Attitude Questionnaire (CAQ) have long been used to predict technology adoption and attitudes in academic settings (Davis, 1989; Knezek & Christensen, 1996). TAM proposes that perceived usefulness (PU) and perceived ease of use (PEU) influence a user's behavioral intention to use technology. Moreover, extensions such as TAM2 and TAM3 integrate additional variables such as support and subjective norm (Marikyan & Papagiannidis, 2023; Lewis, 2019). Meanwhile, CAQ focuses on computer attitudes' affective, behavioral, and cognitive components, which are increasingly important as educational tools become more complex (Suh & Ahn, 2022; Mistretta, 2004).

Theoretical Frameworks

TAM's theoretical foundation emphasizes belief-based models of behavior. PU and PEU are considered key predictors of whether individuals will adopt a technology (Zogheib et al., 2015; Nchindo, 2019). Furthermore, research has consistently supported these relationships across learning environments, including higher education (O'Dell & Sulastri, 2019; Mohamed et al., 2025). CAQ complements TAM by addressing emotional and confidence-related variables, which are especially relevant when students face unfamiliar platforms or lack digital fluency (Suh & Ahn, 2022; Colgan, 2020).

Empirical Findings

Multiple studies support the use of the Technology Acceptance Model in various educational contexts. Doğan and Balkaya (2023) validated a TAM-based scale for YouTube usage through both exploratory and confirmatory factor analysis. Their exploratory factor analysis (EFA) revealed a four-factor structure with 25 items, while the confirmatory factor analysis (CFA) yielded excellent model fit indices ($\chi^2/df = 1.88$, RMSEA = .045, CFI = .96, TLI = .95). The scale demonstrated strong internal consistency with a Cronbach's alpha of 0.91. Heinzman (2022) used qualitative methods to show that high school students in an Introduction to Data Science course reported increased confidence and engagement, with students frequently citing enjoyment of coding and a sense of community as major motivational factors. Similarly, Raigoza (2021) evaluated a pre-college summer program and found that 87% of students reported increased confidence in math and computer science, and 78% indicated they were more likely to pursue STEM fields after the program.

Gaps in Literature

Although TAM and CAQ have been validated in various settings, many studies rely on outdated versions of these instruments or fail to assess their structure using modern techniques like CFA (Bunz et al., 2020; Feldgen & Clua, 2003). There is limited literature evaluating the interaction of TAM and CAQ variables together, particularly

in the context of math and statistics education using platforms like RStudio and online math homework systems (Thompson et al., 2020; Stigberg & Stigberg, 2019). This gap justifies our decision to revalidate both models in an integrated analysis that captures the cognitive, affective, and motivational elements of technology use.

Synthesis of Findings

The annotated bibliographies reviewed confirm that PU and PEU remain strong predictors of intention to use technology (Davis, 1989; Zogheib et al., 2015). However, adding emotional and motivational constructs such as confidence, anxiety, and perceived support can improve the explanatory power of these models (Nchindo, 2019; Suh & Ahn, 2022; Heinzman, 2022). Synthesizing this body of work points to the need for integrated frameworks that combine TAM and CAQ components to better assess technology use in evolving educational settings (Valente et al., 2020).

Discussion

This section synthesizes the findings from the reviewed literature and explores their relevance to both current educational practices and future research. By integrating insights from TAM and CAQ, we can better understand how students' perceptions of digital tools influence their academic engagement and success. The following sections outline practical implications for instructors and institutions, as well as directions for future studies aimed at improving technology integration in mathematics and statistics education.

Implications

A validated instrument capturing both TAM and CAQ dimensions can help educators design interventions that reduce anxiety, increase motivation, and improve student outcomes in technology-enhanced learning environments (González-Ramírez & García-Hernández, 2022; Attallah et al., 2018). Understanding these constructs can also inform student development and performance overall and resource allocation strategies, especially when introducing complex platforms like RStudio and other online math homework systems in mathematics and statistics.

Suggestions for Future Research

Future work in higher education settings should explore how demographic variables such as gender, course modality, and prior experience with platforms like MyLabMath and MyOpenMath and computer languages such as RStudio influence TAM and CAQ outcomes (Mohamed et al., 2025; Reyes et al., 2020). Furthermore, Longitudinal designs could also track changes in perceptions over time as students gain experience with educational technologies (Zogheib et al., 2015). Further investigation is warranted into how symbolic computation tools and block-based programming are compared to reducing student anxiety and fostering engagement (Zabala-Vargas et al., 2019; Eyrikh et al., 2019).

Conclusion

This paper provides a literature review to support the reexamination of TAM and CAQ through psychometric analysis in higher education. The reviewed literature underscores the theoretical strength and empirical value of these frameworks and supports their continued use and revalidation in the context of educational technologies. Findings from future analyses will contribute to a deeper understanding of how students engage with digital tools in mathematics and statistics courses.

References

Attallah, B., Ilagure, Z., & Chang, Y. K. (2018, November). The impact of competencies in mathematics and beyond on learning computer programming in higher education. In *2018 Fifth HCT Information Technology Trends (ITT)* (pp. 77–81). IEEE.

