Journal of Harbin Engineering University
ISSN: 1006-7043

Vol 45 No. 3
March 2024

A Scoping Review of the Professional Practices and Standards in Mathematics in Higher Education

Jay Fie P. Luzano
Bukidnon State University, Malaybalay City, Bukidnon, Philippines

Abstract
The professional practices and standards in mathematics within higher education are essential for academic discourse and progress. With increasing demand for proficient mathematicians and educators, there is a heightened necessity to scrutinize practices and adhere to standards. This review aims to comprehensively analyze existing literature on professional practices and standards in mathematics within higher education, shedding light on dimensions, challenges, and advancements in tertiary mathematics education.This study utilized a scoping review method to synthesize extant literature concerning professional practices and standards in mathematics within the domain of higher education.Results revealed the proceeding themes of related studies and literature on professional practices and professional standards in tertiary mathematics education, such as: (1) *The historical issues*; *(2) Prevalent concerns*; *(3) Gradual successes*; (4) *The proactive implication*; *(5) The pedagogical advantage*; *(6) The significance to the academic community*; and (7) *The lifelong impact on mathematics teachers*.The exploration of professional practices and standards in tertiary mathematics education underscores the need for targeted improvements and standardized frameworks.This concerted effort aims to elevate teaching quality and ensure positive student learning outcomes in tertiary mathematics education.

Keywords: *scoping review, professional practices and standards, mathematics, higher education*

Introduction

The professional practices and standards in mathematics within higher education constitute a pivotal aspect of academic discourse and educational development (Schoen et al., 2003). As the demand for skilled mathematicians and competent educators continues to rise, the scrutiny of professional practices and adherence to standards becomes increasingly pertinent (Carney et al., 2016) This review aims to provide a comprehensive analysis of the existing body of knowledge surrounding professional practices and standards in mathematics within higher education contexts. By examining scholarly works, research articles, and academic publications, this review seeks to elucidate the various dimensions, challenges, and advancements in the realm of mathematics education at the tertiary level.

In recent years, the landscape of higher education, particularly in mathematics, has witnessed significant transformations and debates concerning professional practices and standards (Wiley, 2001). The evolving nature of educational policies, pedagogical approaches, and technological advancements has necessitated a critical examination of the practices employed by mathematics educators (Luzano and Ubalde, 2023). Understanding the nuances of professional practices and the benchmarks set by standards is crucial for fostering an environment conducive to effective teaching and learning in mathematics.

Central to the discussion is the exploration of historical trends and contemporary perspectives shaping professional practices and standards in mathematics education within higher institutions. Historical trajectories reveal the evolution of teaching methodologies, curricular frameworks, and institutional expectations that have influenced the establishment of professional standards (Warin et al., 2011). Moreover, recent educational reforms and global initiatives aimed at standardizing teaching practices underscore the imperative for educators to align with recognized benchmarks and professional expectations (Thompson & Cook, 2017).

Amidst the prevailing discourse, thisreview also aims to identify prevalent concerns and emerging issues surrounding professional practices and standards in mathematics education. Challenges such as the dichotomy between theoretical knowledge and practical application, the integration of technological tools, and the promotion of inclusive pedagogies warrant careful consideration. By acknowledging these challenges, educators and policymakers can collaboratively work towards devising strategies and frameworks that enhance the quality and effectiveness of mathematics education in higher institutions.

This study explored and reviewed different articles on professional practices and standards in mathematics in higher education to better employ innovative and resilient strategies to thrive in the complex-specific demands of the discipline.

Methods

This study utilized a scoping review method to synthesize extant literature concerning professional practices and standards in mathematics within the domain of higher education. As prescribed by Arksey and O'Malley (2005), a scoping review is characterized by its comprehensive approach to literature identification, emphasizing the inclusion of all pertinent studies regardless of their methodological design. This method is characterized by its iterative and non-linear nature, fostering the researcher's reflexivity across its various phases.

Arksey et al. (2005) further discussed the sequential stages of a scoping review, encompassing the identification of research inquiries, the retrieval of relevant studies, study selection, data charting,aggregation, synthesis, and reporting of findings. In the first stage, three distinct research questions were formulated. The second stage involved the retrieval of literature from Google Scholar and ResearchGate, focusing on articles published between 2000 and 2023 and employing the keywords "professional practices and standards in mathematics in higher education" for search queries.

During the third stage, rigorous inclusion criteria were applied, necessitating a thorough examination of each paper's abstract, methodology, results, discussion, and conclusion sections. Papers were selected based on their direct relevance to professional practices and standards in mathematics, with those failing to address central inquiries excluded from the review. Stage 4 resembled data extraction procedures typical of systematic literature reviews, where pertinent data from selected literature were organized systematically.

