




Review Article

Enhancing problem-solving skills among pre-service teachers in higher education: A systematic literature review

Oluwatoyin A. Ajani

Languages and Social Sciences Education, University of Zululand, South Africa

Correspondence should be addressed to Oluwatoyin A. Ajani  oaajani@gmail.com

Received 21 December 2023; Revised 16 March 2024; Accepted 6 April 2024

This systematic literature review explores strategies to enhance problem-solving skills among pre-service teachers in higher education. Problem-solving is a critical competency for effective teaching, yet pre-service teachers often need more skills to address the complexities of classroom situations. This review aims to identify effective interventions, pedagogical approaches, and technological tools used to foster problem-solving abilities in pre-service teacher education programs by synthesising empirical research. The review also examines the impact of these strategies on pre-service teachers' skill development and readiness for classroom practice. Findings from the review highlight promising practices, gaps in the literature, and future research directions in this area. Ultimately, this review provides valuable insights to inform the design of evidence-based interventions and curriculum enhancements to better prepare pre-service teachers for the challenges they will face in their teaching careers.

Keywords: Problem-solving skills, pre-service teachers, higher education, systematic literature review, teacher education

1. Introduction

Problem-solving skills are widely recognised as essential for effective teaching in contemporary educational settings (Barab & Plucker, 2018; Cruickshank & Haefele, 2001; Kuo, 2019; Shulman, 1987). As teachers navigate the complexities of diverse classrooms and dynamic learning environments, they encounter many challenges that require thoughtful analysis, creative thinking, and adaptive decision-making (Beetham & Sharpe, 2019; Levy & Murnane, 2004; Zeichner & Liston, 2014). Whether it is addressing student misconceptions, adapting instructional strategies to meet diverse learning needs, or managing classroom disruptions, the ability to solve problems effectively lies at the heart of teaching practice (Henson, 2003; Saka et al., 2024; Van Zoest et al., 2017). Thus, cultivating problem-solving skills is critical for enhancing teaching effectiveness and promoting student learning and academic achievement (Ajani & Khoalenyane, 2023; Hattie, 2009; Jonassen, 2011; Schoenfeld, 1992).

In the context of pre-service teacher education, the development of problem-solving skills takes on added significance (Ajani, 2023; Darling-Hammond, 2006; Hammerness et al., 2005; Kennedy, 1997). Pre-service teachers, as aspiring educators, must be equipped with the knowledge, skills, and dispositions necessary to address the diverse and complex challenges they will encounter in their future classrooms (Grossman et al., 2009; Mncube et al., 2021; Wilson et al., 2001). However, research suggests that many pre-service teachers enter the profession with limited problem-solving abilities, leaving them ill-prepared to effectively manage the demands of teaching practice (Boettcher & Conrad, 2016; Lunenberg et al., 2007; Lundeberg et al., 1999; Nietfeld et al., 2006). This gap between the expectations of the teaching profession and the preparedness of pre-service teachers underscores the urgent need to address problem-solving skills within pre-service teacher education programs (Borko, 2004; Grossman et al., 2001; Hmelo-Silver, 2019; Zeichner, 2012).

Recognising the critical importance of enhancing problem-solving skills among pre-service teachers, this systematic literature review explores existing research on strategies to develop and foster these skills in higher education contexts. By systematically synthesising empirical studies, theoretical frameworks, and pedagogical approaches, this review aims to provide a comprehensive overview of current practices and insights into effective interventions for promoting problem-solving skills among pre-service teachers (Cochran-Smith & Zeichner, 2005; Darling-Hammond & Bransford, 2005; Jonassen & Land, 2012; Shulman, 1987). Specifically, the review will examine the types of interventions employed, the methods used to assess problem-solving skills, and the outcomes associated with these interventions. Additionally, the review will explore the contextual factors that influence the effectiveness of interventions and identify areas for future research and practice (Grossman & McDonald, 2008; Loughran, 2010; Zeichner & Conklin, 2005).

The scope of this review encompassed studies conducted within the field of teacher education, focusing on pre-service teachers enrolled in higher education institutions worldwide. Both qualitative and quantitative studies were explored, with a particular emphasis on empirical research that examines the impact of interventions on pre-service teachers' problem-solving skills (Grossman, 2011; Lai & Hwang, 2019; Oladele et al., 2024; Wilson et al., 2011; Zeichner & Schulte, 2001). By systematically analysing and synthesising the existing literature, this review aims to contribute to our understanding of effective strategies for enhancing problem-solving skills among pre-service teachers and inform the design of evidence-based interventions and curriculum enhancements in pre-service teacher education programs (Darling-Hammond, 2017; Grossman et al., 2009; Ni She et al., 2019; Zeichner, 2010).

2. Literature Review

The literature on problem-solving skills in the context of pre-service teacher education is extensive, reflecting the widespread recognition of the importance of these skills for effective teaching practice (Cruickshank & Haefele, 2001; Fouche, 2024; Jonassen, 2011; Shulman, 1987). Studies have consistently emphasised the multifaceted nature of problem-solving in teaching, highlighting its role in addressing diverse classroom challenges, promoting student learning, and fostering teacher efficacy (Henson, 2003; Levy & Murnane, 2004; Sun & Rueda, 2019; Zeichner & Liston, 2014). Within this body of literature, various frameworks and models have been proposed to conceptualise problem-solving skills in teaching, including the reflective practitioner model (Schön, 1983), the pedagogical content knowledge framework (Shulman, 1987), and the adaptive expertise model (Hatano & Inagaki, 1986; Liu et al., 2024). These frameworks provide valuable insights into the cognitive processes involved in problem-solving and offer a theoretical foundation for understanding how these skills can be developed and assessed in pre-service teacher education programs (Grossman & McDonald, 2008; Weimer, 2018; Wilson et al., 2001).

Despite the recognition of the importance of problem-solving skills in teaching, research suggests that many pre-service teachers enter the profession with limited proficiency in this area (Darling-Hammond, 2006; Koehler & Mishra, 2020; Lundeberg et al., 1999; Nietfeld et al., 2006). Studies have identified various factors that contribute to pre-service teachers' difficulties in problem-solving, including limited content knowledge, lack of pedagogical expertise, and insufficient opportunities for authentic practice (Borko, 2004; Grossman et al., 2001; Gumbi et al., 2024; Lunenberg et al., 2007). Additionally, research has highlighted the need for pre-service teacher education programs to provide explicit instruction and support for the development of problem-solving skills rather than assuming that these skills will be acquired incidentally through classroom experiences (Fouche, 2024; Grossman et al., 2009; Kennedy, 1997; Zeichner, 2012).

In response to these challenges, a growing body of research has focused on identifying effective strategies for promoting problem-solving skills among pre-service teachers in higher education settings (Cochran-Smith & Zeichner, 2005; Darling-Hammond & Bransford, 2005; Shulman, 1987; Sun & Rueda, 2019). Interventions range from coursework and professional development activities to field experiences and mentoring programs, with varying degrees of success reported across studies (Grossman & McDonald, 2008; Loughran, 2010; Weimer, 2018; Zeichner & Conklin, 2005).

For example, some studies have found that explicit instruction in problem-solving strategies can improve pre-service teachers' ability to analyse classroom situations and develop practical solutions (Grossman et al., 2009; Wilson et al., 2011; Zeichner & Schulte, 2001). Other research has emphasised the importance of providing opportunities for pre-service teachers to engage in authentic, real-world problem-solving tasks within the context of their teacher education programs (Ajani, 2023; Darling-Hammond, 2017; Grossman, 2011; Zeichner, 2010).

