



Pre-service physical science teachers' self-efficacy for sustainable digital pedagogy: Evidence from teaching practice after emergency blended learning

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Submitted: 12 January 2026 Revised: 1 March 2026 Accepted: 8 March 2026

Abstract

Teacher self-efficacy is a critical component of sustainable teacher preparation, shaping confidence in planning, instruction, and reflective practice. During the COVID-19 period, a local university implemented blended teaching and learning under rapid digital transition conditions, creating a context for professional learning in digitally mediated environments. Through a concurrent mixed methods approach, this study sought to establish the self-efficacy of conveniently sampled physical science pre-service teachers [PSTs] ($n = 16$) during teaching practice post-blended learning experience. Data were collected using a questionnaire followed by interviews. Quantitative data were analysed to establish overall strength of sources contributing to perceived self-efficacy of participants. Sources' contribution strengths were recorded as above average for own experiences and vicarious experiences, average for verbal persuasion, and below average for emotional arousal. Content analysis was used on qualitative data responses to unveil explanations associated with the contribution strengths of sources of perceived self-efficacy. The findings indicate that blended learning can support pre-service teachers' self-efficacy development and help make teaching practice more manageable despite reported challenges. The study discusses implications for strengthening sustainable digital transition in science teacher education through structured practice opportunities, modelling, feedback, and supportive conditions that enable resilient professional learning. The study recommends that teacher training institutions need to strengthen PSTs' self-efficacy by prioritizing real classroom exposure through direct teaching, school visits, and practical lesson planning. They are encouraged to integrate online audio-visual resources and blended learning approaches to extend PSTs' understanding of authentic classroom dynamics. Future research across diverse contexts could examine how planned blended learning influences PSTs' professional preparation.

Keywords: Blended learning; Digital pedagogy; Physical science teacher preparation; Pre-service teacher education; Sustainable teacher development; Teacher self-efficacy; Teaching practice

1. Introduction

The challenges facing developing countries within their education sector, especially in science education, have been associated with a variety of factors. For instance, the challenges have been associated with issues such as teacher training (Ogunniyi & Rollnick, 2015; Velthuis et al., 2014), availability of resources and traditional teaching strategies (Makhechane & Qhobela, 2019; Mohafa et al., 2022). Of particular concern is the contention made by Ogunniyi and Rollnick (2015) that science teacher training in most developing countries has had challenges that negatively impact the development of such countries. Another critical consideration that shapes the science teacher is the teacher training modes adopted by training institutions. The level of training on subject matter knowledge (Menon & Sadler, 2018; Velthuis et al., 2014), educational theories, simulated teaching and learning activities, as well as experiences play a critical role in shaping pre-service teachers' identities as well as how they perform tasks in their initial stages of practice (Ma & Cavanagh, 2018). Initial teacher training, in addition to theoretical and practical knowledge, offers pre-service teachers [PSTs] a chance to evaluate their personal attributes, such as beliefs (Pandey et al., 2020). One of these beliefs is self-efficacy, which, according to Bandura (2000) "... refers to beliefs in one's capabilities to organize and execute the courses of action required to produce given levels of attainments" (p.16). It cannot be overemphasised that self-efficacy influences their effectiveness in teaching, and it "...affects their professional perception, persistence and attitude" (Pandey et al., 2020; p.1458). Thus, teachers with high self-efficacy subscribe more to more learner-centred approaches than those with low self-efficacy (Emiru & Gedifew, 2024). Importantly, self-efficacious

teachers can confront challenges, set achievable aims, create stimulating learning environments, reflect on their teaching, engage students in active learning, and are comparatively resilient (Heng & Chu, 2023).

In response to disruptions of the COVID-19 pandemic, many universities including one local university in Lesotho suddenly adopted a blended teaching and learning mode. Prior to the implementation of this approach, an abrupt shift to online teaching and learning had already caused concerns. There were reports from some students and lecturers who were concerned about systems deficiencies and implementation problems that hampered teaching and learning (Makumane, 2021). The abrupt shift to online teaching and learning was later coupled with some face-to-face teaching. Research establishes that face-to-face teaching allows in-person and personalised interactions with the possibility of getting immediate feedback from peers and instructors (Atmacasoy & Aksu, 2018) as opposed to online learning, which may delay feedback. This creates an environment where vicarious experiences and persuasion by others can happen at a greater scale than in an online environment (Atmacasoy & Aksu, 2018). In the same dimension, engagement with tasks is usually higher in face-to-face learning than in online learning (Shu & Gu, 2018). On the other hand, online encounters have the potential to affect the development of pre-service teachers' self-efficacy due to "...lack of expressions of sincerity, the need for internet access, the need for additional time, and anxiety when it comes to criticism" (Inel Ekici, 2018, p. 27). Moreover, technological challenges and glitches affect learning experiences negatively. For instance, Yilmaz and Malone, (2020) conducted a study focusing on preservice teachers' perceptions about blended learning and established that some had internet connectivity challenges which at some point forced them to submit assignments late. In a similar study Mohafa and George (2023) found that science pre-service teachers identified high data costs and lack of authentic opportunities to engage in practical work as some major drawbacks of online learning. Furthermore, the lack of teaching and learning tools, along with teachers' limited competency in using technological tools effectively, adds to the challenges of online teaching and learning. Learners, though able to use technology for other tasks, can still experience challenges to use technology for learning (Altaş & Babacan, 2025).

Beyond emergency responses, blended learning has become part of the broader digital transformation agenda in teacher education, raising questions about how such transitions can be sustained in resource-constrained contexts. Due to the novelty of blended learning in one local University, it was not yet clear how the minimally planned blending of online and face-to-face teaching influenced physical science pre-service teachers' self-efficacy and motivation during teaching practice [TP] in one country. As a result, there was limited empirical evidence on how rapidly implemented blended learning environments shaped PSTs' self-efficacy during teaching practice, particularly through the differential contribution of mastery experience, vicarious experience, verbal persuasion, and affective states.

Against this backdrop, this study, employing mixed method approach explored physical science pre-service teachers' perceived self-efficacy during teaching practice following a rapidly implemented blended learning experience. Grounded in Bandura's social cognitive theory, the study specifically explored the perceived contribution of mastery experience, vicarious experience, verbal persuasion, and affective states to PST self-efficacy. Understanding these dynamics is important for strengthening sustainable teacher preparation and supporting resilient digital transition in science teacher education, particularly in contexts where blended learning is adopted under constrained conditions. The study responds to the research questions:

RQ 1) How do physical science PSTs describe their perceived teaching self-efficacy during teaching practice following a blended learning experience?

