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Original Article

Bridging Theory and Practice: STEM Pre-Service Teachers' Experiences in a Rwandan Model School

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Abstract
Model schools offer aspiring educators' placements in quality educational environments in which they are observed and guided by experienced mentors. They provide opportunities for university students to observe, study, reflect on, and practice education theory while immersing themselves in classroom environments filled with children. However, research that examines the pedagogical challenges and the professional integration of interns during their time in a model school environment remains limited. Framed within a symbolic interactionist perspective, this study explores the teaching practice experiences of interns at a model school affiliated with the University of Rwanda-College of Education (UR-CE). It assesses how effectively a group of student teachers, participating in the Teacher Enhancement Programme (TEP), integrated theory and practice during a four-week practicum covering professional ethics, teaching, pedagogy, reflective practice, and classroom management. Both qualitative and quantitative data were collected through the Student Teacher Internship Exit Questionnaire (STIEQ), observation, and document analysis. Descriptive statistics and emergent themes were used to analyse the data. Despite the TEP aiming for comprehensive skill development, results from the STIEQ indicate limited confidence among interns in competencies such as STEM integration and reflective practice. Additional findings show that, although interns were satisfied with the support from their mentors, observation data suggest that mentors possessed limited instructional expertise in certain STEM learning aspects. Further, time constraints hampered interns' ability to fully internalize learned practices. Therefore, the study recommends school-based capacity building for mentors to improve their skills in supporting pre-service teachers with STEM teaching, including the development of pedagogical content knowledge, and provision of constructive feedback.

Keywords: mentorship, reflective practice, STEM integration, teaching practice, theory-practice gap

Introduction

A prevailing global trend reveals that educators exhibit a lack of confidence and understanding in the pedagogy of science, technology, engineering, and mathematics (STEM) fields (Garvin, 2009). This situation is primarily attributed to the relatively recent emergence of STEM education as a significant global phenomenon, gaining traction in countries such as the United States, China, Australia, South

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Korea, and the United Kingdom, among others. The positive impact of STEM initiatives on national economies and social development has accelerated its adoption in various nations, including the developing countries of Africa. Despite the well-documented strategies associated with the STEM movement, a substantial number of educators continue to grapple with the challenge of conceptualizing how the distinct disciplines of science, technology, engineering, and mathematics can coexist within a unified framework (Kelley & Knowles, 2016). This difficulty is exacerbated by the educational backgrounds of these educators, many of whom received training focused on a single or dual major in subjects such as Physics, Biology, Chemistry, Mathematics, or Computer Science, often without exposure to interdisciplinary methodologies. Consequently, while they may hold a prestigious view of their specialized disciplines, they face significant challenges when tasked with teaching STEM.

This scenario is prevalent across educational institutions, including schools, teacher colleges, and universities, which are expected to cultivate future graduates, including preservice teachers, into proficient STEM professionals. According to Phillips and Condy (2023), pre-service teachers believe that teacher educators are disconnected from real classroom experiences and inadequately equipped to prepare them for teaching. There is evidence of a gap between the training provided on campus and the realities students face in school classrooms (Phillips & Condy, 2023). The implication is a notable theory-practice gap that many STEM graduates encounter in their professional environments. Furthermore, preservice teachers find themselves in a challenging position where they are expected to implement the theoretical principles of STEM education within curricular frameworks and structural contexts that may not align with contemporary pedagogical approaches.

The theory-practice gap is an abstract construct that lacks a precise definition, representing a disparity between the theoretical knowledge acquired in academic settings and the practical realities encountered in professional environments. Scholars such as Phillips and Condy (2023) have conceptualized this gap as the relationship between academic research theory, typically disseminated in universities and colleges, and the experiential components of work placements that necessitate the application of this theory. Upon their initial entry into the educational setting, preservice teachers face a multitude of novel experiences that serve to both challenge and facilitate their professional development (Tynjala & Heikkinen, 2011). Tynjala and Heikkinen (2011) assert that these new experiences may engender an array of challenges, including the apprehension associated with unfamiliar environments, insufficient knowledge and skills, diminished self-efficacy, heightened stress levels, role-related dilemmas within the professional community, and substantial demands for learning in situ. These factors place significant pressure on preservice teachers, highlighting the critical need for psycho-social and professional support from both school mentors and college lecturers.

Empirical research shows that such support is crucial in helping preservice teachers effectively bridge the gap between theory and practice, thereby aiding their adjustment to the complexities of teaching. Effective STEM education requires preservice teachers to continuously learn and develop, including applying research-based knowledge to their practice. However, many teachers see educational research and theories as irrelevant or disconnected from their daily experiences, making the gap between theory and practice an ongoing obstacle to educational improvement (Shaharaban & Yarden, 2019). This study explores a potential approach to enhancing work environments through internships. By analysing the complex processes that shape values and meanings, this research aims to explain how these are created, negotiated, and changed within teaching practice. As Piga and De Domenico (2023) state, understanding this dynamic is essential for addressing the challenges STEM preservice teachers face as they bridge the theory-practice gap, which reflects the difference between the knowledge gained at university and the realities they encounter in practice.