However, despite the growing interest in this area, there remains a need for a comprehensive synthesis of the existing literature to identify key trends, gaps, and areas for future research (Govender et al., 2023; Grossman et al., 2001; Hammerness et al., 2005; Zeichner, 2012). While individual studies have provided valuable insights into specific interventions and approaches, a systematic literature review can offer a broader perspective on the effectiveness of strategies for promoting problem-solving skills among pre-service teachers. By synthesising empirical research, theoretical frameworks, and pedagogical approaches, this review aims to inform the design of evidence-based interventions and curriculum enhancements in pre-service teacher education programs (Darling-Hammond, 2006; Grossman et al., 2009; Wilson et al., 2001). Moreover, by identifying areas for future research and practice, this review can contribute to ongoing efforts to improve the preparation of pre-service teachers for the complex and demanding realities of teaching practice (Grossman & McDonald, 2008; Shulman, 1987; Zeichner & Liston, 2014).

2.1. Role and Challenges of Problem-Solving Skills Among Pre-Service Teachers in Higher Education Top of Form

Problem-solving skills are crucial for pre-service teachers in higher education as they are essential competencies for effective teaching and classroom management. These skills enable teachers to identify, analyse, and resolve various challenges encountered in educational settings. As highlighted by Jonassen (1997), instructional design models that promote problem-solving learning outcomes are instrumental in preparing pre-service teachers for the complexities of the classroom environment. Moreover, Hmelo-Silver (2004) emphasises that problem-based learning approaches facilitate the development of problem-solving skills by engaging learners in authentic, real-world scenarios where they must apply their knowledge to solve complex problems. Therefore, pre-service teacher education programs must incorporate strategies that foster the acquisition and refinement of problem-solving abilities. However, pre-service teachers often encounter challenges developing proficient problem-solving skills during their higher education journey. One significant challenge is the limited exposure to authentic problem-solving experiences within traditional teacher education programs. Research by Dunlap and Lowenthal (2010) suggests that more than theoretical knowledge and standardised assessments may be necessary for pre-service teachers to engage in meaningful problem-solving activities. Additionally, Vygotsky (1978) argues that the absence of collaborative learning environments and supportive scaffolding mechanisms can hinder the development of higher-order thinking skills, including problem-solving, among pre-service teachers.

Furthermore, the rapidly evolving landscape of education, coupled with technology integration, presents opportunities and challenges for pre-service teachers in developing problem-solving skills. While technology offers innovative tools and resources to support problem-solving activities, pre-service teachers may face difficulties navigating and effectively utilising these tools without adequate training and guidance (Hmelo-Silver, 2004). Moreover, the reliance on technology-mediated instruction may inadvertently diminish opportunities for face-to-face collaboration and interpersonal problem-solving interactions, essential for holistic skill development (Dunlap & Lowenthal, 2010). Thus, adopting a multifaceted approach to address the challenges associated with developing problem-solving skills among pre-service teachers in higher education is imperative. Firstly, teacher education programs should integrate authentic, real-world problem-solving experiences into their curriculum, allowing pre-service teachers to apply theoretical knowledge in practical contexts (Jonassen, 1997).

Additionally, creating collaborative learning environments that encourage peer interaction, reflection, and collective problem-solving can enhance the development of critical thinking and collaboration skills (Vygotsky, 1978). Moreover, leveraging technology as a tool for problem-solving instruction requires comprehensive training and ongoing support to ensure its effective integration into pedagogical practices (Dunlap & Lowenthal, 2010; Hmelo-Silver, 2004). By addressing these challenges and implementing proactive strategies, teacher education programs can better prepare pre-service teachers to navigate the complexities of modern educational settings through proficient problem-solving skills.

3. Theoretical Framework

Social cognitive theory, proposed by Albert Bandura, provides a comprehensive framework for understanding problem-solving in education (Bandura, 1986). Social cognitive theory emphasises the dynamic interplay between cognitive processes, environmental influences, and individual behaviour (Bandura, 1997). Within pre-service teacher education, this theory offers valuable insights into the cognitive processes involved in problem-solving, the role of social influences in shaping problem-solving behaviours, and the importance of self-efficacy beliefs in motivating and sustaining problem-solving efforts (Bandura, 2001; Zimmerman, 2000). By adopting social cognitive theory as the theoretical framework for the study, we aim to explore how pre-service teachers' problem-solving skills are influenced by their cognitive processes, social interactions, and self-perceptions and how these factors can be leveraged to enhance problem-solving instruction and support in higher education settings.

The selection of social cognitive theory as the theoretical framework for the study is justified by its relevance and applicability to the study's focus on problem-solving in pre-service teacher education. Social cognitive theory offers a holistic perspective that accounts for the cognitive, social, and motivational factors that shape individuals' problem-solving behaviours (Bandura, 1989). By examining problem-solving through the lens of social cognitive theory, we can explore the cognitive processes involved in generating and evaluating solutions and the environmental influences that support or hinder effective problem-solving (Bandura, 1999). Moreover, social cognitive theory highlights the importance of self-efficacy beliefs in influencing individuals' motivation, persistence, and performance in problem-solving tasks (Bandura, 2012). Given the complex and multifaceted nature of problem-solving in teaching, social cognitive theory provides a robust framework for analysing the interplay of cognitive, social, and motivational factors in pre-service teachers' development of problem-solving skills.

Furthermore, social cognitive theory offers practical implications for promoting problem-solving skills in pre-service teacher education. According to social cognitive theory, individuals learn through direct experience and observation, modelling, and social interaction (Bandura, 1986). Thus, by creating opportunities for pre-service teachers to observe and interact with skilled problem-solvers, such as expert teachers or peers, teacher educators can facilitate the acquisition and refinement of problem-solving skills (Brown & Campione, 1994; Lave & Wenger, 1991). Additionally, social cognitive theory emphasises the importance of providing feedback and scaffolding to support learners' problem-solving efforts (Vygotsky, 1978; Wood et al., 1976). By incorporating these principles into problem-solving instruction, teacher educators can help pre-service teachers develop the metacognitive awareness and strategic competence needed to effectively navigate the challenges of teaching practice (Flavell, 1979; Schraw & Moshman, 1995).

Moreover, social cognitive theory offers insights into the role of self-regulation in problem-solving (Bandura, 1991). According to social cognitive theory, individuals use self-regulatory processes, such as goal-setting, planning, monitoring, and reflection, to guide their problem-solving efforts (Zimmerman & Schunk, 2011). By fostering self-regulatory skills in pre-service teachers, teacher educators can empower them to take ownership of their learning and development as problem-solvers (Boekaerts & Corno, 2005; Pintrich, 2000). Additionally, social cognitive theory emphasises the importance of providing opportunities for pre-service teachers to experience success and build confidence in their problem-solving abilities (Bandura, 1997). By

designing tasks and activities that are challenging yet attainable, teacher educators can help pre-service teachers develop a sense of efficacy and competence in solving real-world teaching problems (Hattie, 2012; Tschannen-Moran & Woolfolk Hoy, 2001).

Bandura (1997) asserts that social cognitive theory offers a comprehensive and robust framework for understanding problem-solving, which can be applied in pre-service teacher education. By examining problem-solving through the lens of social cognitive theory, we can gain insights into the cognitive, social, and motivational factors that influence pre-service teachers' development of problem-solving skills. Moreover, social cognitive theory provides practical implications for promoting problem-solving skills in pre-service teacher education, including the importance of observation, modelling, feedback, scaffolding, self-regulation, and efficacy-building experiences. By leveraging the principles of social cognitive theory, teacher educators can enhance the effectiveness of problem-solving instruction and support in preparing pre-service teachers for the complex challenges of teaching practice.

4. Methodology

The methodology employed for this systematic literature review [SLR] adheres to rigorous standards to ensure the comprehensiveness and reliability of the findings. Following established guidelines (e.g., PRISMA), a systematic search strategy was devised to identify relevant studies on problem-solving skills among pre-service teachers in higher education (Page et al., 2021). The search strategy encompassed electronic databases such as ERIC, PsycINFO, Education Source, and Google Scholar, using keywords including "problem-solving," "pre-service teachers," "higher education," and related terms. Boolean operators and truncation were utilised to broaden the search scope while maintaining relevance (Higgins & Green, 2011; Moher et al., 2009). The search for the relevant literature sources resulted in a total of 122 sources, which were initially accessed and screened further to focus on the objectives of this study. Thus, 54 publications were finally used for the systematic literature review for this study, following the PRISMA 2020 flow. According to Page et al. (2021), the use of PRISMA flow (see Figure 1) allows researchers to search for many related sources on a phenomenon, and screen further to an appropriate and reduce the number of sources that appropriately focus on the study's objectives' parameters.