Finally, stage 5 of the scoping review entailed the application of content analysis techniques to synthesize, summarize, and discuss salient findings extracted from the literature.

Results and Discussion

The professional practices in tertiary mathematics education revolve around the given themes.

The Historical Issues

The educational discourse in recent years in the higher education of the Philippines has been advancing the status of the teaching profession through the development of a framework and standards and supporting the nature of teachers' work in addition to improving student-learning outcomes. The close link between student learning outcomes and the quality of tertiary mathematics teaching has resulted in the call for an increase in teacher accountability and quality (Australian Science Teachers Association, 2002). This review is an exploration of the relevant literature that focuses on the professional practice of the teaching profession of tertiary mathematics teachers at the tertiary level and its potential impact on teaching Mathematics in the Philippines.

The global educational reform movement concentrated on standardizing the professional practice of teachers. In effect, the Philippines has the Philippine Professional Standards for Teachers (PPST), however, the public school teachers in the Department of Education follow this standard. This study would like to propose a new standard specific to the mathematics discipline at the tertiary level in the Philippines. Its primary objective is to enhance teaching techniques and elevate student achievement, which previous endeavors had failed to accomplish. The movement seems to have originated from a worldwide trend towards standardized education,

increased teacher responsibility, and adherence to established benchmarks, and it has now become a focal point across the globe (Delanshere&Petrosky, 2004; Sachs, 2003).

The Prevalent Concerns

The educational dichotomies appear when the opposing notions such as theory versus practice, or national training versus institutional training, are influenced by an ever-changing institutional agenda, which can be argued, to have a positive or a negative impact on tertiary mathematics education according to the context (Hourigan &O'Donoghue, 2007). The influence of governmental policy on the culture of the teaching profession over many years is largely due to inadequate or insufficient professional standards in how professional competence is achieved by a tertiary mathematics teacher. Yet educational policy is becoming rampant to improve the culture of teaching mathematics at the tertiary level (Bottery& Wright, 2000).

Motivating teachers to participate in professional learning appears to be problematic even though in conformance with the politically motivated educational policy due to lack of educational standards. The difficulty lies in crafting standards as success in tertiary mathematics education relies on teachers' awareness of professional responsibility and their ongoing participation in professional growth and development activities (Collinson et al., 2009).

The Gradual Successes

The evidence from previous research suggests that a standards-based approach in mathematics can have a profound effect on both teaching practice and student learning (Wilson & Thornton, 2008). Unfortunately, for many tertiary mathematics teachers, their professional practice is just based on their own experience. This can potentially result in resorting to teaching in the manner they were taught, in the absence of the standard recommended practice (Hodgen& Askew, 2007; White-Clark, 2008).

Over the past several years there has been a move towards promoting the professionalism of teachers through the development of teaching standards both internationally and in the Philippines. In 2001 the Commonwealth Government of Australia established a project known as the Quality Teachers Initiative, Teachers for the 21st Century, where four national teacher associations worked collaboratively to develop a set of standards that were specific to their subject matter and collectively could provide a framework for future development of teaching standards (Althorp et al., 2001). In 2002, the Australian Association of Mathematics Teachers (AAMT) designed a set of professional teaching standards and a program of assessment that concentrated on identifying the knowledge skills and attributes that teachers of mathematics comprise. Teachers who participate in and satisfy the professional requirements of the AAMT teaching standards can be credentialed as Highly Accomplished Teachers of Mathematics (AAMT, 2006).

The Proactive Implication

By definition, standards-based education provides a framework or criteria that teachers can use as a measure of their accomplishments and a way of providing evidence to stakeholders of their achievements and accreditation (Echevarria et al., 2006). There have been a variety of terms applied to the teacher evaluation process: such as supervision, annual performance review, assessment, appraisal, inspection (Collinson et al., 2009). This is nothing new to the teaching profession; in reality, teachers have been made accountable for many years as their teaching was scrutinized, evaluated, and observed by senior faculty from their departments. However, the demands of mathematics teaching quality at the tertiary level in the Philippines are becoming complex and disoriented due to no uniform guidelines prescribed as to how teachers thrive holistically in the tertiary mathematics profession.

The Pedagogical Advantage

Another study on why there is a need to develop professional standards is that evidence suggests that many mathematics teachers lack knowledge and confidence in their own mathematical abilities (Beswick et al., 2006) and struggle with a negative or indifferent attitude toward Mathematics (Klein, 2008). Exhibiting a positive attitude towards mathematics can have a profound effect on the learning that occurs in a classroom (Luzano, 2023). If teachers have excellent mathematical content knowledge and the ability to impart that knowledge through the guidance of professional

standards, they are less likely to create a cycle where students avoid the higher levels of mathematics (Ling, 2009). Purposeful choices by teachers in the area of professional development can support their learning and increase their knowledge base (Luzano, 2023).