Since the theory-practice gap often creates detrimental problems for entry-level interns as they navigate the realities of the workplace, this study explores how the internship experience may facilitate

narrowing the gap in order to ease students' subsequent transitions from college to work life. Specifically, the study is guided by the following research questions:

1. What perceptions regarding various dimensions of teaching practice do the STEM preservice teachers hold?
2. In which dimensions of teaching practice do the preservice teachers excel in closing the theory-practice gap?
3. How do the mentors endeavour to assist the STEM preservice teachers in reducing the theory-practice gap in the development of professional ethics, STEM learning approaches, reflective practice, and classroom management?

Theoretical framework

Symbolic interactionism

The research is based on the symbolic interactionist perspective, which originates from American pragmatism and extensively incorporates sociological theories from social psychology (Piga & De Domenico, 2023). This approach highlights how individuals construct and interpret symbols and meanings through their social interactions. Symbolic interactionism emphasizes the intersubjective nature of communication among individuals as a vital means of understanding human behaviour and social interactions, with meaning being a fundamental principle (Milani Marin & Jacomuzzi, 2022). It posits that communication, particularly through symbols, serves as the foundation of human social existence, which is crucial for grasping social life (Hefniy, Baharun, Agus, & Zaini, 2023). Referencing earlier theorists of symbolic interactionism such as Mead and Blumer, Piga and De Domenico (2023) articulate that the framework is built on three core premises: (i) individuals act toward objects based on the meanings those objects hold for them, (ii) these meanings emerge from social interactions with significant others, and (iii) individuals continually process and modify these meanings through an interpretative process as they engage with their environment.

Charon (2004) outlines five aspects of symbolic interactionism that relate to the stages through which internees navigate the socially constructed realities of the workplace. The first aspect pertains to the role of social interaction, which defines how internees engage with learners, their mentors, and other school staff. As noted by Barnett (2012), this engagement fosters individual reflection, a process that Charon (2004) identifies as the role of thinking. In this context, the actor interacts with others and then contemplates the significance of those interactions. The third aspect emphasizes role definition, a critical phase of meaning-making in which the actor (the preservice teacher) assigns meanings to their experiences. Thus, the process of social interaction followed by reflection leads preservice teachers to define their perceptions regarding various dimensions of teaching practice, such as the development of professional ethics, STEM learning approaches, reflective practice, classroom management, and other curricular activities. These perceptions are formed based on their current experiences rather than pre-existing notions (Barnett, 2012). Finally, Charon (2004) posits that the ultimate role is that of the active human being. This stage represents a transition into action, where the preservice teacher responds to the environment, applying their newly acquired understanding of the demands of teaching. How the preservice teachers maneuver the networks through this environment is explained through the notion of structural symbolic interactionism (Stryker, 2008).

Stryker's (2008) interpretation of symbolic interactionism views society as a collection of organized systems of interactions and relationships among various roles, resulting in complex mosaics of diverse groups, communities, and institutions influenced by multiple divisions rooted in class structures. This perspective highlights the significance of grassroots networks, indicating that social interactions predominantly take place within these smaller groups rather than across society as a whole. Consequently, individuals engage with societal structures that involve pre-established and patterned interactions and relationships (Stryker, 2008). This hierarchical structure comprises proximate,

intermediate, and large social structures (Piga & De Domenico, 2023). Proximate social structures are smaller groups composed of close individuals, such as families, teams, or school departments within broader educational frameworks, and they have a direct impact on individuals. Intermediate social structures encompass larger groups operating in specific contexts, such as religious organizations, schools, associations, and professional boards. In contrast, large social structures pertain to macro networks and interpersonal relationships defined by social boundaries of ethnicity, class, gender, and other factors (Serpe & Stryker, 2011). These structures (particularly at the proximate level) serve as the foundation for shaping identities, where preservice teachers typically gain their primary experiences with mentors and colleagues in the specific departments.

Literature review

Professional integration and the development of STEM pedagogical practices for interns

The journey to becoming fully qualified and competent STEM teachers is both lengthy and intricate. It begins with the teaching practices that preservice teachers engage in throughout their training. During this period, preservice teachers observe, peer- and micro-teach, learn, reflect, and may adjust their initial expectations to embrace novel mindsets that align with the behaviours they acquire (Gutshall, 2014; Soleas & Hong, 2020). They progress from a state of naive enthusiasm to experiencing cognitive dissonance, then to exploring an authentic teaching identity, and ultimately, to developing confidence in their new roles as educators (Wall, 2016). Soleas and Hong (2020) note that the practicum experience for preservice teachers marks a significant increase in their responsibilities and provides initial extended exposure, facilitating a substantial transition from being a post-secondary student to becoming a preservice teacher. As part of their duties, these student teachers are expected to familiarize themselves with the professional ethics governing teachers' conduct, apply various pedagogical practices, manage and control learner (mis) behaviour during lessons, and engage in extracurricular activities.