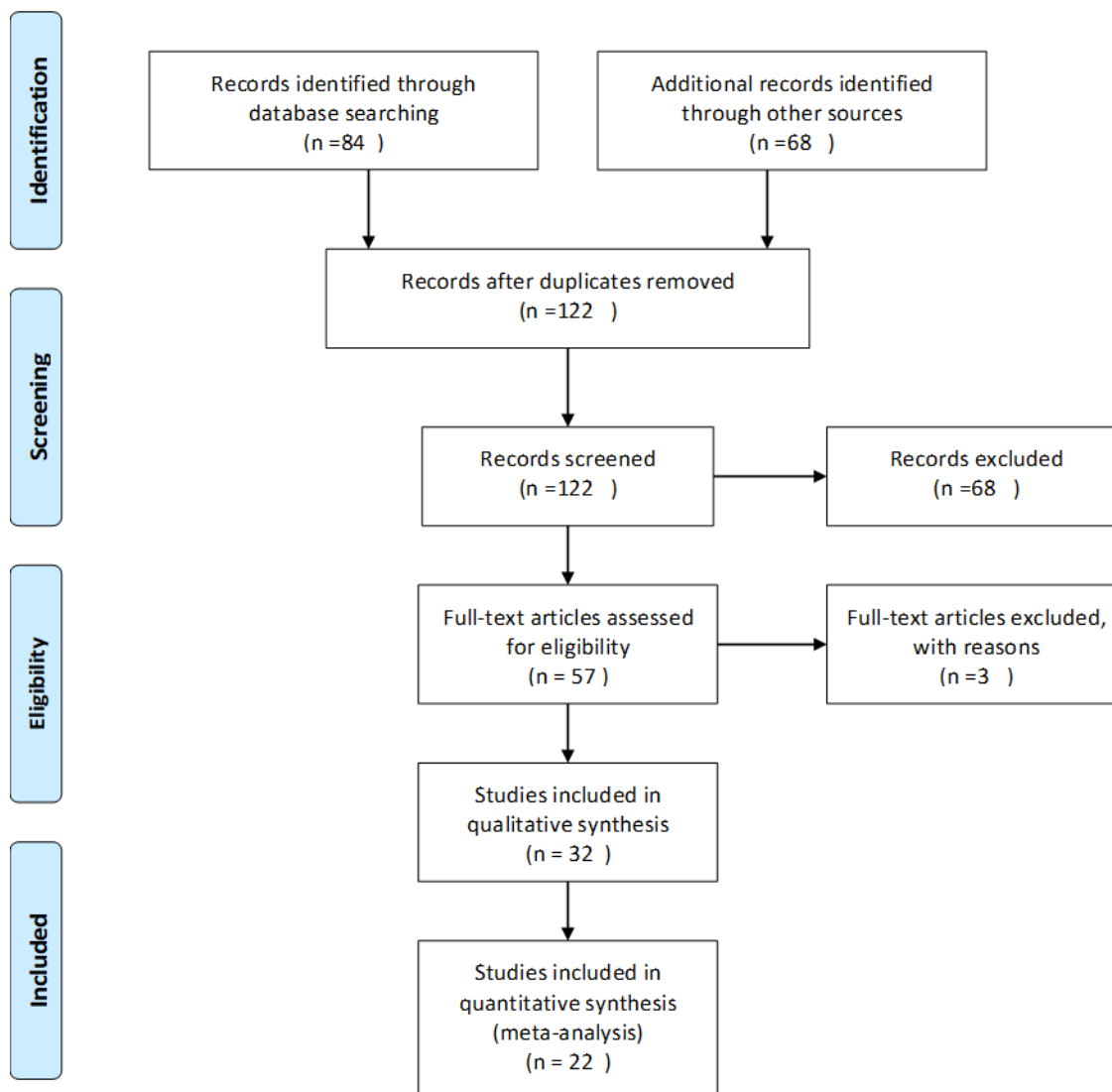
To ensure the inclusion of high-quality studies, specific selection criteria were applied. Only peer-reviewed articles published in English within the last decade were considered eligible for inclusion. Studies on problem-solving skills development, interventions, assessments, and outcomes among pre-service teachers in higher education contexts were included. At the same time, those outside the scope or lacking empirical evidence were excluded. Moreover, studies employing diverse methodologies, including quantitative, qualitative, and mixed-methods approaches, were considered to provide a comprehensive understanding of the topic (Hart, 2018). The data extraction and analysis procedures followed a systematic approach to synthesise the findings across selected studies. Relevant data were extracted using a standardised form, including study characteristics, problem-solving frameworks, instructional strategies, assessment methods, and outcomes. Thematic analysis was employed to identify recurring themes, patterns, and discrepancies across the literature (Braun & Clarke, 2006). Additionally, the quality of included studies was assessed using established appraisal tools, such as the Critical Appraisal Skills Programme [CASP] checklist for qualitative studies and the Joanna Briggs Institute [JBI] Critical Appraisal Checklist for Systematic Reviews and Research Syntheses for quantitative studies (Joanna Briggs Institute, 2017; CASP, 2018).

Furthermore, to enhance the rigour and trustworthiness of the review process, multiple reviewers independently screened the search results, assessed study eligibility, and conducted data extraction and analysis. Any discrepancies or disagreements were resolved through discussion and consensus among the reviewers. Additionally, a comprehensive reference list of included studies was compiled to facilitate transparency and reproducibility of the review process. Overall, this study's systematic literature review methodology ensures a robust and comprehensive synthesis of the existing evidence on problem-solving skills among pre-service

teachers in higher education. By adhering to rigorous search, selection, and analysis procedures, this review aims to provide valuable insights into the current state of research, identify gaps and limitations, and offer recommendations for future research and practice in pre-service teacher education.

Figure 1

PRISMA Flow Diagram



5. Results

This section presents the findings of the systematic literature review on strategies to enhance problem-solving skills among pre-service teachers. The synthesis of empirical research findings reveals several key themes and effective interventions, pedagogical approaches, and technological tools identified in the literature.

5.1. Theme 1: Problem-Based Learning [PBL] Pedagogy

Numerous studies highlighted the effectiveness of problem-based learning [PBL] in enhancing pre-service teachers' problem-solving skills (Hmelo-Silver, 2004; Jonassen, 1997). PBL engages students in authentic, real-world problems, promoting critical thinking, collaboration, and decision-making (Gu et al., 2020). Through active engagement with complex problems, pre-service teachers develop a more profound understanding and application of problem-solving strategies. Problem-Based Learning [PBL] Pedagogy has garnered significant attention in the literature as a

practical approach to enhancing problem-solving skills among pre-service teachers. PBL engages students in authentic, real-world problems, allowing them to apply their knowledge and skills to solve complex issues (Barrows & Tamblyn, 1980). Research by Hmelo-Silver (2004) emphasises that PBL promotes active learning, critical thinking, and problem-solving by immersing students in inquiry-based tasks. Furthermore, Jonassen (1997) argues that PBL encourages self-directed learning and fosters a deeper understanding of the subject matter as students grapple with open-ended problems and seek solutions through inquiry.