Bunz, U., Seibert, J., & Hendrickse, J. (2020). From TAM to AVRTS: Development and validation of the Attitudes Toward Virtual Reality Technology Scale. *Virtual Reality, 24*(4), 635–654. https://doi.org/10.1007/s10055-020-00437-7

Chan, S.-W., Looi, C.-K., Ho, W. K., & Kim, M. S. (2022). Tools and approaches for integrating computational thinking and mathematics: A scoping review of current empirical studies. *Journal of Educational Computing Research, 60*(8), 2036–2080. https://doi.org/10.1177/07356331221098793

Colgan, L. (2020, September). Elementary math matters: Logo-coding to learn. *ProQuest*. https://www.proquest.com/docview/2448445666

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340. https://doi.org/10.2307/249008

Doğan, F., & Balkaya, M. (2023). Scale development and validation study on using YouTube as a learning environment in secondary education according to the technology acceptance model. *African Educational Research Journal, 11*(1), 1–20. https://doi.org/10.30918/AERJ.111.22.061

Eyrikh, N. V., Fishman, B. E., Bazhenov, R. I., Markova, N. V., & Pitsuk, I. L. (2019, September). Hands-on games for motivating students' math training. In *2019 International Conference "Quality Management, Transport and Information Security, Information Technologies"* (pp. 477–481). IEEE.

Feldgen, M., & Clua, O. (2003, November). New motivations are required for freshman introductory programming. In *33rd Annual Frontiers in Education, 2003. FIE 2003* (Vol. 1, pp. T3C24–T24). IEEE Computer Society.

González-Ramírez, T., & García-Hernández, A. (2022). Design and validation of a questionnaire to assess student satisfaction with mathematics study materials. *International Journal of Instruction, 15*(1), 1–20. https://doi.org/10.29333/iji.2022.1511a

Heinzman, E. (2022, July). "I love math only if it's coding": A case study of student experiences in the Introduction to Data Science course. *EBSCOhost*. https://web-s-ebscohost-com.libproxy.library.unt.edu

Marikyan, D., & Papagiannidis, S. (2023). Technology Acceptance Model: A review. In S. Papagiannidis (Ed.), *TheoryHub Book*. http://open.ncl.ac.uk

Mistretta, R. M. (2004, November 30). Integrating technology into the mathematics classroom: The role of teacher preparation programs. *Mathematics Educator*. https://eric.ed.gov/?id=EJ845844

Mohamed, M., Ayub, A. F. M., Yasin, M., Nawi, N. R. C., & Salim, N. R. (2025). Investigating items as predictors for application of personalized mathematics learning instrument among pre-university students in the Maldives: An exploratory factor analysis. *Malaysian Journal of Mathematical Sciences, 19*(1), 53–78. https://doi.org/10.47836/mjms.19.1.04

Nchindo, E. B. (2019). *Teachers' perceptions of the introduction of computer-assisted learning in mathematics in rural senior secondary schools in the Zambezi Region, Namibia* (Master's thesis, University of Namibia).

Noh, N. H. M., Raju, R., Eri, Z. D., & Ishak, S. N. H. (2021). Extending Technology Acceptance Model (TAM) to measure the students' acceptance of using digital tools during open and distance learning (ODL). *IOP Conference Series: Materials Science and Engineering, 1176*, 012037. https://doi.org/10.1088/1757-899X/1176/1/012037

O'Dell, D. G., & Sulastri, T. (2019). The impact of using the internet for learning for students with Technology Acceptance Model (TAM). *International Journal of Environmental Engineering Education, 1*(2), 46–52. https://doi.org/10.5281/zenodo.3375176

Raigoza, J. (2021, October). Student success analysis from running a pre-college computer science and math summer program. In *2021 IEEE Frontiers in Education Conference (FIE)* (pp. 1–4). IEEE.

Reyes, A. A., Elkin, C., Niyaz, Q., Yang, X., Paheding, S., & Devabhaktuni, V. K. (2020, August). A preliminary work on visualization-based education tool for high school machine learning education. In *2020 IEEE Integrated STEM Education Conference (ISEC)* (pp. 1–5). IEEE.

Stigberg, H., & Stigberg, S. (2019). Teaching programming and mathematics in practice: A case study from a Swedish primary school. *Policy Futures in Education, 18*(4), 483–496. https://doi.org/10.1177/1478210319894785

Suh, W., & Ahn, S. (2022). Development and validation of a scale measuring student attitudes toward artificial intelligence. *SAGE Open, 12*(2), 1–12. https://doi.org/10.1177/21582440221100463

Thompson, J., Wu, S. P., & Mills, J. (2020, June). The use of computer programming in a secondary mathematics class. In *2020 ASEE Virtual Annual Conference Content Access*. https://doi.org/10.18260/1-2--35378

Valente, A., Marchetti, E., & Wang, J. (2020, September). Design of an educational multimedia library to teach Python to non-technical university students. In *2020 9th International Congress on Advanced Applied Informatics (IIAI-AAI)* (pp. 169–175). IEEE.

Zabala-Vargas, S. A., García-Mora, L. H., Ardila-Segovia, D. A., & de Benito-Crosetti, B. L. (2019, September). Motivation increase of mathematics students in engineering—A proposal from game-based learning. In *2019 International Symposium on Engineering Accreditation and Education (ICACIT)* (pp. 1–6). IEEE.

Zogheib, B., Rabaa'i, A., Zogheib, S., & Elsaheli, A. (2015). University student perceptions of technology use in mathematics learning. *Journal of Information Technology Education: Research, 14*, 417–438. http://www.jite.org/documents/Vol14/JITEv14ResearchP417-438Zogheib2039.pdf