For STEM preservice teachers, the demands that they are expected to meet in this initial professional integration process are even greater. Among other things, they are expected to develop competences and mastery in subject matter knowledge (SMK), pedagogic content knowledge (PCK), inquiry-based and STEM integration approaches, and abilities for teamwork and collaboration with other staff. PCK is viewed as crucial for STEM disciplines. It is defined as the teacher's expert knowledge situated at the intersection of their subject matter knowledge and pedagogical knowledge. Pedagogical Content Knowledge (PCK) integrates both pedagogical and content knowledge, yielding a distinctive understanding of how to teach specific subject matter effectively. For educators to excel in their subjects and present material in a way that resonates with students, it is essential to merge these two types of knowledge (Tyas, Insih, & Dadan, 2025). By enhancing their PCK, teachers can create more impactful and meaningful learning experiences tailored to the diverse needs and characteristics of their learners. Prior research indicates that the development of pre-service teachers' pedagogical content knowledge (PCK) is significantly enhanced through opportunities to implement their lesson plans, engage in reflective practice, learn from experienced mentor teachers, and participate in courses that specifically introduce PCK (Yip, 2025). Therefore, preservice STEM educators who possess well-developed PCK are better equipped to represent and adapt content and tasks in various ways to meet the differing learning requirements of their students (Kim, 2021).

Preservice STEM teachers also require skills in inquiry approaches. The concept of inquiry relates to the overall characteristics of student-led questioning, problem-solving, active engagement with the surroundings, and the continual creation and re-creation of knowledge through such engagement (Bogar, 2019). According to some researchers (Margus et al., 2015), inquiry-based learning consists of five specific stages: Orientation (identifying the problem), Conceptualization (formulating questions and generating hypotheses), Investigation (exploring, researching, and interpreting data), Conclusion, and

Discussion (reflecting and communicating). Consequently, Bogar (2019) notes that (1) learners are engaged by questions that are scientifically oriented, (2) prioritize evidence, enabling them to develop and assess explanations that respond to scientifically oriented questions, (3) construct explanations based on evidence to answer scientifically oriented questions, (4) assess their explanations in the context of alternative explanations, especially those aligned with scientific understanding, and (5) articulate and defend their proposed explanations. Therefore, preservice STEM teachers must fulfil this requirement for learning in the STEM fields during their internship.

While some scholars (Lo, 2021; Stubbs & Myers, 2016) argue that the field of STEM integration (iSTEM) is primarily suited for skilled and seasoned teachers, it is essential that preservice teachers receive training in iSTEM education. Ryu, Mentzer, and Knobloch (2019) note that despite obstacles related to prevailing school culture and structure, lack of expertise in STEM areas, and a shortage of role models, preservice teachers in the US who participated in a college course focused on STEM integration methods effectively created and delivered STEM integration lessons. Utilizing resources and ideas from their backgrounds, classroom observations, and online materials, the participants of this study (Ryu, Mentzer, & Knobloch, 2019) showcased various strategies in crafting their lesson plans, which included choosing curricular topics for STEM integration and designing engineering tasks along with other instructional resources. Integrated STEM education provides avenues for cultivating 21st-century skills such as creativity, innovation, critical thinking, collaboration, and communication, which are optimally developed through the adoption of student-centred learning methodologies like problem-, project-, or design-based learning while addressing real-world contexts (Stevenson & Thompson, 2025).

Within the framework of the school-based practice for internees, the development of the competences, as mentioned earlier, is refined through observing the exemplary practices displayed by mentors. This underscores the necessity for high-quality mentorship in the success of internship programs. Various studies (Laura, Shuman, Sanderson, & Grauer, 2011; Hardie, Shamika, & Ross, 2018) indicate that effective mentoring programs require the formation of strong partnerships between mentors and protégés, paired with an institutional setting that supports and values these connections. As noted by Hardie, Shamika, and Ross (2018), the quality of supervision and mentorship can significantly impact the overall efficacy of the internship, as well as the interns' success. The responsibilities of mentors encompass teaching, providing support, fostering friendships, and modelling professional behaviour and STEM teaching methods (Snodgrass, Henderson, Doan, Greer, & Manuel, 2022). According to Atkins et al. (2020), a useful approach to cultivating scientific identity and enhancing its importance among STEM undergraduates is mentoring. Students who received both instrumental and emotional support from their mentors exhibited a stronger scientific identity, while adverse mentoring experiences were linked to a diminished scientific identity (Atkins et al., 2020). These results imply that mentoring can offer students various types of support, research abilities, and independence, as well as enhance their scientific self-efficacy, all of which contribute to shaping their scientific identities.