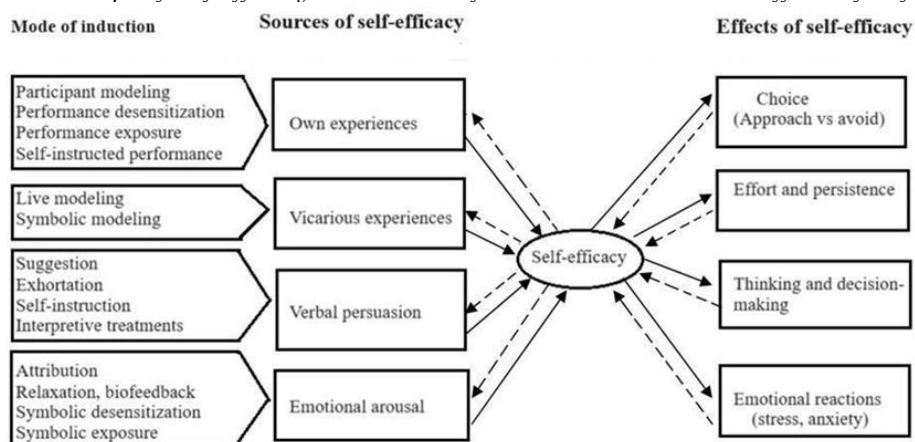
RQ 2) How do PSTs perceive the relative contribution of mastery experience, vicarious experience, verbal persuasion, and affective/physiological states to their self-efficacy after blended learning?

2. Theoretical Framework and Literature Review

The current study is informed by Bandura's (1988) conception of self-efficacy within the social cognitive theory framework as conceptualised by Lippke (2020). Figure 1, as adapted from Lippke (2020), highlights critical elements of the framework. Lippke's (2020) conceptualisation model gives rise to three issues the current study adopted. Firstly, the model proposes that different modes of induction facilitate the manifestation of different sources of self-efficacy. Secondly, the model proposes that the sources of self-efficacy influence self-efficacy. Thirdly, it proposes that a developed level of self-efficacy affects a number of issues, as depicted by solid arrows radiating away from self-efficacy. Generally, the framework shows a linear influence from modes of induction to the effects. Literature shows the articulation of distinctive identities of individuals with low and high self-efficacy (Bandura & Wessels, 1997; Heng & Chu, 2023). Contrary to people with low self-efficacy, people with high self-efficacy demonstrate significant confidence in their abilities, feel more satisfied when engaged in challenging tasks and are more resilient even in the presence of obstacles (Bandura & Wessels, 1997; Zee & Koomen, 2016). These differences provide information that can help understand a person's self-efficacy level without direct assessment. Therefore, the current study, noting the work of Gist and Mitchell (1992), Bandura and Wessels (1997), Zee and Koomen (2016) and Lippke (2020), proposes two more relationships. Firstly, it is possible to use the level of self-efficacy to trace the collective influence of its sources from its level (Ma & Cavanagh, 2018; Zee & Koomen, 2016). Secondly, it is also possible to understand the level of teachers' self-efficacy from the choices, efforts, persistence, thinking, and decision-making processes a teacher makes and how they show their emotional reactions (Glackin & Hohenstein, 2018).

Figure 1

Relationships of self-efficacy with modes of induction, sources and effects of self-efficacy



Note. Adapted from Lippke (2020, p.4723).

While Figure 1 reflects three components, this study focuses more on the sources and the effects of self-efficacy. Various sources of self-efficacy, including own experiences (Mastery experiences), vicarious experiences, verbal persuasion, and emotional (physiological and affective states), have been reported in the literature (Bandura & Wessels, 1997; Lippke, 2020). Own experience refers to the kind of performance and outcomes one has in a particular task, which in this study refer to activities related to actual teaching. Positive experiences reinforce self-efficacy, while negative experiences lower self-efficacy. Vicarious experience relates to the development of self-efficacy through learning from the success and resilience of others, leading to developing a feeling of being capable of engaging in similar or even novel tasks (Bandura & Wessels, 1997). Emotional arousal relates to physiological and affective states which include how an individual copes with stressful or anxiety-evoking situations (Bandura, 1988).

Within blended learning environments, Bandura's four sources of self-efficacy can manifest in various ways that shape teaching practice. For instance, mastery experiences can be achieved

through opportunities for practice and iterative feedback across online and face-to-face contexts. Vicarious experiences arise when student teachers observe peers and mentors modelling strategies in ways that capture teaching and learning experiences (Yurekli et al., 2020). For instance, through the physical micro-teaching sessions and science content practical sessions, the PSTs engaged in both experiential and vicarious learning opportunities that had the potential to inform their professional practices (Yurekli et al., 2020). Verbal persuasion is implemented through among others, feedback from lecturers, mentors, and peers (Bandura, 1977) in both digital and physical spaces. Finally, the potential influences of affective states can emanate from some of the experiences of blended conditions, such as anxiety under time pressure, connectivity disruptions (Yilmaz & Malone, 2020), fear to share opinions and the heightened visibility of critique in online forums (Gasmi, 2022). The critical issue is whether the experiences that PSTs had during blended learning positively contributed to their self-efficacy and as a result helped them to successfully engage in teaching practice activities. Self-efficacy is evidenced in parameters such as choice, effort and persistence, thinking and decision-making, and the emotional reactions an individual makes about the task at hand (Bandura & Wessels, 1997).

2.1. Influence of Teachers' Self-efficacy

Research studies have established attributes of teachers with high and or low self-efficacy. For instance, teachers with high self-efficacy actively engage students in their learning more effectively than those with low self-efficacy who predominantly subscribe to individualistic teaching (Emiru & Gedifew, 2024). Furthermore, as earlier asserted by Bandura (1977), the current literature reports the characteristics of teachers with high self-efficacy and how they contribute to desirable students' attributes (Emiru & Gedifew, 2024). Self-efficacious teachers can confront challenges, set achievable aims, create stimulating learning environments, reflect on their teaching, and engage students in active learning (Heng & Chu, 2023). Again, they are comparatively resilient, solution-focused, and persistent in confronting challenges for the benefit of students' achievement (Heng & Chu, 2023). However, self-efficacy beliefs are variable, contextual, and dynamic in nature, and they bring our attention to the fact that a teacher may have varying self-efficacy levels across different elements. For example, a teacher may feel more confident in classroom management than in student engagement (Lazarides & Warner, 2020).

