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Metacognitive awareness and the zone of proximal intermediate phase mathematics teachers' professional development

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Abstract

This paper investigates in-service intermediate phase mathematics teachers' metacognitive awareness based on their engagement in a professional development intervention in two rural- and one township school in South Africa. Professional teacher development interventions should be structured and collaborative as teachers tend to revert to traditional modes of teaching when interventions are brief and sporadic. This research was scaffolded across the zone of proximal teacher development (ZPTD) as conceptualized by Warford (2011). The aim of the study was to investigate how metacognitive awareness facilitated intermediate phase mathematics teachers' ZPTD, i.e., from their actual knowledge to "proximal development". 10 intermediate phase mathematics teachers participated in the qualitative research (n=10). The professional development intervention was conducted on two consecutive Saturdays, infused with an adapted lesson study approach. The data was collected through (i) individual interviews, (ii) reflective prompts, (iii) observations, and (iv) reflective journals. The data from each data source were coded and categorized and were triangulated to answer the research question. Participants deemed the professional development intervention and the accompanying materials as supportive and showed increased metacognitive awareness of their personal teaching praxis during and after the intervention, hence growth along the ZPTD occurred.

Keywords: intermediate phase mathematics teachers, metacognitive awareness, professional development intervention, zone of proximal teacher development

INTRODUCTION

Teacher professional development in South Africa is mandated by national policies and legislation. According to Bantwini (2010), Bertram (2011), and Luneta (2012), teacher professional development in South Africa, as provided in various schooling districts, has received criticism from both teachers and stakeholders. Teacher professional development critique characterizes the teacher as being 'presenter-centered' hinged on the transmission of information (Girvan et al., 2016). Coe et al. (2010) note that teachers tend to use few of the innovative ideas presented at workshops for teaching-learning. This can most likely be linked to the fact that teachers attend workshops being 'teachers-as-participants', rather than 'teachers-as-learners', since few practice opportunities are provided for teachers during these professional development interventions, especially when constructed across social constructivist theories (De Beer & Kriek, 2018). The notion of 'teachers-as-participants' assumes that teacher learning occurs individually (isolated), hence one cannot hope for change to occur in the teaching-learning praxis of these teachers, since little support emanates from individual endeavors (van der Walt & Potgieter, 2018). According to Chigonga and Mutodi (2019) and Jansen and Taylor (2003), since the inception of curriculum assessment policy statement (CAPS) (DBE, 2011) in South African classrooms, a dearth in pedagogical content knowledge (PCK) occurred, impacting little on teacher professional development interventions in mathematics teaching-learning. Since many countries in the world undertook curriculum reform, there are often insufficient support of teachers to adjust, develop and refine new practices if necessitated by new curriculum content and new pedagogies available (Camburn & Han, 2015).

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Contribution to the literature

- The research in this article contributes to the body of scholarship based on the scaffolding of professional development interventions for in-service teachers across the Zone of Proximal Teacher Development (ZPTD).
- The integration of metacognition strengthens teachers' awareness of their development before, during and after professional development interventions, hence enhancing their thinking of what they teach, how they teach it, why they teach it and how they will adapt it for future teaching-learning endeavors.

Problem Statement

Therefore, the need for improved professional development interventions is necessitated where teachers put theory to practice, leading to the notion of '*teachers-as-learners*' (Warford, 2011). Chigonga and Mutodi (2019) support this notion as professional development occupying teachers in collaborative learning activities, have been found to be most effective. As soon as teacher professional development becomes relevant to teachers' praxis, it becomes authentic in the way in which it is transferred into daily teaching, therefore becomes instructionally focused (Hunzicker, 2011; Meijs et al., 2016). Professional development occurring in a positive and vibrant manner, allow for teachers (as learners) to impact on meaningful changes in their own classrooms (Haiyan et al., 2017). Lave and Wenger (1991) and Luneta (2012) assert that the knowledge which teachers bring to professional development interventions, served as a starting point since it can be integrated to scaffold their knowledge, creating a positive and vibrant synergy among participants collaborating to achieve common teaching-learning goals.

According to Warford (2011), when teachers attend professional development interventions, they need sufficient opportunity to reflect on

(i) their metacognitive knowledge (knowledge of cognition of self and others, cognitive demands of tasks and available and appropriate cognitive- and metacognitive strategies), and

(ii) self-regulation (planning, monitoring, and evaluation regarding their own teaching-learning praxis).

When competent (knowledgeable) peers assist these teachers, proximal development would take place, hence improving teaching curriculum content. Reflection is the medium through which teachers develop professionally to inform and change their teaching-learning praxis (Cornoldi, 2009). Reflection features as the 'vehicle' travelling between warehouses i.e. metacognitive knowledge and self-regulation (i.e., metacognitive awareness). Reflection serves as a teaching-learning tool (Minott, 2010). According to Girvan et al. (2016), the integration of reflection during professional development leads to active participation, and improved transfer of new knowledge to classrooms.

This argument has led to an interest in exploring a teacher professional development intervention, where a metacognitive methodology is implemented while the pedagogy of play–using puppetry–is introduced. Hence teachers might feel empowered along the zone of proximal teacher development (ZPTD), implicating holistic teacher development.

The aim of the study was to investigate how metacognitive awareness (through a metacognitive methodology) facilitate intermediate phase mathematics teachers' ZPTD. Participants' development from their actual knowledge [what participants were able to accomplish without the assistance of knowledgeable others] to "proximal development" [where participants attained valuable teaching-learning strategies facilitated by capable others] (Warford, 2011) served to investigate the teachers' professional development. Note that intermediate phase refers to learners in grades 4 to 6 who are 10 to 12 years of age.