Method

Study design

The study is framed within a postpositivist paradigm and guided through a concurrent triangulation design. A concurrent design allows the generation of both quantitative and qualitative data concurrently to confirm, cross-validate, and corroborate study findings (Hanson, Cresswell, Plano-Clarke, Petska, & Cresswell, 2005).

Study participants and context

The teaching practice described in this study is organized under a new Teaching Enhancement Program (TEP) at the University of Rwanda-College of Education (UR-CE). The TEP aims to improve how student teachers are integrated into work environments through hands-on experience. The program

includes observation, teaching, and peer-mentor stages. The first stage is for candidates in their first year. It is a four-week practice period that lets students observe teaching in a real school setting. Students move to the next stage when they are in their second year. In this stage, students have the opportunity to observe and teach lessons in their specialization areas under the supervision of a school mentor. The final stage happens after the college practicum, which is a three-month placement in a practicing school of their choice. Students who perform well in the first and second stages, as well as in the college practicum during their third year, are eligible for a third stage (peer mentors) that begins at the start of their fourth year. Ideally, these peer mentors support novices in stages one and two with their teaching practice. Therefore, the study population consisted of UR-CE preservice teachers specializing in STEM disciplines. Twenty-one preservice teachers were purposively sampled because they were observing and teaching simultaneously. This group was in the second stage of the TEP.

The online survey achieved a 100% retention rate among the participating preservice teachers (N=21). The cohort, with ages ranging from 18 to 25 years, consisted of 76.2% males and 23.88% females. Regarding their subject specializations within Education, a plurality of the participants (33.2%) was completing their teaching practicum in the Math-Economics combination. The remaining participants were distributed across various other combinations, including Math-Physics (14.3%), Math-Geography (14.3%), Biology-Chemistry (14.3%), Physics-Geography (9.5%), Physics-Chemistry (4.8%), Math-Computer Science (4.8%), and Math-Chemistry (4.8%), with no representation in the Math-Biology track. In terms of prior teaching experience, nearly half of the cohort (47.6%) had taught for up to six months, 38.1% reported having no prior teaching experience, and 14.3% had served as teachers awaiting training for a duration of seven months up to one year. Drawing upon this participant profile, the following sections report findings on the preservice teachers' experiences concerning professional ethics, teaching, pedagogy, reflective STEM practice, and classroom management.

Data collection

Qualitative and quantitative data are gathered through the Student Teacher Internship Exit Questionnaire (STIEQ), observation, and document analysis. The STIEQ, which comprised a combination of closed and open-ended questions, was administered as an online survey that was completed by the preservice teachers at the end of their practicum. The online survey allowed the researchers to collect data in real time, thus guaranteeing a short time frame for the collection of responses that were transferred automatically into a Google database for easy analysis (Lefever, Dal, & Matthíasdóttir, 2007). The STIEQ items were spread over three dimensions of teaching practice, that is, professional ethics, teaching, pedagogy, and classroom management dimensions. Observations were made on the general conduct of the preservice teachers, their lesson delivery, and classroom management approaches. Observations also extended to mentors and how they endeavoured to assist the mentees. A total of eight (8) lessons taught by the preservice teachers and three (3) demonstration lessons taught by the mentors were observed. These were followed by post-lesson discussions amongst the researchers, the intern, and the mentor. The preservice teachers' pedagogical documents, inclusive of lesson plans, the scheme of work, record of marks, and the class diary, were also analysed. The three data collection approaches provided for triangulation to strengthen the validity of the findings (Hanson, Cresswell, Plano-Clarke, Petska, & Cresswell, 2005).

Data analysis

Descriptive statistics (weighted mean score and average mean score) and emergent themes are used to analyse the data. The weighted mean served as a summary statistic to describe the interns' satisfaction and the confidence they felt regarding the reduction of their theory-practice gap concerning the STIEQ items. The average mean score was calculated for each of the three dimensions (professional ethics, teaching and pedagogy, and classroom management) on the STIEQ. This average mean was used to

compare differences in the preservice teachers' confidence in reducing the theory-practice gap across dimensions. The participants' responses in the open-ended sections of the STIEQ and field notes from the observation and document study were subjected to content analysis, organized into patterns and codes that led to themes used to report the findings qualitatively. To ensure anonymity, the participants' qualitative responses were reported using their pseudonyms, Preservice Teacher (PST) 1-21.

Findings

Professional ethics and development

The preservice teachers reported that the majority of professional ethics aspects manifested as a "hidden curriculum" in the school. They learnt a lot from the school climate, culture, and overall tone that prevailed in the entire school. PST 3 observed that although he had not set sight on any of the documents outlining the expected conduct of public servants in Rwanda, he had seen how the school administrators and other teachers dressed and conducted themselves in the school, during assembly, in meetings, and the other places. The preservice teachers' perceptions on professional ethics development were also captured in Table 1 below.