2.2. View of PSTs about their Self-efficacy

The literature shows some contrasting views concerning PSTs' self-efficacy during their teaching practice experience. The views differ in relation to levels of PSTs' self-efficacy (Clark & Newberry, 2019). PSTs with low self-efficacy report challenges in various teaching and learning activities, such as instructional strategies and classroom management (Golubtchik, 2024) and students' engagement (Colson et al., 2017). PSTs further refer to being less confident due to less extensive training and, as a result, are unable to respond to contextual classroom challenges such as students' unfavourable behaviour or actions (Golubtchik, 2024). Similar records were made by Colson et al. (2017) where they noted that PSTs who had more training time exhibited high self-efficacy than their counterparts who had less time. The low self-efficacy and its unfavourable effects seem responsible for some negative experiences at work. For instance, the lack of conventional ways to prevent, manage and deal with in-class issues, which negatively hamper the development of a conducive learning environment, has been echoed by PSTs, and as a result, some may resort to a 'bossy attitude' (Martins et al., 2015). The issue of challenges with classroom management for PSTs has also been associated with inadequate strategies to engage students in active learning, command respect, balance their authority and learners' autonomy, maintain communication and interest during lessons (Kılıç, 2022). While there is some evidence that vicarious experience can improve PSTs' self-efficacy, some have experienced a negative effect, where PSTs make assertions that they feel down when they cannot match their peers' level of competence (Martins et al., 2015). Furthermore, PSTs regard simulated teaching practice as inadequate for developing their self-efficacy as most activities do not mirror realities in the actual classroom (Yurekli et al., 2020).

PSTs with high self-efficacy express their views that cover several dimensions of competencies. Among the competencies, PSTs in one study highlighted their ability to manage classes, use a variety of instructional strategies and engage students (Colson et al., 2017). Additionally, PSTs with high self-efficacy are highly driven by the need to ensure the success of every student, they create time to attend to students' individual needs even beyond scheduled school time and create healthy relationships with students by communicating expectations and attending to their social challenges (Martins et al., 2015). PSTs develop high self-efficacy when their training provides favourable conditions in which they get assured that they possess adequate teaching competencies (Clark & Newberry, 2019; Menon & Sadler, 2018). For instance, their engagement in planning and lesson enactment, observations of classes for mentors and peers enable PSTs to anticipate and prepare for some school realities even before TP started, thereby improving their self-efficacy (Martins et al., 2015). In summary, PSTs' self-efficacy seems to vary with how they experienced initial training (Clark & Newberry, 2019), the support they received, and how long they have been in TP (Colson et al., 2017).

3. Method

3.1. Study Design

The study adopted a concurrent mixed method approach to establish how the prior blended learning experiences of PSTs influenced their self-efficacy and motivation of physical science PSTs during teaching practice. According to Johnson and Christensen (2020), the mixed-method approach allows for the collection of multiple kinds of data in the form of a mix of variables, words, categories and images. They further show that mixed methods use qualitative and quantitative methods to analyse data. Creswell (2014) argues that the mixed method approach brings strengths to the study design while minimising the limitations of both qualitative and quantitative approaches. This study used two instruments, a questionnaire with open and closed-ended questions and follow-up interviews. The questionnaire, which was given to PSTs, took about 45 minutes to complete and allowed the PSTs to indicate and justify their choices (Creswell, 2014). Meanwhile, the follow-up interviews which took between 15 to 20 minutes offered the researchers the insights into the experiences and justifications that the PSTs made.

3.2. Participants

The participants in this study were a combination of two cohorts of physical science PSTs (n=16) from one local university in Lesotho. The PSTs were numbered from 1- 16 and given anonymous identifications such as PST-1 to show the first PST. They took physics (n= 8) or chemistry (n= 8) with any other subject and were all in the final year of Bachelor of science with education (BSc.Ed.) programme. They had completed ten weeks of teaching practice in different secondary schools in several districts in Lesotho. Teaching practice happened during the second semester of the academic year 2021/2022. These cohorts were taught using blended mode during the academic years 2020/2021 and 2021/2022 because of the COVID-19 pandemic lockdowns. The sample comprised physical science PSTs taking curriculum courses offered by the authors. Different lecturers used different ways of blending face-to-face and online teaching. Face-to-face teaching primarily dealt with practical elements of courses where arrangements were made such that; smaller groups attended physically for science practical work on campus and made pre-booked consultations where necessary. For instance, students attended physical sessions for science content experiments (e.g. Chemistry, Physics) and peer-teaching in science education courses (e.g. curriculum studies). In contrast, online teaching mainly dealt with the theoretical aspects of the courses, like lesson planning, through several media: For instance, synchronous lectures on theoretical issues were held on platforms such as telegram, zoom, WhatsApp and Telegram. Lectures and extra reading materials were shared in advance through LMS, WhatsApp and emails. Summative assessments for both science content and science education courses were done online.

3.3. Data Collection

Data were collected using two data collection tools. A questionnaire with two sections was used. The first part with the Likert scale items were adapted from the Pfitzner-Eden (2016) instrument, a validated questionnaire with internal consistencies (α) above 0.70 for the sub-scales of four sources of self-efficacy consisting of closed-ended questions. The close-ended section had five-point Likert subscales on which PSTs had to indicate their agreement or disagreement on how much of the sources of self-efficacy. Namely own (mastery) experiences, vicarious experiences, verbal persuasion, and emotional arousal (physiological and affective states) influenced their self-efficacy. The 15 original items from the Pfitzner-Eden instrument were modified to emphasise blended learning. For instance, the statement "I successfully mastered the requirements of the practicum" was modified to '*I successfully mastered the requirements of teaching practice because of skills I acquired during blended learning*' as shown in Table 1. The second part with open-ended questions was developed by authors in line with Pfitzner-Eden (2016) items on sources of self-efficacy and required PSTs to show and justify whether they were well prepared to engage students. Then, a follow-up interview was done with four PSTs, two from chemistry and two from physics, who were purposively selected. The interviews were audio recorded. The open-ended questions and interview protocol instruments were assessed for constructs and content validity through discussions by authors.

3.4. Data Analysis

Quantitative data were analysed using SPSS to establish the degree of influence of sources of self-efficacy through descriptive statistics. The analysis was done on each source of self-efficacy subscale to determine their contribution strength to perceived self-efficacy. In order to interpret the strength of the contribution of Bandura's four sources of self-efficacy (mastery experience, vicarious experience, verbal persuasion, and affective/physiological states), a five-point Likert scale was utilized. The PSTs indicated their level of agreement from strongly disagree (1) to strongly agree (5). Each response category was associated with a specific interval range, thereby enabling interpretation of contribution strength. Scores between 1.00 and 1.79 were classified as low, while scores from 1.80 to 2.59 reflected a below average contribution. A mean score within the range of 2.60 to 3.39 was interpreted as average, whereas scores between 3.40 and 4.19 were considered above average. Finally, scores from 4.20 to 5.00 were attributed to a high contribution.

Content analysis was used to determine the details and depth of meaning in all textual data from open-ended questionnaires and interview audio transcripts (Erlingsson & Brysiewicz, 2017). Priori codes under sources and effects of self-efficacy were derived from the Lippke (2020) model and used for deductive data analysis (Forman & Damschroder, 2007). The three authors identified the priori codes based on the theoretical framework and research questions and then agreed on how to apply them to the data. The first two authors adopted a consensus coding approach. They individually read the data several times, carried out initial coding, and organised coded data into sources and effects of self-efficacy followed by interpretations. All three authors held several meetings throughout the analysis process to discuss progress and reconcile emerging issues (Forman & Damschroder, 2007).