The Significance to the Academic Community

The establishment of a Professional Standards framework and an Institute of Teachers in New South Wales came about as a result of suggestions made by Ramsey in his Review of Teacher Educationand the subsequent Report of the Taskforce into the Review of Teacher Education (McMorrow, 2001). Within the summary of the Taskforce Report, McMorrow outlined several key recommendations one of which recognized the impact that quality teaching has something to with the professional standards followed by a mathematics faculty.

Professional standards for tertiary mathematics teachers play an important role in ensuring quality instruction and student learning outcomes. The development of professional standards for tertiary mathematics teachers has been a topic of discussion and research in the field of mathematics education. In many countries, professional standards have been developed by government bodies, professional organizations, or academic institutions to provide guidance and expectations for teachers in terms of their knowledge, skills, and dispositions (Morales et al., 2019).

The Lifelong Impact to Mathematics Teachers

The relevance of professional standards for tertiary mathematics teachers in the field of mathematics education is inarguably impactful to their professional practice. Some argue that professional standards can help to promote a shared vision for teaching and learning, as well as provide a basis for ongoing professional development and evaluation (Oates et al., 2005). Others suggest that professional standards can capture the complexity of teaching and learning in mathematics (Sowder, 2007).

As a result, three suggestions were put forward to strengthen the professional practice of tertiary mathematics teachers, such as development of framework of professional teaching standards drawn from the professional insight and experience of teachers, recognition of standards of professional practice for mathematics teachers and professional leadership, and establishment of the conditions necessary to support teachers' professional growth (McMorrow, 2001). mathematics teacher to begin and finish the profession well.

Synthesis

The existence of an explicit set of professional standards for tertiary mathematics teachers and the articulation of those standards provides a means by which tertiary mathematics teachers can uphold a strong sense of professionalism both inside and outside the profession. The professional standards can contribute to the holistic professional practice of tertiary mathematics teachers and may enhance the status of the teaching profession in mathematics at the tertiary level in the Philippines.

Conclusion and Recommendation

The exploration of professional practices and standards in tertiary mathematics education underscores the need for targeted improvements and standardized frameworks. The historical context reveals a growing emphasis on teacher accountability and quality, particularly in aligning teaching practices with student learning outcomes. While global movements advocate for standardized education, including the Philippines' adoption of general professional standards, there's a clear call for subject-specific standards, especially in mathematics at the tertiary level. Despite prevalent concerns such as the dichotomies in educational approaches and motivating teachers for professional development, gradual successes are evident in acknowledging the importance of standards-based approaches and promoting professionalism among teachers. The pedagogical advantage of developing professional standards is apparent in enhancing teachers' mathematical knowledge, attitudes, and classroom practices. Recognizing the significance of professional standards to the academic community and acknowledging their lifelong impact on mathematics teachers' practice, it's imperative to formulate tailored standards and supportive conditions for their implementation and growth. Recommendations include the

collaborative development of subject-specific standards, recognition of professional practice, and fostering environments conducive to teachers' ongoing professional development and leadership. This concerted effort aims to elevate teaching quality and ensure positive student learning outcomes in tertiary mathematics education.

References

[1] Althorp, J., Cockburn, C., Hayes, T. &Morony, W. (2001). Teachers teaching – teachers leading: Professional standards for Australian educators. Adelaide.

[2] Australian Association of Mathematics Teachers (2006). Standards for excellence in teaching mathematics in Australian schools. Adelaide: Australian Association of Mathematics Teachers.

[3] Australian Science Teachers Association (2002). The national professional standards for highly accomplished teachers of science. Retrieved February 4, 2010, from http://www.asta.edu.au/resources/professional_standards_for_tea/asta_national_professional_standards

[4] Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. International journal of social research methodology, 8(1), 19-32. https://doi.org/10.1080/1364557032000119616

[5] Beswick, K., Watson, J., & Brown, N. (2006). Teachers' confidence and beliefs and their students' attitudes to mathematics. In P. Grootenboer, R. Zevenbergen, & M. Chinnappan (Eds.), Identities, cultures and learning spaces (Proceedings of the 29th annual conference of the Mathematics Education Research Group of Australasia, Canberra, pp. 68-75). Adelaide, SA: MERGA.