Table 1.

STIEQ Items on Preservice Teachers' confidence levels about Professional ethics and development

STIEQ Items	SA	A	N	D	SD	Mean
During my internship, I role-modelled a worthwhile character in front of learners.	57.10	33.30	9.50	-	-	89.4
I learnt that integrity means punctuality, doing all assigned duties, and fulfilling all job expectations.	81	19	-	-	-	96.2
My mentors had enough time to advise me on all the Rwanda regulations and laws for public service workers.	42.90	42.90	9.50	4.80	-	84.8
My relationship with learners was maintained at a professional level.	61.90	33.30	4.80	-	-	91.4
In my teaching, I gave gender sensitive tasks to the learners	52.40	47.60	-	-	-	90.5
I had experience sharing ideas in Communities of Practice (CoPs).	38.10	52.40	9.50	-	-	85.7
During my internship, mentors demonstrated that professionalism is about expertise, commitment, and lifelong learning.	61.90	38.10	-	-	-	92.4
During my internship, I also learnt that care and respect for the learners' voice is important for creating conducive learning environments.	81	19	-	-	-	92.6

Table 1 shows that the preservice teachers (N=21) gained an appreciation of what integrity meant for the teaching profession. This is indicated by their high perceptions on punctuality, doing all assigned duties, and fulfilling all job expectations (M=96.2), gender sensitive tasks to the learners (M=90.5), commitment, and lifelong learning (M=92.4), and care and respect for the learners' voice (M=92.6). Despite the general trend of high scores on the majority of aspects, the preservice teachers were somewhat less confident when asked about their experience with Rwanda regulations and laws for public service workers (M=84.8), and sharing ideas in Communities of Practice (CoPs) (M=85.7).

Teaching, pedagogy, and reflective STEM practice

In this sub-section, the preservice teachers were asked about their engagement with learners during lesson delivery, and what lessons they learnt from their mentors. Table 3 shows their perceptions on teaching, pedagogy, and reflective STEM practice.

Table 2.

STIEQ Items on Teaching, pedagogy, and reflective STEM practice

STIEQ Items	SA	A	N	D	SD	Mean
Engaging learners in higher-order thinking and deeper learning was not always easy for me during my teaching.	19	47.6	14.3	19	-	73.3
In my teaching, I made sure learners interacted in collaborative group projects.	52.4	42.9	4.8	-	-	89.6
My teaching approaches considered learners' cultural, historical, and social backgrounds.	28.6	57.1	14.3	-	-	82.9
Mentors demonstrated to us the importance of technology integration in teaching and learning.	57.1	38.1	4.8	-	-	90.5
Using ICT such as videos, internet research, and other software applications was part of our regular teaching routine.	57.1	42.9	-	-	-	91.4
I had an opportunity to reflect on, analyse, and adapt my teaching to suit the needs of the learners.	52.4	47.6	-	-	-	90.5
In my opinion, growing into a reflective teacher (as described in 5 above) was not easy.	14.3	33.3	33.3	9.5	9.5	66.6
The mentors demonstrated and taught us how to embed generic competences and cross-cutting issues in our lessons.	42.9	57.1	-	-	-	88.6
During my teaching, I sometimes used approaches that ensured the integration of the STEM subjects	14.3	42.9	19	19	4.8	68.6
Becoming a facilitator means allowing learners more responsibility for their learning.	66.7	28.6	4.8	-	-	92.5
The mentors allowed me time to develop my teaching skills and guided me on how to introduce, develop, and conclude lessons effectively.	71.4	23.8	4.8	-	-	93.3

On a general level, the data in Table 2 shows that the preservice teachers thought that they had gained substantially with respect to technology integration. They reported high satisfaction (M=90.5) with their mentors' use and deployment of technology. For the majority of the preservice teachers, this benefited them in two aspects. Firstly, they learnt how technology is deployed in STEM disciplines. Secondly, it demonstrated to them the importance. However, data from our observations confirmed this trend for some of the preservice teachers while revealing limitations for the others. The former group of preservice teachers used a variety of ways, such as the use of YouTube videos, the Smart board, online (internet research), and the projector as part of their lesson delivery. The latter group only used the projector in the majority of their lesson delivery without diversifying into other technology resources. Notably, however, both groups revealed some limitations in the use of the projector. In the majority of cases, the projector was used as a direct teaching method, that is, as a lecturing and note-taking tool.