4. Findings

The results reveal two major findings. First is the overall strength of sources contributing to perceived self-efficacy of PSTs. Second, the explanation of the strength of sources contributing to perceived self-efficacy of PSTs as well as the effects linked to perceived self-efficacy.

4.1. Strength of Factors Contributing to Perceived Self-efficacy

The presentation of results is based on physical science PSTs' self-efficacy in carrying out different tasks during their TP after experiencing blended learning. The self-efficacy scales were organised such that they were matched with sources of self-efficacy so that judgements could be made

regarding the nature of experiences the physical science PSTs had during blended learning. Table 1 presents results based on 5-point Likert scales of analysis from sources of self-efficacy subscales.

Table 1

Strength of factors contributing to perceived SE of PSTs.

<i>Sources of Self-efficacy</i>	<i>Sources of self-efficacy subscales sample statements</i>	<i>Average</i>	<i>SD</i>
Own experiences	I successfully mastered the requirements of teaching practice because of skills I acquired during blended learning.	4.34	0.25
Vicarious experiences	I observed teachers who conducted good lessons so that I could apply skills during my TP.	4.11	0.28
Verbal persuasion	I was able to do well in TP because of feedback from my Lecturers that I would be a good teacher The positive feedback I got from my fellow pre-service teachers allowed me to do well in TP	4.04	0.34
Emotional arousal	I could motivate students during my TP using strategies I learned during blended teaching	2.75	0.34

Note. Legend: (4.20-5.00: High, 3.40-4.19: above average, 2.60-3.39: average, 1.80-2.59: below average, 1.00-1.79: low)

The results in Table 1 show the recorded contribution strengths for each source of perceived self-efficacy. Two sources have above average contribution strengths, namely, own experiences ($M= 4.34$, $SD= 0.25$) and vicarious experiences ($M=4.11$, $SD= 0.28$). Verbal persuasion has above average ($M = 4.04$, $SD= 0.34$) while emotional arousal has below average ($M=2.75$, $SD= 0.34$) contribution strengths respectively.

4.2. Qualitative Interpretation of the Strength of sources contributing to perceived self-efficacy

The next sub-sections provide details about the views of the PSTs in relation to the strength of sources contributing to perceived self-efficacy. Further details on the ways in which the PSTs viewed the contribution of the various sources of their self-efficacy are highlighted.

4.2.1. Sources of self-efficacy

PSTs' responses reflected mostly three sources of self-efficacy- own experiences, verbal persuasion, and emotional arousal, while the fourth source, the vicarious experiences, is minimally observed in the responses.

Own experiences. Own experiences refer to direct personal, first-hand encounters of activities by the PSTs related to teaching and learning, such as lesson planning and actual instruction. The component of mastery experience became dominant across the PSTs' responses as a source of their self-efficacy. When asked if blended teaching and learning prepared them to engage students meaningfully during teaching practice PST-11 wrote,

Yes, I have been taught [...] how to create learning activities that engage learners and promote conceptual understanding. How to plan for the lesson, things we must consider when planning for the lesson and ensure that all learners are given an opportunity to learn in class and are actively involved...how to deliver content to the learners [...] thus helped me to engage students meaningfully at teaching practice.

The important lesson drawn from the extract above is that PST-11 had the impression that blended teaching provided the knowledge and competence to master the concept of fully engaging students in meaningful learning. The components mentioned in the extract highlight issues done online. This was also demonstrated in the extract by PST-5 below.

...SCE 402 and SCE 452 equipped us with knowledge and skills on how we can engage students through learning. [...] I can refer to peer teaching and lesson plans that we used to do that helped us to master our teaching practice. Using a variety of teaching approaches helped students to see some things differently.

The two extracts above demonstrate the influence of what was taught online and what they did face- to-face. They also provide some essential information illustrating how own experiences were facilitated through providing opportunities for PSTs to have hands-on engagement with planning as well as actual teaching (performance exposure). The explanation below illustrates how the mastery of this competence was reflected in teaching practice, as PST-6 explained,

I was able to develop activities that are interactive for the learners. For example, I used some worksheets to engage learners. I also used teaching and learning aids to bring some abstract concepts into reality. I used teaching strategies that always encouraged learners to raise their thoughts so that I as the teacher, can be able to identify their misconceptions and clear them accordingly.

PST-6 used various activities and strategies that facilitated learner engagement. Thus, suggesting his mastery in engaging students in effective learning. He further explained this in the interview as shown in the extract below.

We were given topics to present, then we were ought to present them in a way that will really engage learners that is if... we managed to bring teaching aids to class... **We were allowed to do so.** Then we had such a chance ...I **remember very well what I had... I was teaching** about uses of metals in chemistry topic...I **tried to bring real-life issues as examples.** [...]. So...**the fact that we bring reality to class, I observed that it allows learners to be engaged.** (bold =translations from Sesotho to English).

Thus, the PSTs believe that blended teaching provided them with sufficient knowledge and competence to master the TP practices. The PSTs, as illustrated in the above extracts, view their self-efficacy in planning and instructional activities during TP as a result of positive opportunities they had during blended learning.

Verbal persuasion. Verbal persuasion encompasses suggestions, feedback and any form of encouragement that is verbally or written aimed to enhance PSTs self-efficacy.

PSTs' responses revealed that the suggestions made by lecturers during blended teaching and learning influenced their teaching practice duties, as illustrated by the responses of two PSTs. PST-4 wrote,

Yes, it provided me with enough motivation to do my teaching practice by giving us feedback it always motivate me to do better next time, this goes again when going in class with my tutor then after gave me feedback, it also motivates a lot because I could see that I was getting there being a good teacher.

According to PST-4, comments made through feedback were motivating and thus persuaded her to be a good teacher. Similarly, PST-6 outlined,

Yes, blended teaching and learning prepared me to be motivated to do work during teaching practice. The complements that I got from the lecturer and my peers made me to always feel like I can conduct teaching and learning class with the learners...

The response by PST-6 highlights how the contribution made by comments from peers and the lecturer produced persuasion effects to enhance his self-efficacy. The PST took compliments as affirmations for his capabilities and developed confidence from the feedback. He expanded on this in the interview as illustrated in the response extract below.

...I remember having that chance. I received compliments. **I also had** complements **even when we were from our** Science education (SCE) courses. **When I presented, confidence was the first thing. So, it would happen that when we went out of class and talking with my peers, my peers would say.... well, Mr.LY** (Pseudo-name) your presentation was quite good, **and you did it!...**

The responses highlight the motivating power and persuasive nature that the feedback received during the presentations had on the PSTs' confidence. Thus, the feedback and comments from peers and lecturers served as modes of induction (e.g. suggestions and exhortation) under verbal persuasion.