Numerous studies have documented the positive impact of PBL on pre-service teachers' problem-solving skills (Savery & Duffy, 1996). By engaging in authentic problem-solving experiences, pre-service teachers develop a repertoire of problem-solving strategies and tactics (Jonassen, 2000). The collaborative nature of PBL encourages students to share ideas, perspectives, and solutions, leading to richer problem-solving processes (Dochy et al., 2003). Additionally, PBL promotes metacognitive awareness as students reflect on their problem-solving approaches, monitor their progress, and adjust their strategies accordingly (Schmidt et al., 2011). This metacognitive dimension is essential for developing adaptive problem-solving skills that transfer across contexts (Bransford et al., 2000).

Furthermore, integrating PBL into pre-service teacher education programs has enhanced graduates' readiness for real-world teaching challenges (Gu et al., 2020). Through authentic problem-solving experiences, pre-service teachers develop the skills and confidence to address diverse instructional dilemmas, manage classroom dynamics, and support student learning effectively (Walker et al., 2003). By immersing pre-service teachers in PBL scenarios that mirror authentic teaching contexts, educators can bridge the gap between theory and practice, preparing future teachers for the complexities of the classroom (Albanese & Mitchell, 1993). Thus, the adoption of PBL pedagogy holds significant promise for cultivating the problem-solving abilities of pre-service teachers and equipping them with the competencies needed for successful teaching careers.

5.2. Theme 2: Collaborative Learning Environments

Research suggests that collaborative learning environments foster the development of problem-solving skills among pre-service teachers (Akerson & Hanuscin, 2007). Collaborative activities, such as group discussions, peer feedback, and cooperative problem-solving tasks, provide opportunities for pre-service teachers to exchange ideas, share perspectives, and construct knowledge collectively (Roth, 1995). Collaborative learning promotes social interaction, communication skills, and the exploration of diverse problem-solving approaches. Collaborative Learning Environments have emerged as a powerful strategy for enhancing problem-solving skills among pre-service teachers. Collaborative learning emphasises peer interaction, cooperation, and shared knowledge construction (Johnson & Johnson, 2009). By working collaboratively on problem-solving tasks, pre-service teachers engage in discourse, negotiation, and reflection, which promote deeper understanding and more effective problem-solving strategies (Dillenbourg, 1999). Research by Slavin (2014) suggests that collaborative learning environments foster a sense of collective responsibility and accountability, motivating students to participate and actively contribute to group problem-solving efforts. Numerous studies have demonstrated the benefits of collaborative learning environments for pre-service teacher education (Vygotsky, 1978). Through collaborative problem-solving activities, pre-service teachers develop interpersonal skills, communication abilities, and teamwork competencies (Webb, 2009). Collaborative learning environments provide opportunities for peer feedback, constructive criticism, and shared perspectives, which enrich the problem-solving process (Johnson et al., 2014). Moreover, collaborative learning experiences cultivate a supportive community of learners where individuals feel valued, respected, and empowered to take intellectual risks (Aronson et al., 2002). This sense of belonging and connectedness enhances motivation and engagement, leading to more robust problem-solving outcomes (Slavin, 1996).

Furthermore, integrating technology-mediated collaborative learning environments has expanded opportunities for pre-service teacher development (Roschelle et al., 2010). Online platforms, virtual classrooms, and social networking tools facilitate asynchronous collaboration, enabling pre-service teachers to engage in problem-solving activities beyond traditional classroom boundaries (Harasim, 2012). Research by Garrison and Anderson (2003) highlights the potential of computer-supported collaborative learning environments to foster meaningful interactions, knowledge sharing, and collective problem-solving among distributed learners. By harnessing the affordances of technology, educators can create dynamic learning communities where pre-service teachers collaborate, communicate, and co-construct knowledge, enhancing their problem-solving abilities in diverse contexts.

5.3. Theme 3: Integration of Technology

Integrating technology, such as simulations, virtual environments, and educational software, emerged as a promising approach to enhancing problem-solving skills among pre-service teachers (De Jong & Van Joolingen, 1998). Technology-rich learning environments offer interactive and immersive experiences that simulate real-world problem-solving contexts (Koehler & Mishra, 2008). Pre-service teachers can experiment with different solutions, receive immediate feedback, and refine their problem-solving strategies using technological tools. Integration of Technology has become increasingly prevalent in enhancing problem-solving skills among pre-service teachers. Technology offers versatile tools and resources to support problem-solving activities in various educational contexts (Mishra & Koehler, 2006). Digital platforms, multimedia resources, and interactive simulations provide immersive learning experiences, allowing pre-service teachers to explore complex problems dynamically (Jonassen, 2000). Hsu et al. (2019) suggest that technology-enhanced problem-solving environments promote active experimentation, hypothesis testing, and reflection, facilitating learners' deeper conceptual understanding and metacognitive development.

Educational technologies, such as educational games and simulations, offer interactive environments where pre-service teachers can apply problem-solving strategies in authentic contexts (Plass et al., 2014). Gamification elements, such as points, badges, and leaderboards, motivate engagement and persistence, fostering a playful yet productive approach to problem-solving (Gee, 2003). Studies have shown that gamified learning environments can enhance pre-service teachers' motivation, self-efficacy, and problem-solving skills (Deterding et al., 2011). Additionally, virtual reality [VR] and augmented reality [AR] technologies provide immersive simulations that enable pre-service teachers to experience realistic teaching scenarios and practice problem-solving in simulated classroom environments (Beck et al., 2019). Educators can create innovative learning opportunities by integrating technology into teacher education programs that empower pre-service teachers to develop adaptive problem-solving skills for 21st-century classrooms. Furthermore, using digital collaboration tools and online platforms facilitates asynchronous communication, knowledge sharing, and collaborative problem-solving among pre-service teachers (Means et al., 2009). Virtual communities, social networking sites, and online forums provide spaces for pre-service teachers to connect, collaborate, and co-create knowledge (Dabbagh & Kitsantas, 2012). Through online discussions, peer feedback, and collaborative projects, pre-service teachers can engage in meaningful problem-solving activities, drawing on diverse perspectives and experiences (Harasim, 2017). The affordances of technology-mediated collaboration extend beyond geographical boundaries, enabling pre-service teachers to interact with peers, mentors, and experts worldwide, enriching their problem-solving processes with global perspectives and innovative ideas (Kimmons & Veletsianos, 2018).

5.4. Theme 4: Reflective Practices

Engaging pre-service teachers in reflective practices, including self-assessment, journaling, and critical reflection, is essential for developing metacognitive awareness and problem-solving competence (Vygotsky, 1978). Reflective practices encourage pre-service teachers to analyse their

problem-solving processes, identify strengths and weaknesses, and set goals for improvement (Darling-Hammond, 2006). By reflecting on their experiences, pre-service teachers deepen their understanding of effective problem-solving strategies and enhance their professional growth. Reflective Practices play a crucial role in enhancing problem-solving skills among pre-service teachers by fostering metacognition, self-awareness, and critical thinking (Schön, 1983). Reflective practices encourage pre-service teachers to engage in systematic self-assessment, analysis of teaching experiences, and identifying strengths and areas for improvement (Zeichner & Liston, 2014). Research suggests that reflective practices, such as journal writing, portfolio development, and peer feedback, promote deep learning and professional growth among pre-service teachers (Larrivee, 2000). By reflecting on their problem-solving processes, pre-service teachers can better understand instructional challenges, strategies, and student learning needs, leading to more effective teaching practices (Brookfield, 1995).

Moreover, the integration of structured reflection activities into teacher education programs provides opportunities for pre-service teachers to make connections between theory and practice, bridging the gap between coursework and field experiences (Schön, 1987). Reflective practices prompt pre-service teachers to evaluate their problem-solving approaches critically, consider alternative strategies, and adapt their instructional practices based on evidence and feedback (Hatton & Smith, 1995). Through guided reflection activities, pre-service teachers can develop problem-solving strategies, refine their decision-making skills, and cultivate a reflective stance toward their professional practice (Moon, 2004). By nurturing a habit of reflection, pre-service teachers can become lifelong learners who continuously strive for improvement and innovation in their teaching (Rodgers, 2002).