Despite the TEP expecting an all-around acquisition of competences, the findings from the STIEQ reveal minimal interns' confidence in competences such as STEM integration (M=68.6) and reflective practice (M=66.6). These two aspects were particularly difficult for the majority of the preservice teachers. This was confirmed by some of the participants in the open-ended section of the STIEQ. PST 15 said:

> *I am not sure what STEM integration means because, from the knowledge that I have gained in university, we are told that integration of my subject, mathematics, is done through ICT. Now, to suggest integration of mathematics and biology or chemistry to me is kind of new.*

PST 07 added:

> *I did not see my mentor doing any kind of STEM integration, besides the use of the projector. I did not meet that kind of content in the university either. Which means I have to read more on this aspect. In some cases, the pressure to perform even in circumstances where I was not sure compelled me to use the approaches that my high school teachers used on us, then. But I think it is possible to find ways to connect mathematics to physics or geography to chemistry.*

Similar sentiments as above were echoed by PSTs 11, 13, and 21 when it came to the aspect of reflective practice. They intimated that it was difficult to know everything about teaching in one term, more so when practicing teachers already in the field used these approaches sparingly. To confirm this, the majority of lesson evaluations in the preservice teachers' pedagogical documents also showed scant comments such as: *lesson was done, completed, objectives achieved, content not covered, to be taught again*, and other statements that did not indicate strengths, weaknesses of the lesson, the causes, insights learnt, and suggestions for future improvement. These findings seemed to reflect on the quality of mentorship the preservice teachers received. Despite the internees' satisfaction with the assistance they received from mentors (Mean=93.3), observation data showed that the mentors had limited instructional expertise in some aspects of STEM learning. The mentors showed limitations in the provision of constructive feedback, STEM integration approaches, the development of a refined PCK for STEM teaching, and using technology resources interactively in ways that empowered the learners. Regarding PCK, observations showed that both preservice teachers and their mentors exhibited minimal engagement with problem-based learning, used formative assessment sparingly, faced challenges in recognizing interdisciplinary connections, had limited skills in addressing diverse learners, struggled to anticipate students' misconceptions, and focused more on procedures than on concepts.

Classroom management

In terms of classroom management, the preservice teachers expressed less satisfaction with the experiences they had gone through than they did with professional ethics development and the teaching, pedagogy, and reflective practice. On average, the data shows that their experiences in the areas of professional ethics development (M=90), and teaching, pedagogy, and reflective practice (M=84) had assisted them in closing the theory-practice gap much better than in the classroom management dimension (M=71). Table 3 below shows their responses.

Table 3.

STIEQ Items on Preservice teachers' confidence levels with some aspects of classroom management

STIEQ Items	SA	A	N	D	SD	Mean
It is important to set clear and consistent expectations for students so they know what is expected of them.	28.6	28.6	9.5	4.8	28.6	64.8
During my stay, I tried to show genuine interest in students' lives and interests to establish trust and rapport.	28.6	47.6	-	4.8	19	72.4
Before I taught, I ensured desks and materials were properly arranged to support the lesson's objectives and minimize distractions.	47.6	33.3	-	4.8	14.3	79.0

STIEQ Items	SA	A	N	D	SD	Mean
Part of teaching meant establishing routines and providing reminders so students can stay on track.	14.3	52.4	14.3	4.8	14.3	69.6
Using positive reinforcement meant that I identified behaviours I wanted to reinforce, such as academic achievements, participation, and effort.	42.9	38.1	4.8	-	14.3	79.1
The mentors were skilled in creating a classroom environment where students were dedicated to their studies and well-behaved.	28.6	52.4	4.8	-	14.3	76.3
In the class that I attended, the mentors gave physical punishment to learners who misbehaved.	-	38.1	23.8	19	19	52.2
The classroom I attended followed regulations and rules that were put in place for every learner	19	61.9	4.8	-	14.3	74.3

Table 3 shows that the preservice teachers received guidance from the mentors on classroom management skills. Firstly, the preservice teachers somewhat disagreed with the assertion that the mentors gave physical punishment to learners who misbehaved (M=52.2). Secondly, they highly appreciated the mentors whom they thought were skilled in creating a classroom environment where students were dedicated to their studies and well-behaved (M=76.3). That implied the mentors were good role models and effective managers of the classroom. As a corollary, the preservice teachers followed suit and ensured desks and materials were properly arranged to support the lesson's objectives and minimize distractions (M=79.0), used positive reinforcement rather than punishment (M=79.1), and showed genuine interest in students' interests and feelings to establish trust and rapport (M=72.4). Despite this, the open responses from the STIEQ showed that the preservice teachers had met many challenges. PST 01 said:

> *Classroom management was not easy. Particularly in the Senior 1 classes. These two classes are large, with an average of 60 learners in each class. The learners are always making noise. Once they finish what they are doing, they make noise. Some boys in Senior 1 B have this habit of asking for permission to go outside more frequently than the others. This disrupts the smooth flow of the lesson.*

PST 09 had this to say:

> *Organising group work was very difficult with some of the large classes. In the senior classes, the learners want to test your patience by engaging in off-task behaviours. You need to stay calm. After some time, they comply with whatever you say to them. But if you are not careful, the situation can get out of hand.*

The other interns observed that maintaining classroom order was a challenge due to some issues like student disruptions, behavioural issues, diverse learning needs, technology disruptions, inconsistent rule enforcement, and the phenomenon of shy and withdrawn learners. Data from the observations also corroborated the sentiments of PSTs 01 and 09. When it was time for the preservice teachers to deliver lessons, the learners tended to be more disruptive than they would be when the mentor was teaching. Thus, in the majority of cases, the mentors would help maintain order when they realized that their mentees were failing to manage. The preservice teachers thought that the period for their practice was too short to allow meaningful acquisition of the skills required to meet the diverse demands of individual learner preferences. The majority of them lamented that the two-week period was not adequate to establish the needed rapport with the learners.