Emotional arousal. Emotional arousal relates to physiological and affective states, including how an individual copes with stressful or anxiety-evoking situations. Classroom management is one

area which has been highlighted in research literature as challenging for pre-service teachers and has potential to evoke emotional reactions.

Some PSTs indicated that they were well prepared on classroom management issues. The PSTs' responses on this aspect focused on the ability to keep order in the classroom. For instance, PST-3 stated, "Yes, indeed I was well prepared to make use of variety of classroom management during blended teaching. During my teaching practice this was reflected when I encouraged students to help and build the classroom expectations..."

Similar assertions were raised by PST-14 who pointed out,

In the class some learners were very stubborn, but I managed to guide them on how a student has to behave and gave them class regulations for smooth teaching and learning. I sometimes had to keep them busy by giving them tasks and then mark them...

While the issue of keeping order in the classroom as one of the characteristics of classroom management can be psychologically draining for novices, the responses above suggest that some PSTs felt that their self-efficacy to handle classroom management through various activities was a result of training experiences.

However, other PSTs indicated that they were not well prepared to engage with classroom management, thus highlighting that they were not quite emotionally ready to engage with classroom management issues. This is evidenced by the statement from PST-4, who wrote,

Classroom management took me time to master in some classes maybe because I was not well prepared in the use of a variety of classroom management strategies during teaching and learning. But I used a lot of strategies that I thought could work, even ask my mentors what I could do...

The PST had to seek assistance from mentors to improve his/her confidence in classroom management. Therefore, PSTs who struggled with classroom management felt less self-efficacious as they were minimally prepared to keep students' order in the classroom.

Vicarious experiences. Vicarious experiences are indirect experiences as opposed to one's own experience. This is where PSTs learnt something through observing others perform tasks such as being part of audience in a peer teaching session.

The effects of this source of self-efficacy were observed in the PSTs' responses. For instance, PST-6 pointed out,

I was well prepared during blended teaching and learning to use a variety of teaching and learning strategies. The peer teaching sessions that we conducted before teaching practice helped me to learn different teaching strategies from my peers and as a result, I adopted those strategies in my actual teaching during teaching practice...

PST-6 explained the contribution of peer teaching experiences towards enhancing his teaching. This was also revealed in an interview with PST-8, who explained the influence of the micro-teaching aspect by stating,

I think I was well prepared... because I realised which strategies were best for teaching the students, how to manage the class and motivate them which I adapted in my teaching practice..., and we used various teaching strategies during blended teaching which helped me to learn how to apply them on my own...

The micro-teaching component of PSTs' training influenced PST-8's realisation and, hence consideration of the best strategies, which were then used to perform TP activities. As a result, PSTs felt a sense of enhanced self-efficacy to handle instructional activities during TP. Generally, it can be asserted that through *live modelling*, the PSTs developed some confidence through learning from their peers and the lecturers.

4.2.2. Effects of self-efficacy

The effects of self-efficacy refer to the areas which are directly influenced by the nature of self-efficacy level.

The effects of the development of PSTs self-efficacy were revealed mainly in their efforts, persistence, and emotional reactions when undertaking TP activities. The findings also reveal some limitations related to two effects: making choices and thinking and decision-making.

Efforts made. Efforts made include responses of PSTs to challenging situations which need a teacher to critically exercise professional knowledge such as how to promote a student-centered environment as opposed to teacher-dominated.

Most PSTs' responses reveal efforts made during TP, which suggests their self-efficacious beliefs. The efforts were evident in activities such as student *engagement*, *varying instructional strategies*, *Classroom management*, and the aspect of *motivation* illustrated in the excerpts that follow.

Under the *engagement of students*, PSTs engage students through several activities in classes, such as group activities, individual work, classroom talk strategy, and discussions. PST-3 outlined, "...This was achieved and was reflected during the classroom-talk teaching strategy conducted classes that learners were fully and meaningfully engaged. This made learners take the role of front lines and that reflected their engagement in their learning".

Varying instructional strategies were employed by PSTs to cater for learner diversity and to encourage the participation of all learners, as shown by PST-11 who narrated,

... In my classes I had open minded students and slow learning students, therefore I had to apply different methods to accommodate every learner and mostly use strategies that made them to effectively participate...Discussion and experiments methods made learners to fully take part in class...

Classroom management rules were formulated so that learners were aware of what was expected to ensure the smooth running of lessons. PST-3 shared one he adopted for classroom management by stating, "... I encouraged students to help and build the classroom expectations and indeed learners did abide by those rules because they were part of setting of them..."

Regarding motivation, PSTs were aware that students' feedback is important. As a result, made efforts to give students timely feedback and used motivational words that encouraged students to work hard. This is evidenced by PST-14 who asserted,

Mostly when I gave them an assignment to do, I often marked them at the right time and then give them the feedback so that they would make corrections where they got the answers wrong. Also, when I give them tests, I would write motivating words like good, keep it up, excellent for those who performed well and give motive words to those who did not do good.

The PSTs made efforts to implement the knowledge acquired during blended teaching into their practices during TP which reflect their self-efficacious beliefs.

Emotional reactions. The concept of emotional reactions encompasses PSTs affective responses to emotive experiences.

Some of the PSTs' responses portray some form of emotions resulting from what happened during their TP. For example, after indicating that the impact of feedback received from both the lecturer and peers provided him with confidence to carry over TP activities diligently, PST-6 further said,

...Learners were not happy when I told them I will be leaving their school on the 13th of May. They really wanted me to be their teacher forever. They liked the way we did things in class with them. They even asked me about other means that can be used for me to keep on helping them and I was motivated, and I ensured them that there is a way by creating a WhatsApp group with them.

Similarly, PST-4 showed some emotional reactions in her response. She indicates that the feedback received from lecturers motivated her to be a good teacher, which was reflected in her teaching during TP. Reflecting on her teaching during TP, she wrote,

...Learners answering questions in class or even trying to answer something or giving their thoughts on a new topic also motivated me. Lastly what made me even work hard was seeing them passing tests. So, it meant I wasn't talking alone when teaching.

The reactions from the PSTs resulting from students' engagement further contributed to the development of their self-esteem and beliefs in their ability to want to be effective teachers. This effect demonstrates the PSTs' level of self-efficacy.

Choice-approach. *The issue of choice approach involves incidences where PSTs had variable options such as to give up in challenging situations or to find alternative ways to address a challenge.*

While PST-12 argued that classroom management was not easy, a choice was made not to avoid the task but to approach it by continuing to implement strategies learned during blended teaching. The extract below shows how PST-12 reacted to classroom management issues.

Classroom management was not easy for me. But I had to invent various strategies such as setting classroom guidelines, expectations and rules as to deal with it. It worked sometimes but it was not always efficient. This was reflected on their results because sometimes they did not listen to my instructions as a result failed to complete some tasks or activities.