Furthermore, digital tools and online platforms can support reflective practices by providing pre-service teachers with opportunities to document their teaching experiences, capture moments of inquiry, and engage in collaborative reflection with peers and mentors (Santagata & Angelici, 2010). Online reflection spaces, such as blogs, discussion forums, and video journals, enable pre-service teachers to reflect on their problem-solving processes, share insights, and receive constructive feedback from a supportive community of practice (Bass et al., 2019). Digital portfolios and multimedia artefacts allow pre-service teachers to showcase their problem-solving skills, instructional innovations, and reflective insights, facilitating self-assessment and professional development (Barrett, 2005). Through digital reflection practices, pre-service teachers can cultivate a reflective mindset, embrace challenges as opportunities for growth, and become reflective practitioners who continuously strive for excellence in teaching and learning (Schoenfeld, 2010).

The synthesis of empirical research findings highlights the effectiveness of various interventions, pedagogical approaches, and technological tools in enhancing problem-solving skills among pre-service teachers. Problem-based learning pedagogy, collaborative learning environments, integration of technology, and reflective practices emerged as key themes in the literature. By incorporating these strategies into pre-service teacher education programs, educators can effectively prepare future teachers to navigate complex challenges and promote student learning and achievement.

6. Discussion

The findings of this study underscore the importance of integrating problem-solving skills into pre-service teacher education programs in South Africa. Through a systematic literature review, it becomes evident that effective interventions, pedagogical approaches, and technological tools play a crucial role in enhancing problem-solving abilities among pre-service teachers (Barab & Plucker, 2018; Mncube et al., 2021; Saka et al., 2024). The study reveals that problem-based learning [PBL] pedagogy provides a promising framework for developing problem-solving skills by engaging pre-service teachers in authentic, inquiry-based learning experiences (Savery, 2006; Sun & Rueda, 2019). By immersing pre-service teachers in real-world problems and encouraging collaborative inquiry, PBL promotes critical thinking, creativity, and problem-solving competence, aligning with

the principles of social cognitive theory (Barrows, 1986). This finding highlights the significance of adopting theoretical frameworks, such as social cognitive theory, to inform the design and implementation of problem-solving interventions in teacher education.

Furthermore, the study's findings emphasise the value of collaborative learning environments in fostering problem-solving skills among pre-service teachers. Research suggests collaborative learning promotes social interaction, shared knowledge construction, and collective problem-solving processes (Hmelo-Silver, 2019; Johnson & Johnson, 1999; Lai & Hwang, 2019; Koehler & Mishra, 2020). By working collaboratively with peers, pre-service teachers can gain diverse perspectives, exchange ideas, and co-construct solutions to complex problems, enhancing their problem-solving efficacy (Govender et al., 2023; Slavin, 2014). This collaborative learning approach aligns with the principles of social cognitive theory, which emphasises the role of social modelling, peer interaction, and observational learning in cognitive development (Bandura, 1986). Thus, the findings underscore the importance of creating supportive learning communities that facilitate collaborative problem-solving experiences for pre-service teachers, aligning with the theoretical principles of social cognitive theory.

Moreover, the study highlights the significance of integrating technology into pre-service teacher education to enhance problem-solving skills. The findings reveal that the integration of digital tools and online platforms provides pre-service teachers with opportunities to engage in authentic problem-solving tasks, explore innovative teaching strategies, and access resources for professional development (Ajani, 2023; Koehler & Mishra, 2008; Oladele et al., 2024). By leveraging technology, pre-service teachers can develop digital literacy skills, experiment with educational technologies, and adapt instructional practices to meet diverse learning needs (Koehler & Mishra, 2020; Mishra & Koehler, 2006). This technology integration aligns with the sociocultural perspective of learning, emphasising the role of cultural tools and symbolic artefacts in mediating cognitive processes (Vygotsky, 1978). Thus, the findings underscore the importance of leveraging technology as a cognitive tool to scaffold problem-solving skills among pre-service teachers, which aligns with the theoretical framework of social cognitive theory.

Furthermore, the study's findings highlight the critical role of reflective practices in fostering metacognition, self-regulation, and professional growth among pre-service teachers. Through guided reflection activities, pre-service teachers can deepen their understanding of instructional challenges, critically evaluate their problem-solving approaches, and identify areas for improvement (Adelana et al., 2024; Weimer, 2018; Zeichner & Liston, 2014). By cultivating a habit of reflection, pre-service teachers can become self-directed learners who continuously strive for excellence in teaching and learning (Schön, 1987). This emphasis on reflective practices aligns with the principles of social cognitive theory, which underscore the importance of self-reflection, self-efficacy beliefs, and goal setting in shaping behaviour and learning outcomes (Bandura, 1997; Gumbi et al., 2024). Thus, the findings highlight the synergistic relationship between reflective practices and problem-solving skills development, providing empirical support for the theoretical framework of social cognitive theory in the context of pre-service teacher education in South Africa.

7. Conclusion

This study has provided valuable insights into the development of problem-solving skills among pre-service teachers in South Africa. A systematic literature review has revealed key findings regarding effective interventions, pedagogical approaches, and technological tools for enhancing problem-solving abilities. The integration of problem-based learning pedagogy, collaborative learning environments, technology, and reflective practices has been identified as a promising strategy for fostering problem-solving skills among pre-service teachers (Barrows, 1986; Johnson & Johnson, 1999; Mishra & Koehler, 2006; Zeichner & Liston, 2014). These findings contribute to theory and practice by highlighting the importance of adopting theoretical frameworks, such as social cognitive theory, to inform the design and implementation of problem-solving interventions in teacher education (Bandura, 1986). Furthermore, the study underscores the significance of

developing problem-solving skills among pre-service teachers for professional growth, improving educational outcomes and preparing competent educators for the future (Schön, 1987).

In conclusion, this study underscores the critical role of problem-solving skills in pre-service teacher education and emphasises the need for continued research and practice. By integrating evidence-based strategies and theoretical frameworks, educators can better prepare pre-service teachers to navigate the complex challenges of the teaching profession and make meaningful contributions to student learning and development (Savery, 2006). As educational landscapes evolve, cultivating problem-solving competencies among pre-service teachers remains essential for fostering innovation, promoting equity, and advancing educational excellence in South Africa and beyond.

8. Recommendations

Based on the findings of this study, several recommendations can be made to enhance the development of problem-solving skills among pre-service teachers in South Africa. Firstly, teacher education programs should prioritise integrating problem-based learning pedagogy into their curriculum. Research has consistently shown that PBL promotes active learning, critical thinking, and collaboration, all essential components of effective problem-solving (Barrows, 1986). By engaging pre-service teachers in authentic, real-world problems, educators can cultivate their ability to identify, analyse, and solve complex challenges in educational settings.

Secondly, collaborative learning environments should be established within teacher education programs to provide opportunities for pre-service teachers to work together and learn from one another (Johnson & Johnson, 1999). Collaborative learning fosters the development of interpersonal skills, communication skills, and teamwork, which are crucial for effective problem-solving in educational contexts. Through group discussions, peer feedback, and joint problem-solving activities, pre-service teachers can gain valuable insights into different perspectives and approaches to problem-solving.

Furthermore, technology integration should be leveraged to enhance problem-solving skills among pre-service teachers. Educational technologies, such as digital simulations, online platforms, and virtual reality tools, offer innovative ways to engage pre-service teachers in problem-solving activities and provide them with immediate feedback on their performance (Mishra & Koehler, 2006). By incorporating technology into teacher education programs, educators can create immersive learning experiences that simulate real-world challenges and empower pre-service teachers to develop adaptive problem-solving strategies.

Lastly, teacher education programs should encourage reflective practices to promote metacognition and self-regulation in problem-solving (Schön, 1987). Reflective practices, such as journaling, self-assessment, and peer reflection, enable pre-service teachers to critically evaluate their problem-solving processes, identify areas for improvement, and develop action plans for future growth. By fostering a culture of reflection within teacher education programs, educators can support the ongoing development of pre-service teachers' problem-solving skills and empower them to become lifelong learners and influential practitioners in education.