Discussion

The study aimed to explore how the internship experience can help close the gap to make students' transitions from college to work smoother. The results showed a range of experiences among STEM preservice teachers across different aspects of teaching practice. On one hand, the interns demonstrated enthusiasm and confidence in their dedication to duty, punctuality, respect for learners, the quality of mentorship they received, and their ability to incorporate technology during lessons. On the other hand, observation data revealed some gaps in specific areas of STEM integration. Some preservice teachers expressed frustration with limited time, classroom management challenges such as handling large classes, learner misbehaviour, and managing equipment in science labs. In other findings, participants reported greater improvements in professional ethics (Average M=90) and teaching, pedagogy, and reflective practice (Average M=84) than in classroom management (Average M=71). This was concerning because classroom management theorists believe these three aspects work together to achieve the best learning outcomes. Effective management strategies should be implemented in a way that aligns classroom goals, learning processes, and learning outcomes. This alignment must be combined with engaging and dynamic teaching practices to effectively foster positive behavioural outcomes in the classroom environment (Christofferson & Sullivan, 2015).

The findings regarding preservice teachers' reflective practice were particularly revealing. While they indicated a strong opportunity to reflect on, analyse, and adapt their teaching to meet the needs of their learners (M=90.5), they later acknowledged the difficulties of evolving into reflective practitioners (M=66.6). These results highlighted the discrepancy between intention and action, illustrating that engaging in reflective practice is a challenging endeavour. This aligns with the research by Menon and Ngugi (2022), who noted that preservice teachers often do not engage in high-quality reflective thinking, as reflection is frequently premature in the preservice years. In the current study, Menon and Ngugi's assertions seemed to equally apply to the mentors as well, as they failed to properly advise the internees on this and some other critical aspects of STEM teaching, such as problem-based learning, use of formative assessment, engaging interdisciplinary teaching, and handling of anticipated students' misconceptions. This scenario was cause for concern given the essential role that reflective practice plays in bridging the theory-practice gap. Menon and Ngugi (2022) further argue that reflective practice provides preservice teachers with the opportunity to reassess their preexisting beliefs about science teaching in light of new experiences, which can significantly contribute to their professional growth as educators.

Another emerging finding from the qualitative data is that the internees faced some pressure to perform even in situations they had not expected. In those cases, they relied on their intuitive knowledge to succeed. For the individual preservice teacher, this meant drawing from their past experiences to perform effectively. This finding indicates that the reduction of the theory-practice gap occurs within various aspects of the preservice teachers' practice. Based on this, the researchers propose the Ecological Spheres of the STEM preservice teacher's theory-practice gap model, as shown in Figure 1.

The personal sphere (A) is the centre of the Ecological spheres of the STEM preservice teacher's theory-practice gap model. It represents the individual preservice teacher's theoretical knowledge that is influenced by their interactions with the other spheres. The ability of the preservice teacher to acquire, retain, and deploy their possessed theoretical knowledge depends to a large extent on individual psycho-social disposition. Immediately after the personal sphere is the school's sphere (B). This sphere of influence is critical in shaping the professional development of the preservice teacher. It aligns with Charon's (2004) first of the five aspects of symbolic interactionism that relate to the stages through which internees navigate the socially constructed realities of the workplace. The first aspect pertains to the role of social interaction, which defines how internees engage with learners, their mentors, and other school staff.