A similar reaction is observed in the PST-8 response who said, "My preparation in this category was not that sufficient but I had to learn along the way how to manage my classroom..."

The response shows that PST-8 had to find other ways of managing the classroom, thus indicating that he/she did not avoid the issue but made a choice to seek ways of addressing it. The interview data showed that PST-8 experienced 'reality shock' more than a manifestation of lack of preparation when some learners did not follow instructions as anticipated, especially in the beginning lessons.

Although both PSTs had challenges with classroom management, they chose resilience over avoidance of their role. Thus, showing that the high self-efficacy played a role in the choices made.

Thinking and decision-making. Thinking and decision making relates to how PSTs exercised critical thinking and professional judgment in responding to classroom situations.

Some of the PSTs' responses reflected some form of adaptive decision-making. In one of his responses, PST-3 wrote,

...this was the area where I was most prepared on, to make use of different teaching and learning methods. For example, this was reflected when learners could not recall the knowledge assumed as per plan and a different teaching strategy had to be used since the class could no longer go as per plan.

The response indicates that the PST made decisions to approach a learning difficulty using a different teaching approach based on assumed knowledge reflecting high self-efficacy. The extract points to the limited scope, assessment, and use of assumed knowledge as recall, which was the main drive of the lesson.

5. Discussion

This paper reports on a study that intended to establish how training through blended teaching and learning influenced the self-efficacy of physical science PSTs. It is essential to understand how teachers are trained and how the training affects their identities during teaching practice. The self-efficacious beliefs of PSTs can provide evidence to examine the responsiveness of teacher training programmes toward developing a holistic teacher who can function in the physical classroom environment and effectively teach the learners for understanding (Clark & Newberry, 2019). Therefore, understanding PSTs' self-efficacy is necessary to highlight their readiness to tackle new tasks persistently (Garza et al., 2016).

The findings in this study illustrate that most PSTs felt self-efficacious in engaging students, varying instructional strategies, managing their classrooms and motivating students during teaching practice. They attributed their reported self-efficacy beliefs to several issues linked to the opportunities provided during blended teaching mode, which provided them with knowledge and skills to undertake classroom activities efficiently. The findings of this study provide some evidence that the PSTs had high overall self-efficacy, noting the findings from Golubtchik (2024) and Menon and Sadler (2018), who found that the PSTs high self-efficacy has a positive relationship with the nature of their training experiences. PSTs indicated that online sessions

mostly provided them with necessary theoretical knowledge whereas face-to-face engagements provided them with practical knowledge, through multiple peer teaching, which helped to develop their confidence in their abilities to teach effectively. However, the findings of this study, from a blended setting provide a different dimension to the findings of other similar studies from contexts where only online learning was dominant and resulted in more challenges. For instance, Fokkens-Bruinsma et al. (2024) conducted a study on PSTs perseverance and sense of preparedness during the COVID 19 pandemic. Their study established that some PSTs felt less prepared due to challenges such as minimal support, lack of physical engagements, less structured learning experiences, isolation and unclear communications from their training institution. Their findings further highlight that some PSTs started to have doubts about their capacities and joining teaching as a career which consequently, evoke stress, anxiety and negative thoughts about teaching profession among PSTs. Under extreme cases some PSTs may even consider leaving the teaching profession due to low self-efficacy (Golubtchik, 2024).

The PSTs recognise multiple attempts and sessions that required planning, teaching and reflection during peer teaching sessions to have contributed to the development of their beliefs in their abilities (Jakopovic et al., 2023). The in-person encounters gave PSTs confidence, support, and immediate feedback from peers and instructors (Atmacasoy & Aksu, 2018) before teaching in authentic classroom environments (Jakopovic et al., 2023) as well as a chance to benefit from vicarious experiences. As a result, PSTs were able to develop self-efficacy through their own experiences. Most PSTs in this study highlighted important own experiences, as indicated above as a prominent source of their self-efficacy during peer teaching sessions. Consistent with this are the findings of Jakopovic et al. (2023), who revealed that the PSTs in their study cited mastery experience and verbal persuasion to have highly contributed to their self-efficacy. Moreover, the finding agrees with the earlier assertions by Bandura and Wessels (1997) that individuals develop a strong and resilient sense of efficacy through experience in overcoming obstacles through perseverant effort. Furthermore, PSTs' choice of a variety of instructional activities was an effect demonstrating developed self-efficacy (Martins et al., 2015).

The verbal persuasion by others, namely peers and lecturers, played a critical role in developing the PSTs' efficacious beliefs. The positive and critical suggestions made by their peers and lecturers assured them of their abilities to teach and would perform TP activities successfully (Atmacasoy & Aksu, 2018). This finding is consistent with the findings of Jakopovic et al. (2023), who reported social persuasion as one key source of self-efficacy beliefs. However, this source of self-efficacy is considered relatively weak and easy to threaten in the face of challenges and unsuccessful results (Bandura & Wessels, 1997) but effective if combined with mastery experience (Garza et al., 2016), as was the case in this study. As Morris et al. (2017) asserted, the effectiveness of verbal persuasion also depends on who delivers it and how a message is framed.

While other PSTs reported having been well equipped to perform classroom management roles during blended teaching, some PSTs said they were less confident and hence faced challenges in this role during TP, thus suggesting a low self-efficacy level in this area (Fokkens-Bruinsma et al., 2024). Flower et al. (2017) attributed lack of confidence in classroom management to training that fails to adequately equip PSTs with necessary knowledge and skills to engage in meaningful and productive classroom management practices. Similar to the findings of Yurekli et al. (2020), some of the PSTs highlighted that the peer teaching sessions did not adequately provide them with the real dynamics and challenges of a real classroom as the activities were artificial. The artificial nature of peer teaching, seems not to replicate the complex nature of real classroom situations and as such, PSTs could not gain the depth of experience required to prepare them adequately for classroom management. As a result, the development of classroom management skills was limited by the mode of experience. However, the PSTs in this study indicated that while they faced classroom management challenges, they found ways to deal with them, demonstrating resilience and persistence in confronting and solving challenges- displaying characteristics of a high self-efficacy level (Heng & Chu, 2023). The findings also show that students' behaviours and positive

outcomes towards the PSTs' instructional practices later enhanced PSTs' sense of efficacy (Morris et al., 2017) which also evoked PSTs motivation to undertake teaching activities with dedication.