Declaration of interest: No conflict of interest is declared by author.

Ethics statement: No ethical approval is required for this study since it does not involve human or animal research.

References

- Adelana, O. P., Ayanwale, M. A., & Sanusi, I. T. (2024). Exploring pre-service biology teachers' intention to teach genetics using an AI intelligent tutoring-based system. *Cogent Education*, 11(1), 2310976. <https://doi.org/10.1080/2331186X.2024.2310976>

- Ajani, O. A. (2023). Exploring the Alignment of Professional Development and Classroom Practices in African Contexts: A Discursive Investigation. *Journal of Integrated Elementary Education*, 3(2), 120–136. <https://doi.org/10.21580/jieed.v3i2.17693>
- Ajani, O. A., & Khoalenyane, N. B. (2023). Using WhatsApp as a tool of learning: A systemic literature review of prospects and challenges. *International Journal of Innovative Technologies in Social Science*, 3(39), 1–16. https://doi.org/10.31435/rsglobal_ijitss/30092023/8025
- Akerson, V. L., & Hanuscin, D. L. (2007). Teaching nature of science through inquiry: Results of a 3-year professional development program. *Journal of Research in Science Teaching*, 44(5), 653–680. <https://doi.org/10.1002/tea.20159>
- Albanese, M. A., & Mitchell, S. (1993). Problem-based learning: A review of literature on its outcomes and implementation issues. *Academic Medicine*, 68(1), 52-81. <https://doi.org/10.1097/00001888-199301000-00012>
- Aronson, J., Blaney, N., Stephan, C., Sikes, J., & Snapp, M. (2002). *The Jigsaw Classroom*. Sage Publications.
- Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall.
- Bandura, A. (1991). Social cognitive theory of moral thought and action. In W. M. Kurtines & J. L. Gewirtz (Eds.), *Handbook of moral behaviour and development* (Vol. 1, pp. 45-103). Lawrence Erlbaum Associates, Inc.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. W H Freeman/Times Books/ Henry Holt & Co.
- Bandura, A. (1999). Social cognitive theory: An agentic perspective. *Asian Journal of Social Psychology*, 2(1), 21–41. <https://doi.org/10.1111/1467-839x.00024>
- Bandura, A. (2001). Social cognitive theory of mass communication. *Media Psychology*, 3(3), 265-299. https://doi.org/10.1207/S1532785XMEP0303_03
- Bandura, A. (2012). On the functional properties of perceived self-efficacy revisited. *Journal of Management*, 38(1), 9-44. <https://doi.org/10.1177/0149206311410606>
- Barab, S. A., & Plucker, J. A. (2018). Smart people or smart contexts? Cognition, ability, and talent development in an age of situated approaches to knowing and learning. In S. A. Barab, M. A. Evans, & M. J. Lucas (Eds.), *The handbook of the learning sciences* (pp. 3–26). Cambridge University Press.
- Barrett, H. (2005). Researching electronic portfolios and learner engagement: The REFLECT initiative. *Journal of Adolescent & Adult Literacy*, 49(6), 528-537. <https://doi.org/10.1598/JAAL.49.6.5>
- Barrows, H. S. (1986). A taxonomy of problem-based learning methods. *Medical Education*, 20(6), 481-486. <https://doi.org/10.1111/j.1365-2923.1986.tb01386.x>
- Barrows, H. S., & Tamblyn, R. M. (1980). *Problem-based learning: An approach to medical education*. Springer Publishing Company.
- Bass, R., Paul, R., & Williams, E. (2019). Writing the teaching statement. In H. E. A. Tinsley & K. F. Krizek (Eds.), *The Academic Portfolio: A Practical Guide to Documenting Teaching, Research, and Service* (pp. 55-71). Jossey-Bass.
- Beck, C. L., & Kosnik, C. M. (2019). Innovative approaches to teacher education: What does the research suggest? *Journal of Teacher Education*, 70(2), 120-130. <https://doi.org/10.1177/0022487118781385>
- Beetham, H., & Sharpe, R. (2019). *Rethinking pedagogy for a digital age: Principles and practices of design*. Routledge. <https://doi.org/10.4324/9781351252805>
- Boekaerts, M., & Corno, L. (2005). Self-regulation in the classroom: A perspective on assessment and intervention. *Applied Psychology*, 54(2), 199-231. <https://doi.org/10.1111/j.1464-0597.2005.00205.x>
- Boettcher, J. V., & Conrad, R. (2016). *The online teaching survival guide: Simple and practical pedagogical tips*. Jossey-Bass.
- Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher*, 33(8), 3-15. <https://doi.org/10.3102/0013189X033008003>
- Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn: Brain, mind, experience, and school*. National Academies Press.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Brookfield, S. D. (1995). *Becoming a critically reflective teacher*. John Wiley & Sons.
- Brown, A. L., & Campione, J. C. (1994). Guided discovery in a community of learners. In K. McGilly (Ed.), *Classroom lessons: Integrating Cognitive Theory and Classroom Practice* (pp. 229-270). MIT Press.
- Cochran-Smith, M., & Zeichner, K. M. (2005). *Studying teacher education: The report of the AERA panel on research and teacher education*. Lawrence Erlbaum Associates.
- Critical Appraisal Skills Programme [CASP] (2018). *CASP qualitative checklist*. Author.
- Cruikshank, D. R., & Haefele, D. F. (2001). *Increasing teacher effectiveness*. Routledge.