[6] Bottery, M. & Wright, N. (2000) The directed profession: teachers and the state in the third millennium. Journal of In-Service Education, 26:3, 475-487, DOI: 10.1080/13674580000200125

[7] Carney, M., Brendefur, J., Thiede, K., Hughes, G., & Sutton, J. (2016). Statewide Mathematics Professional Development. Educational Policy, 30, 539 - 572. https://doi.org/10.1177/0895904814550075.

[8] Collinson, V., Ekaterina, K., Yu-Hao, K., Ling, L., Matheson, I., Newcombe, L. (2009). Professional development of teachers: A world of change. European Journal of Teacher Education, 32(1), 3 - 19.

[9] Echevarria, J., Short, D. & Powers, K. (2006). School Reform and Standards-Based Education: A Model for English-Language Learners. The Journal of Educational Research, 99:4, 195-211, DOI: 10.3200/JOER.99.4.195-211

[10] Delanshere, G., &Petrosky, A. (2004). Political rationales and ideological stances of the standards-based reform of teacher education in the US. Teacher and Teacher Education, 20(1), 1-15.

[11] Hodgen, J., & Askew, M. (2007). Emotion identity and teacher learning. Oxford Review of Education, 33(4), 469 - 487.

[12] Hourigan, M., &O'Donoghue, J. (2007). Mathematical under-preparedness: the influence of the pre-tertiary mathematics experience on students' ability to make a successful transition to tertiary level mathematics courses in Ireland. International Journal of Mathematical Education in Science and Technology, 38, 461 - 476. https://doi.org/10.1080/00207390601129279.

[13] Klein, M. (2008). Preservice teachers and numeracy education: Can poststructuralism contribute to tertiary education?. Journal of Education, 23, (2), 132-136.

[14] Ling, P. (2009). Development of academics and higher education futures, vol. 1, report. Sydney: Australian Learning and Teaching Council.

[15] Luzano, J. &Ubalde, M. (2023). Notable Accounts of the Professional Practice of Tertiary Mathematics Teachers in the Philippines. Science International (Lahore), 35(2), 129-133.

[16] Luzano, J. (2023). The Interplay of Conceptual Understanding and Problem-Solving Competence in Mathematics. International Journal of Multidisciplinary Approach and Studies, 10(2), 89-97.

[17] Luzano, J. (2023). An ADDIE Model Analysis on the Engineering of Contextualized Intervention Materials (CIMs) and Students' Achievement in Mathematics. International Journal of Multidisciplinary Approach and Studies, 10 (6), 25-47.

[18] McMorrow, J. (2001). Report of the taskforce on the review of teacher education in New South Wales. New South Wales.

[19] Morales, M., Anito, J., Avilla, R., Abulon, E., &Palisoc, C. (2019). Proficiency Indicators for Philippine STEAM (Science, Technology, Engineering, Agri/fisheries, Mathematics) Educators. Philippine Journal of Science 148 (2): 263 – 275. June 2019.

[20] Oates, G., Patterson, J., Reilly, I., & Statham, M. (2005). Effective tutorial programmes in tertiary mathematics. International Journal of Mathematical Education in Science and Technology 36(7), 731–739.

[21] Sachs, J. (2003). Teacher professional standards: Controlling or developing teaching? Teachers and Teaching, 9(2), 175-186.

[22] Schoen, H., Cebulla, K., Finn, K., & Fi, C. (2003). Teacher Variables That Relate to Student Achievement When Using a Standards-Based Curriculum.Journal for Research in Mathematics Education, 34, 228. https://doi.org/10.2307/30034779.

[23] Sowder, J. T. (2007). The mathematical education and development of teachers. In F. K. Lester Jr. (Ed.). Second handbook of research on mathematics teaching and learning (pp. 157–223). Reston, VA: National Council of Teachers of Mathematics.

[24] Warin, B., Kolski, C., & Sagar, M. (2011). Framework for the evolution of acquiring knowledge modules to integrate the acquisition of high-level cognitive skills and professional competencies: Principles and case studies. Comput. Educ., 57, 1595-1614. https://doi.org/10.1016/j.compedu.2011.02.013.

[25] White-Clark, R., Di-Carlo, M., &Gilchriest, N. (2008). "Guide on the side": an instructional approach to meet mathematics standards. The High School Journal, 91(4), 40-44.

[26] Wiley, S. (2001). Contextual Effects on Student Achievement: School Leadership and Professional Community. Journal of Educational Change, 2, 1-33. https://doi.org/10.1023/A:1011505709050.

[27] Wilson, S., & Thornton, S. (2008). "The factor that makes us more effective teachers": Two preservice primary teachers experience of bibliotherapy. Mathematics Teacher Education and Development, 9, 21-35.