Taken together, the findings of this study provide some essential insights with regard to PSTs' mode of training, their self-efficacy and how their self-efficacy influence their practice and affective feelings as illustrated in the adapted model in Fig. 1. The adapted model in Fig. 1 allowed for tracing the views about the experiences of the physical science PSTs and relating them to their perceived level of self-efficacy. In addition to the direct causal relationships in the adapted Lippke (2020) model, the findings demonstrated other relationships between the self-efficacy, its effects, and its sources. Therefore, this study argues that from the contribution strengths of sources of perceived self-efficacy, it is possible to have some idea of PSTs' overall self-efficacy. Again, the aggregated characteristics of the nature of choices, amount of effort and persistence, thinking and decision-making and emotional reactions of the PSTs provided useful information about the possible level of their self-efficacy.

6. Conclusion

The findings in this study provide some evidence that when properly implemented, blended teaching has the potential to enhance the PSTs' self-efficacy beliefs in their competence necessary to undertake the desired goal of becoming effective teachers. This was demonstrated by the PSTs' reports of the efforts and persistence in their performance of TP activities referring to their training. As argued by most PSTs, the virtual sessions, which mainly were theoretical, were complemented by the face-to-face sessions that maximised interactions and higher engagements with tasks. Overall, using a blended teaching mode in physical science pre-service training will be efficient if it develops the PSTs' competence in theory and practical knowledge, shaping their identities and maximising opportunities that enhance contribution of the sources of self-efficacy.

7. Limitations

Although the study offers valuable insights on PSTs sources of self-efficacy, modes of induction as illustrated in the adapted Lippke (2020) model were not analysed as separate components, which is a limitation to the study. Analysing modes of induction as a separate component would provide a balance between what happened and how it happened under each source of self-efficacy. But due to some limitations in the data collected, for some sources of self-efficacy, only generic information on modes of induction could be extracted from data without explicitly showing how the induction occurred. Furthermore, the findings of study are based on a sample of PSTs from one university which is not representative of a wider population of PSTs. Another issue acknowledged as a limitation is that, this study provides findings form a minimally planned blended learning experience which may not provide conclusive insights about blended learning and PSTs training. Therefore, the findings need to be interpreted and applied with caution to other contexts.

8. Recommendations

This study recommends that teacher training institutions incorporate opportunities that aim to provide opportunities for enhanced contribution of the sources to the perceived self-efficacy of PSTs including exposure to the dynamics of real-classroom teaching. More specifically, teacher training institutions can enhance training of PSTs when more time is spent on direct experiences like planning and actual teaching in addition to dealing with specialisation content and theoretical issues in education. Furthermore, teacher training institutions can take advantage of available online audio-visual resources like videos on sample lesson implementations in real classrooms so that PSTs can have an idea of how a classroom environment is like. Such online resources can help PSTs to extend their knowledge of real classroom as they highlighted that peer teaching is more artificial and lacks some realities of the actual classroom. Moreover, visits to schools can be organised so that PSTs have opportunities to experience the classroom environment before going for the main TP attachment. To ensure sustained relevance, resilience, and impact during disruptive emergencies and beyond, institutions of higher learning need to strategically harness

the affordances of information and communication technology, thereby broadening access to diverse learners. Future studies, involving several institutions in other contexts can be conducted under planned blended-learning to expand our understanding of how blended learning experience influences PSTs training.

Author Contributions: Every author contributed to the article's conception, design, data gathering, interpretation, writing, and critical revision. The article's final draft has been approved by all writers.

Data availability: Upon reasonable request, the corresponding author will provide the datasets created and/or analysed during the current work.

Declaration of interest: The authors declare no competing financial or personal interests in this paper.

Ethical declaration: Informed consent was sought from the participants, and their voluntary participation disclosed to them. The identity of participants is not revealed in any part of this manuscript.

Funding: No funding was obtained for this study.

References

- Altas, E. A., & Babacan, T. (2025). From training to transformation: The impact of online ICT training on Turkish EFL teachers' TPACK competences and innovative teaching practices. *Journal of Pedagogical Research*, 9(4), 173-201. <https://doi.org/10.33902/JPR.202535200>
- Atmacasoy, A., & Aksu, M. (2018). Blended learning at pre-service teacher education in Turkey: A systematic review. *Education and Information Technologies*, 23, 2399-2422. <https://doi.org/10.1007/s10639-018-9723-5>
- Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological Review*, 84(2), 191. <https://doi.org/10.1037/0033-295X.84.2.191>
- Bandura, A. (1988). Self-regulation of motivation and action through goal systems. In Hamilton V., Bower G. H., & Frijda N. H. (Eds.), *Cognitive perspectives on emotion and motivation* (pp. 37-61). Springer. https://doi.org/10.1007/978-94-009-2792-6_2
- Bandura, A. (2000). Self-efficacy: The foundation of agency. In W. J. Perrig & A. Grob (Eds.), *Control of human behavior, mental processes, and consciousness: Essays in honor of the 60th birthday of August Flammer* (pp. 17-33). Lawrence Erlbaum Associates Publishers.
- Bandura, A., & Wessels, S. (1997). *Self-efficacy*. Cambridge University Press.
- Clark, S., & Newberry, M. (2019). Are we building pre-service teacher self-efficacy? A large-scale study examining teacher education experiences. *Asia-Pacific Journal of Teacher Education*, 47(1), 32-47. <https://doi.org/10.1080/1359866X.2018.1497772>
- Colson, T., Sparks, K., Berridge, G., Frimming, R., & Willis, C. (2017). Pre-service teachers and self-efficacy: A study in contrast. *Discourse and Communication for Sustainable Education*, 8(2), 66-76. <https://doi.org/10.1515/dcse-2017-0016>
- Creswell, J. W. (2014). *Research design: qualitative, quantitative, and mixed methods approaches* (4th ed.). Sage.
- Emiru, E. K., & Gedifew, M. T. (2024). The effect of teacher self-efficacy on learning engagement of secondary school students. *Cogent Education*, 11(1), 1-21. <https://doi.org/10.1080/2331186X.2024.2308432>
- Erlingsson, C., & Brysiewicz, P. (2017). A hands-on guide to doing content analysis. *African Journal of Emergency Medicine*, 7(3), 93-99. <https://doi.org/10.1016/j.afjem.2017.08.001>
- Flower, A., McKenna, J. W., & Haring, C. D. (2017). Behavior and classroom management: Are teacher preparation programs really preparing our teachers? *Preventing School Failure: Alternative Education for Children and Youth*, 61(2), 163-169. <https://doi.org/10.1080/1045988X.2016.1231109>
- Fokkens-Bruinsma, M., Tigelaar, E. H., Van Rijswijk, M. M., & Jansen, E. P. W. A. (2024). Preservice teachers' resilience during times of COVID-19. *Teachers and Teaching*, 30(7-8), 1083-1096. <https://doi.org/10.1080/13540602.2023.2172391>
- Forman, J., & Damschroder, L. (2007). Qualitative content analysis. In L. Jacoby & L. A. Siminoff (Eds.), *Empirical methods for bioethics: A primer* (pp. 39-62). Emerald. [https://doi.org/10.1016/S1479-3709\(07\)11003-7](https://doi.org/10.1016/S1479-3709(07)11003-7)