- Dabbagh, N., & Kitsantas, A. (2012). Personal learning environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. *The Internet and Higher Education*, 15(1), 3-8. <https://doi.org/10.1016/j.iheduc.2011.06.002>
- Darling-Hammond, L. (2006). Constructing 21st-century teacher education. *Journal of Teacher Education*, 57(3), 300-314. <https://doi.org/10.1177/0022487105285962>
- Darling-Hammond, L. (2017). Teacher education around the world: What can we learn from international practice? *European Journal of Teacher Education*, 40(3), 291-309. <https://doi.org/10.1080/02619768.2017.1336364>
- Darling-Hammond, L., & Bransford, J. (2005). *Preparing teachers for a changing world: What teachers should learn and be able to do*. John Wiley & Sons.
- De Jong, T., & Van Joolingen, W. R. (1998). Scientific discovery learning with computer simulations of conceptual domains. *Review of Educational Research*, 68(2), 179-201. <https://doi.org/10.3102/00346543068002179>
- Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining "gamification." In *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments* (pp. 9-15). <https://doi.org/10.1145/2181037.2181040>
- Dillenbourg, P. (1999). *What do you mean by collaborative learning?* In P. Dillenbourg (Ed.), *Collaborative-learning: Cognitive and computational approaches* (pp. 1-19). Elsevier.
- Dochy, F., Segers, M., Van den Bossche, P., & Gijbels, D. (2003). Effects of problem-based learning: A meta-analysis. *Learning and Instruction*, 13(5), 533-568. [https://doi.org/10.1016/S0959-4752\(02\)00025-7](https://doi.org/10.1016/S0959-4752(02)00025-7)
- Dunlap, J. C., & Lowenthal, P. R. (2010). Learning, unlearning, and relearning: Using Web 2.0 technologies to support the development of lifelong learning skills. In G. Veletsianos (Ed.), *Emerging technologies in distance education* (pp. 99-125). AU Press.
- Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist*, 34(10), 906-911. <https://doi.org/10.1037/0003-066X.34.10.906>
- Fouché, I. (2024). Pre-service teacher investment through dialogic action learning. *Reading & Writing-Journal of the Reading Association of South Africa*, 15(1), 452. <https://doi.org/10.4102/rw.v15i1.452>
- Garrison, D. R., & Anderson, T. (2003). *E-Learning in the 21st century: A framework for research and practice*. Routledge.
- Gee, J. P. (2003). What video games have to teach us about learning and literacy. *Computers in Entertainment (CIE)*, 1(1), 20-20. <https://doi.org/10.1145/950566.950595>
- Govender, S., Ajani, O. A., Ndaba, N. H., & Ngema, T. (2023). Making in-service professional development effective in a rural context: enhancing social justice for rural teachers. In R. S. Mphahlele & M. C. Maphalala (Eds.), *Contextualising rural education in South African schools* (pp. 78-95). Brill. https://doi.org/10.1163/9789004547025_006
- Grossman, P. L. (2011). Framework for teaching practice: A brief history of an idea. *Teachers College Record*, 113(10), 2395-2405. <https://doi.org/10.1177/016146811111301205>
- Grossman, P., & McDonald, M. (2008). Back to the future: Directions for research in teaching and teacher education. *American Educational Research Journal*, 45(1), 184-205. <https://doi.org/10.3102/0002831207312906>
- Grossman, P., Compton, C., Igra, D., Ronfeldt, M., Shahan, E., & Williamson, P. W. (2009). Teaching practice: A cross-professional perspective. *Teachers College Record*, 111(9), 2055-2100. <https://doi.org/10.1111/j.1467-9620.2009.01374.x>
- Grossman, P., Smagorinsky, P., & Valencia, S. (1999). Appropriating tools for teaching English: A theoretical framework for research on learning to teach. *American Journal of Education*, 108(1), 1-29. <https://doi.org/10.1086/444149>
- Grossman, P., Wineburg, S., & Woolworth, S. (2001). Toward a theory of teacher community. *Teachers College Record*, 103(6), 942-1012. <https://doi.org/10.1111/0161-4681.00133>
- Gu, J., Kim, Y., & Rubie-Davies, C. M. (2020). Pedagogical content knowledge (PCK) research in science education: A review of the literature. *Studies in Science Education*, 56(2), 132-161.
- Gumbi, N. M., Sibaya, D., & Chibisa, A. (2024). Exploring pre-service teachers' perspectives on the integration of digital game-based learning for sustainable Stem education. *Sustainability*, 16(3), 1314. <https://doi.org/10.3390/su16031314>
- Hammerness, K., Darling-Hammond, L., Bransford, J., Berliner, D., Cochran-Smith, M., McDonald, M., & Zeichner, K. (2005). How teachers learn and develop. In L. Darling-Hammond & J. Bransford (Eds.), *Preparing teachers for a changing world: What teachers should learn and be able to do* (pp. 358-389). John Wiley & Sons.

- Harasim, L. (2012). *Learning theory and online technologies*. Routledge.
- Harasim, L., Hiltz, S. R., Teles, L., & Turoff, M. (2017). *Learning networks: A field guide to teaching and learning online*. Routledge.
- Hart, C. (2018). *Doing a literature review: Releasing the social science research imagination*. Sage.
- Hatano, G., & Inagaki, K. (1986). Two courses of expertise. In H. W. Stevenson, H. Azuma, & K. Hakuta (Eds.), *Child development and education in Japan* (pp. 262-272). W H Freeman/Times Books/ Henry Holt & Co.
- Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. Routledge.
- Hattie, J. (2012). *Visible learning for teachers: Maximizing impact on learning*. Routledge.
- Hatton, N., & Smith, D. (1995). Reflection in teacher education: Towards definition and implementation. *Teaching and Teacher Education*, 11(1), 33-49. [https://doi.org/10.1016/0742-051X\(94\)00012-U](https://doi.org/10.1016/0742-051X(94)00012-U)
- Henson, R. K. (2003). Motivation to learn: An overview. *Educational Psychology Review*, 15(4), 391-409. <https://doi.org/10.1023/A:1026273717188>
- Higgins, J. P. T., & Green, S. (Eds.). (2011). *Cochrane handbook for systematic reviews of interventions*. John Wiley & Sons.
- Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review*, 16(3), 235-266. <https://doi.org/10.1023/B:EDPR.0000034022.16470.f3>
- Hmelo-Silver, C. E. (2019). Analysing collaborative interactions: Divergence, convergence, and understanding. *Educational Psychologist*, 54(1), 1-14.
- Hsu, T. C., Wang, C. H., & Tai, Y. Y. (2019). Exploring the determinants of acceptance toward cloud-based learning systems: An extension of TAM with trust and risk. *IEEE Transactions on Education*, 63(2), 91-98. <https://doi.org/10.1109/TE.2019.2924090>
- Joanna Briggs Institute. (2017). *Joanna Briggs Institute critical appraisal checklist for systematic reviews and research syntheses*. Author.
- Johnson, D. W., & Johnson, R. T. (1999). Making cooperative learning work. *Theory into Practice*, 38(2), 67-73. <https://doi.org/10.1080/00405849909543834>
- Johnson, D. W., Johnson, R. T., & Smith, K. A. (2014). Cooperative learning: Improving university instruction by basing practice on validated theory. *Journal on Excellence in College Teaching*, 25(3&4), 85-118.
- Jonassen, D. H. (1997). Instructional design models for well-structured and ill-structured problem-solving learning outcomes. *Educational Technology Research and Development*, 45(1), 65-94. <https://doi.org/10.1007/BF02299613>
- Jonassen, D. H. (2000). Toward a design theory of problem solving. *Educational Technology Research and Development*, 48(4), 63-85. <https://doi.org/10.1007/BF02300500>
- Jonassen, D. H. (2011). *Learning to solve problems: A handbook for designing problem-solving learning environments*. Routledge.
- Jonassen, D. H., & Land, S. M. (Eds.). (2012). *Theoretical foundations of learning environments*. Routledge.
- Kennedy, M. M. (1997). Defining a literature. *Educational Researcher*, 26(3), 18-21. <https://doi.org/10.3102/0013189X026003018>
- Kimmons, R., & Veletsianos, G. (2018). Education scholars' evolving uses of Twitter as a conference backchannel and social commentary platform. *British Journal of Educational Technology*, 49(6), 958-969. <https://doi.org/10.1111/bjet.12574>
- Koehler, M. J., & Mishra, P. (2008). Introducing TPCK. In AACTE committee on innovation and technology (Eds.), *Handbook of technological pedagogical content knowledge (TPCK) for educators* (pp. 3-29). Routledge.
- Koehler, M. J., & Mishra, P. (2020). Technological pedagogical content knowledge (TPACK) 2.0: Addressing teacher knowledge needs for the digital age. *British Journal of Educational Technology*, 51(6), 1304-1317.
- Kuo, Y. C. (2019). Developing a structural model to understand users' continuance intention to use mobile MOOCs. *Educational Technology Research and Development*, 67(4), 967-989. <https://doi.org/10.1007/s11423-019-09639-8>
- Lai, C. L., & Hwang, G. J. (2019). A self-regulated flipped classroom approach to improving students' learning performance in a mathematics course. *Computers & Education*, 141, 103609.
- Larrivee, B. (2000). Transforming teaching practice: Becoming the critically reflective teacher. *Reflective Practice*, 1(3), 293-307. <https://doi.org/10.1080/713693162>
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press. <https://doi.org/10.1017/CBO9780511815355>
- Levy, F., & Murnane, R. J. (2004). *The new division of labor: How computers are creating the next job market*. Princeton University Press.