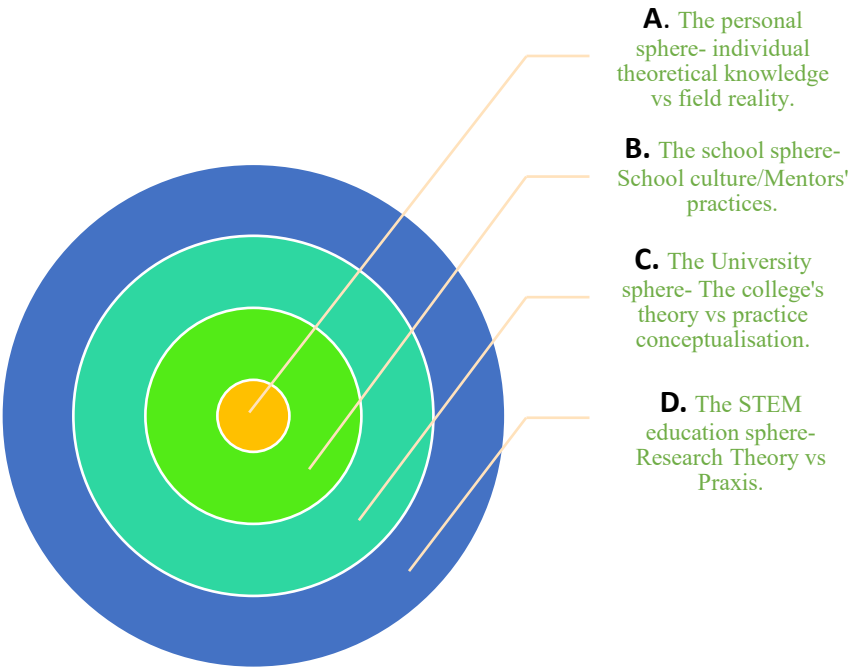

Figure 1. Ecological spheres of the STEM preservice teacher's theory-practice gap (Source: Authors own elaboration)

However, the Ecological spheres of the STEM preservice teacher's theory-practice gap model extend this interaction to other external agents such as their college tutors, peers, and other teachers from other schools, and any other relevant text materials providing theoretical knowledge in the field of teaching practice. Furthermore, the school culture, which is shaped from a collection of knowledge, beliefs, customs, norms, values, and sanctions of the particular staff and the learners, also exerts considerable influence (Singh & Dubey, 2019). Participants in this study confirmed the power of school traditions, contrasting with other scholars (Alvarez, 2015) who observe that the professional socialization of teachers within school cultures often yields limited incentives for the exploration and development of intellectual discourse among educators thus contributing to the persistence and reinforcement of the theory-practice gap in educational settings. The University sphere (C) determines what knowledge, skills, and competences to inculcate in the preservice teacher. It also determines how the preservice teachers are supervised during the internship. Thus, these institutions' knowledge affordance or limitations impact the individual preservice teacher's conceptualization of the theory-practice gap. This implies that if college tutors have limitations in their understanding of STEM education approaches, the product candidate is affected negatively when they enter the teaching practice arena. The last sphere in the STEM education sphere (D). This sphere represents the research theory and knowledge on STEM trends that preservice teachers can acquire through further reading or engaging in action research. Extant literature (Allen & Wright, 2013; Ulvik, Riesse, & Roness, 2017) has consistently shown that preservice teachers who research on their practice or link their teaching to some research-based theory have a greater opportunity for the successful application of theory into practice.

Conclusion

STEM preserve teachers face substantial dilemmas when they enter the teaching practice field for the first time. They find themselves in a challenging position where they are expected to implement the theoretical principles of STEM education within curricular frameworks and structural contexts that may not align with contemporary pedagogical approaches. These challenges reflect the dilemmas in the

broader STEM education discourse, that is, school structure, curriculum design, teacher training, and the quality of mentorship programmes (Shaharaban & Yarden, 2019). The implication is that the preservice teachers need support to successfully engage in quality experiences that positively impact the theory-practice gap. Such support comes in various ways, including mentors' demonstration lessons, their constructive feedback, and the opportunity to learn. The findings in the current study revealed some mixed experiences. On one hand, the interns demonstrated enthusiasm and confidence in their dedication to duty, punctuality, respect for learners, the quality of mentorship they received, and their ability to incorporate technology during lessons. On the other hand, observation data revealed some gaps in specific areas of STEM integration, such as the handling of large classes, learner misbehaviours, and the management of equipment in the science laboratories. Despite assisting the internees in technology integration, behaviour control, and other areas, the mentors failed to properly advise the internees on the engagement on reflective practice and some other critical aspects of STEM teaching, such as problem-based learning, use of formative assessment, engaging interdisciplinary teaching, and handling of anticipated students' misconceptions. Based on the findings, the study concluded that the TEP programme is a commendable innovation. It provides the preservice teachers with opportunities to observe, practice, and refine their teaching. It offers the STEM preservice teachers ample time for practice, that is, from their first year in college through to the fourth and final year. The initial phases, one and two of this programme, which were the context for the current study, provide the internees with valuable experiences that assist them in navigating the theory-practice gap while simultaneously developing their identity as STEM teachers.

Based on these findings, it is highly recommended that the discourse on STEM integration be actively extended into ongoing teacher development and mentorship programs. Furthermore, there is a critical need for school-based capacity-building initiatives aimed at current mentors. Enhancing mentors' competencies will better equip them to assist preservice teachers in developing pedagogical content knowledge, delivering constructive feedback, and implementing effective STEM practices. To facilitate this, future research should focus specifically on investigating the existing skills gaps among school mentors to accurately identify and address their targeted training needs.

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