- Garza, R., Werner, P., & Wendler, L. F. (2016). Transitioning from student to professional: pre-service teachers' perceptions. *New Waves-Educational Research and Development Journal*, 19(2), 19-35.
- Gasmi, A. A. (2022). Through the lens of students: how online discussion forums affect students' learning. *International Journal of Technology in Education*, 5(4), 669-684. <https://doi.org/10.46328/ijte.291>
- Gist, M. E., & Mitchell, T. R. (1992). Self-efficacy: A theoretical analysis of its determinants and malleability. *Academy of Management Review*, 17(2), 183-211. <https://doi.org/10.5465/amr.1992.4279530>
- Glackin, M., & Hohenstein, J. (2018). Teachers' self-efficacy: Progressing qualitative analysis. *International Journal of Research & Method in Education*, 41(3), 271-290. <https://doi.org/10.1080/1743727X.2017.1295940>
- Golubtchik, L. (2024). Increasing teacher retention by improving self-efficacy and classroom management skills in pre-service teachers. *Journal of Education and Learning*, 13(4), 1-17.
- Heng, Q., & Chu, L. (2023). Self-efficacy, reflection, and resilience as predictors of work engagement among English teachers. *Frontiers in Psychology*, 14, 1160681. <https://doi.org/10.3389/fpsyg.2023.1160681>
- Inel Ekici, D. (2018). Development of pre-service teachers' teaching self-efficacy beliefs through an online community of practice. *Asia Pacific Education Review*, 19, 27-40. <https://doi.org/10.1007/s12564-017-9511-8>
- Jakopovic, P., Karpf, A., Lemke, J., & McGlamery, S. (2023). The impact of microteach experiences on pre-service teachers' self-efficacy development. *Delta Kappa Gamma Bulletin*, 90(1), 28-41.
- Johnson, B., & Christensen, L. B. (2020). *Educational research: quantitative, qualitative, and mixed approaches* (7th ed.). Sage.
- Kılıç, A. (2022). The impact of reflective practices on pre-service science teachers' classroom teaching practices. *Journal of Pedagogical Research*, 6(1), 152-170. <https://doi.org/10.3390/JPR.2022175781>
- Lazarides, R., & Warner, L. M. (2020). *Teacher self-efficacy: Oxford research encyclopedia of education*. Oxford University Press. <https://doi.org/10.1093/acrefore/9780190264093.013.890>
- Lippke, S. (2020). Self-efficacy. In V. Zeigler-Hill, & T. K. Shackelford (Eds.), *Encyclopaedia of personality and individual differences* (pp. 4722-4727). Springer. https://doi.org/10.1007/978-3-319-24612-3_1165
- Ma, K., & Cavanagh, M. S. (2018). Classroom ready? Pre-service teachers' self-efficacy for their first professional experience placement. *Australian Journal of Teacher Education*, 43(7), 134-151. <https://doi.org/10.14221/ajte.2018v43n7.8>
- Makhechane, M., & Qhobela, M. (2019). Understanding how chemistry teachers transform stoichiometry concepts at secondary level in Lesotho. *South African Journal of Chemistry*, 72, 59-66. <https://doi.org/10.17159/0379-4350/2019/v72a9>
- Makumane, M. A. (2021). Students' perceptions on the use of LMS at a Lesotho university amidst the COVID-19 pandemic. *African Identities*, 21(2), 209-226. <https://doi.org/10.1080/14725843.2021.1898930>
- Martins, M., Costa, J., & Onofre, M. (2015). Practicum experiences as sources of pre-service teachers' self-efficacy. *European Journal of Teacher Education*, 38(2), 263-279. <https://doi.org/10.1080/02619768.2014.968705>
- Menon, D., & Sadler, T. D. (2018). Sources of science teaching self-efficacy for preservice elementary teachers in science content courses. *International Journal of Science and Mathematics Education*, 16(5), 835-855. <https://doi.org/10.1007/s10763-017-9813-7>
- Mohafa, L. G., Qhobela, M., & George, M. J. (2022). Evaluating the influence of interactive simulations on learners' academic performance in stoichiometry. *South African Journal of Chemistry*, 76, 01-08. <https://doi.org/10.17159/0379-4350/2022/v76a01>
- Mohafa, L., & George, M.J. (2023). Assessing pre-service science teachers' perceptions about online teaching and learning. *International Journal of Scholars in Education*, 6(1), 93-111. <https://doi.org/10.52134/ueader.1245351>
- Morris, D. B., Usher, E. L., & Chen, J. A. (2017). Reconceptualising the sources of teaching self-efficacy: A critical review of emerging literature. *Educational Psychology Review*, 29, 795-833. <https://doi.org/10.1007/s10648-016-9378-y>
- Ogunniyi, M. B., & Rollnick, M. (2015). Pre-service science teacher education in Africa: Prospects and challenges. *Journal of Science Teacher Education*, 26(1), 65-79. <https://doi.org/10.1007/s10972-014-9415-y>
- Pandee, M., Tepsuriwong, S., & Darasawang, P. (2020). The dynamic state of pre-service teachers' self-efficacy: A critical incident study in Thailand. *Issues in Educational Research*, 30(4), 1442-1462.
- Pfitzner-Eden, F. (2016). Why do I feel more confident? Bandura's sources predict pre-service teachers' latent changes in teacher self-efficacy. *Frontiers in Psychology*, 7, 1486. <https://doi.org/10.3389/fpsyg.2016.01486>
- Shu, H., & Gu, X. (2018). Determining the differences between online and face-to-face student-group interactions in a blended learning course. *The Internet and Higher Education*, 39, 13-21. <https://doi.org/10.1016/j.iheduc.2018.05.003>

-
- Velthuis, C., Fisser, P., & Pieters, J. (2014). Teacher training and pre-service primary teachers' self-efficacy for science teaching. *Journal of Science Teacher Education*, 25(4), 445-464. <https://doi.org/10.1007/s10972-013-9363-y>
- Yılmaz, Ö., & Malone, K. L. (2020). Pre-service teachers perceptions about the use of blended learning in a science education methods course. *Smart Learning Environments*, 7(1), 1-21. <https://doi.org/10.1186/s40561-020-00126-7>
- Yurekli, B., Işıksal-Bostanb M. & Çakıroğlu, E. (2020) Sources of pre-service teachers' self-efficacy in the context of a mathematics teaching methods course. *Journal of Education for Teaching*, 46(5), 631-645. <https://doi.org/10.1080/02607476.2020.1777068>
- Zee, M., & Koomen, H. M. (2016). Teacher self-efficacy and its effects on classroom processes, student academic adjustment, and teacher well-being: A synthesis of 40 years of research. *Review of Educational Research*, 86(4), 981-1015. <https://doi.org/10.3102/0034654315626801>