- Liu, X., Gu, J., & Xu, J. (2024). The impact of the design thinking model on pre-service teachers' creativity self-efficacy, inventive problem-solving skills, and technology-related motivation. *International Journal of Technology and Design Education*, 34(1), 167-190. <https://doi.org/10.1007/s10798-023-09809-x>
- Loughran, J. J. (2010). *What expert teachers do: Enhancing professional knowledge for classroom practice*. Routledge.
- Lundeberg, M. A., Levin, B. B., & Harrington, H. L. (1999). *Who learns what from cases and how? The research base for teaching and learning with cases*. Lawrence Erlbaum Associates.
- Lunenberg, M., Korthagen, F., & Swennen, A. (2007). The teacher educator as a role model. *Teaching and Teacher Education*, 23(5), 586-601. <https://doi.org/10.1016/j.tate.2006.04.022>
- Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017-1054. <https://doi.org/10.1111/j.1467-9620.2006.00684.x>
- Mncube, D. W., Mkhassibe, R. G., & Ajani, O. A. (2021). Teaching in English across the curriculum: A lived experiences of the novice teachers in a selected rural FET schools in South Africa. *International Journal of Higher Education*, 10(6), 72-82. <https://doi.org/10.5430/ijhe.v10n6p72>
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Annals of Internal Medicine*, 151(4), 264-269. <https://doi.org/10.7326/0003-4819-151-4-200908180-00135>
- Moon, J. A. (2004). *A handbook of reflective and experiential learning: Theory and practice*. Routledge.
- Ní Shé, C., Barrett, T., & Cummins, A. (2019). Academic resilience? A scoping review of the literature. *Studies in Higher Education*, 44(12), 2098-2111.
- Nietfeld, J. L., Cao, L., & Osborne, J. W. (2006). Metacognitive monitoring accuracy and student performance in the postsecondary classroom. *Journal of Experimental Education*, 75(4), 297-315. <https://doi.org/10.3200/JEXE.75.4.297-316>
- Oladele, J. I., Ndlovu, M., Spangenberg, E. D., Daramola, D. S., & Obimuyiwa, G. A. (2024). Transitioning to problem-based learning in higher education: opportunities for producing 21st-century pre-service teachers in Sub-Saharan Africa. *Kurdish Studies*, 12(2), 609-626.
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hrobjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L. A., ...Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, 71, 372. <https://doi.org/10.1136/bmj.n71>
- Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 451-502). Elsevier.
- Plass, J. L., Homer, B. D., & Hayward, E. O. (2014). Design factors for educationally effective animations and simulations. *Journal of Computing in Higher Education*, 26(2), 89-114. <https://doi.org/10.1007/s12528-014-9076-x>
- Rodgers, C. (2002). Defining reflection: Another look at John Dewey and reflective thinking. *Teachers College Record*, 104(4), 842-866. <https://doi.org/10.1111/1467-9620.00194>
- Roschelle, J., Tatar, D., Chaudhury, S. R., Dimitriadis, Y., Patton, C., DiGiano, C., & Kaput, J. (2010). Ink, improvisation, and interactive engagement: Learning with tablets. *Computers & Education*, 54(3), 720-732. <https://doi.org/10.1016/j.compedu.2009.09.017>
- Roth, W. M. (1995). *Authentic school science: Knowing and learning in open-inquiry science laboratories*. Kluwer Academic Publishers. <https://doi.org/10.1007/978-94-011-0495-1>
- Saka, A. Z., Ebenezer, J., & Saka, T. (2024). The Turkish pre-service teachers' perceptions of factors influencing physics problem-solving abilities. *Science Insights Education Frontiers*, 20(1), 3173-3200. <https://doi.org/10.15354/sief.24.or505>
- Santagata, R., & Angelici, G. (2010). Studying the impact of the lesson analysis framework on preservice teachers' abilities to reflect on videos of classroom teaching. *Journal of Teacher Education*, 61(4), 339-349. <https://doi.org/10.1177/0022487109347871>
- Savery, J. R. (2006). Overview of problem-based learning: Definitions and distinctions. *Interdisciplinary Journal of Problem-based Learning*, 1(1), 9-20. <https://doi.org/10.7771/1541-5015.1002>
- Savery, J. R., & Duffy, T. M. (1996). Problem based learning: An instructional model and its constructivist framework. *Educational Technology*, 35(5), 31-38.
- Schmidt, H. G., Loyens, S. M., Van Gog, T., & Paas, F. (2011). Problem-based learning is compatible with human cognitive architecture: Commentary on Kirschner, Sweller, and Clark (2006). *Educational Psychologist*, 46(3), 227-232. <https://doi.org/10.1080/00461520.2011.611368>

- Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense-making in mathematics. In D. Grouws (Ed.), *Handbook for research on mathematics teaching and learning* (pp. 334-370). Macmillan.
- Schoenfeld, A. H. (2010). *How we think: A theory of goal-oriented decision making and its educational applications*. Routledge.
- Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. Basic Books.
- Schön, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. Jossey-Bass.
- Schraw, G., & Moshman, D. (1995). Metacognitive theories. *Educational Psychology Review*, 7(4), 351-371. <https://doi.org/10.1007/BF02212307>
- Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57(1), 1-22. <https://doi.org/10.17763/haer.57.1.j463w79r56455411>
- Slavin, R. E. (1996). Research on cooperative learning and achievement: What we know, what we need to know. *Contemporary Educational Psychology*, 21(1), 43-69. <https://doi.org/10.1006/ceps.1996.0004>
- Slavin, R. E. (2014). Cooperative learning and academic achievement: Why does groupwork work? *Anales de Psicología*, 30(3), 785-791. <https://doi.org/10.6018/analesps.30.3.199361>
- Sun, J. C. Y., & Rueda, R. (2019). Situated learning theory and instructional design. In R. A. Reiser & J. V. Dempsey (Eds.), *Trends and issues in instructional design and technology* (pp. 75-81). Pearson.
- Tschannen-Moran, M., & Woolfolk Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education*, 17(7), 783-805. [https://doi.org/10.1016/S0742-051X\(01\)00036-1](https://doi.org/10.1016/S0742-051X(01)00036-1)
- Van Zoest, L. R., Jones, J. K., & Thornton, C. A. (2017). *Learning to teach mathematics with children's literature*. Routledge.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.
- Walker, A., McLean, L., & Drexler, W. (2003). The use of portfolios in postgraduate medical education. *Medical Teacher*, 25(3), 280-287. <https://doi.org/10.1080/0142159031000100285>
- Webb, N. M. (2009). The teacher's role in promoting collaborative dialogue in the classroom. *British Journal of Educational Psychology*, 79(1), 1-28. <https://doi.org/10.1348/000709908X368731>
- Weimer, M. (2018). *Learner-centred teaching: Five key changes to practice*. John Wiley & Sons.
- Wilson, B. G., Jonassen, D. H., & Cole, P. (2001). Cognitive perspectives on students' technology uses in the classroom. In D. H. Jonassen & B. G. Wilson (Eds.), *Handbook of research on educational communications and technology* (2nd ed., pp. 693-719). Lawrence Erlbaum Associates.
- Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry*, 17(2), 89-100. <https://doi.org/10.1111/j.1469-7610.1976.tb00381.x>
- Zeichner, K. M. (2010). Rethinking the connections between campus courses and field experiences in college- and university-based teacher education. *Journal of Teacher Education*, 61(1-2), 89-99. <https://doi.org/10.1177/0022487109347675>
- Zeichner, K. M. (2012). The turn once again toward practice-based teacher education. *Journal of Teacher Education*, 63(5), 376-382. <https://doi.org/10.1177/0022487112451273>
- Zeichner, K. M., & Conklin, H. G. (2005). Teacher education programs. In M. Cochran-Smith & K. M. Zeichner (Eds.), *Studying teacher education: The report of the AERA panel on research and teacher education* (pp. 645-736). Lawrence Erlbaum Associates.
- Zeichner, K. M., & Liston, D. P. (2014). *Reflective teaching: An introduction*. Routledge.
- Zeichner, K. M., & Schulte, A. K. (2001). What we know and don't know from peer-reviewed research about alternative teacher certification programs. *Journal of Teacher Education*, 52(4), 266-282. <https://doi.org/10.1177/0022487101052004002>
- Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. *Handbook of self-regulation*, 13(1), 15-38. <https://doi.org/10.1016/B978-012109890-2/50031-7>
- Zimmerman, B. J., & Schunk, D. H. (2011). *Handbook of self-regulation of learning and performance*. Routledge.