Metacognitive awareness and PoP using puppetry, link to innovative teaching-learning praxis in the intermediate phase mathematics classroom. Pedagogy of play refers to playful ways (such as games or puppetry) which can be used in teaching, assisting the teacher to scaffold content for learners, making learning fun and accessible (Ahlcrona & Östman, 2018).

LITERATURE STUDY

The unique design of the intervention lead to the following discussion on the conceptual framework. According to Frey (2018), a conceptual framework provides a map of what researchers intend to study, hence the exploration of organized elements (such as ideas, facts and perceptions) applicable to this study. Therefore, provided in the following format.

Teacher Professional Development

Innovation in teaching-learning praxis require the ability and willingness of teachers within professional development interventions, to collaborate in the sharing of ideas and the exchanging of resources which link to the teaching-learning of mathematics (Botha & Herselman, 2016). According to Voogt and Knezek (2008), change in knowledge, beliefs and attitudes of teachers, can be a step in the right direction in acquiring new skills, conceptual understanding and innovative

ideas for implementation in participating teachers' classrooms.

Furthermore, teacher professional development should not be considered as the panacea for curriculum reform, but rather as a critical element for educational related efforts in the enhancement of teachers' teaching and learners' learning (Chigonga & Motodi, 2019; Ono & Ferreira, 2010). These authors reveal that despite efforts in professional development interventions based on content knowledge (as the basis on which teachers develop their pedagogical knowledge repertoire), mathematics teachers lack various kinds of knowledge to improve learners' learning and performance (CDE, 2007). For example, one kind of knowledge that teachers lack and are not familiar with is innovation in pedagogies of play and in this study teaching with puppets–as PoP–was introduced and implemented. Girvan et al. (2016) contradicted the notion that teaching-learning praxis will be reformed rapidly, by their substantial evidence supporting the fact that professional development is an ongoing process where teachers adapt what they learn and know to fit the context of their school, its learners and their teaching praxis.

Further research indicates that improved quality of teachers influences the quality of learner achievements (Mestry et al., 2009). Stronge (2007) asserts that it is

> "not only the presence or absence of teachers that makes a difference, but also the teachers who are competent in content, pedagogy and assessment of their subject area."

Mathematics is not made accessible to learners in the context of meaningful learning, since teachers are underprepared (PCK) to do so (van der Walt et al., 2019). Mathematical knowledge, concepts, and procedures are mostly presented in its abstract format only. Therefore, improving teaching and the quality of learners' learning interconnect to teacher professional development as teachers (irrespective of their knowledge, skills, values, and attitudes), who should be willing to learn, leading to the transfer of newly obtained skills, and knowledge to their classrooms (Bantwini, 2017; Mestry et al., 2009).

Botha and Herselman (2016) proposed important key ideas for the planning of a teacher professional development intervention. In this research, these key ideas by Botha and Herselman (2016) featured in the planning of the PDI:

1. A positive attitude by teachers towards the integration of a PoP (puppetry) was fostered in this intervention;
2. Workshop fatigue was avoided by integrating PoP (puppetry) and other collaborative activities (such as De Bono's Hats and Boomwhackers and music–van der Walt et al., 2019);
3. Teachers were supported by course facilitators (researchers) to the extent that they integrate PoP (puppetry) into the mathematics content which they need to teach when returning to their respective intermediate phase mathematics classrooms;
4. The researchers provided the teachers with puppets (physical resources). Teachers were empowered to take ownership of their individual puppet, infusing puppetry (PoP) into their own mathematics classrooms;
5. The researchers scaffolded the intervention in such a manner that teachers were introduced to the theory of PoP, of puppetry, of metacognitive awareness and the link between the mathematics curriculum and teaching-learning mathematics; and
6. Teachers were motivated to participate *as learners* themselves through various collaborative activities they participated in.

The intervention did not foster "apprenticeship of observation" [teachers who teach as they were taught] (Lortie, 1975), but rather allowed teachers to get involved in best practices that had been modelled and acted out via collaborative activities, enhanced reflection (prompts provided) and integrated concepts regarding innovative teaching with PoP that was the vantage point in this intervention.

Pedagogy of Play

Pedagogy of play refers to playful ways (such as games–indigenous or computer-based–or puppetry), which can be integrated in teaching, assisting the teacher to scaffold content for learners, making learning fun and accessible (Ahlcrona & Östman, 2018). According to Lindqvist (1996), PoP is an essential pedagogy in any classroom, since it allows for new learning experiences, where learners experiment with characteristics and behaviors needed for real-life experiences–something that teachers are hesitant to cultivate in their own classrooms due to a lack of knowledge or no familiarity of PoP–in this case teaching with puppets (Lindqvist, 1996; Overholt, 2010; Vygotsky, 1967).

Puppetry

Puppetry is an early form of entertainment and was used to animate and communicate key ideas and needs of humans, forming an integral part of their culture and being (Fourie, 2009). Puppetry in education has addressed various issues such as improved communication, positive classroom environments and creating a safe space for learners to participate as the puppet is seen as a peer (Potgieter, 2020). However, existing literature reveals little research on the application of puppetry in the intermediate phase, especially in school mathematics (Keogh et al., 2008).

Therefore, the need for teachers to be metacognitively aware of the potentialities of a PoP (puppetry) allowed them to reflect metacognitively on their own teaching-learning praxis. This research was conducted within a metacognitive methodology.

Metacognition

Metacognition expands to various research fields such as neuroscience (Shimamura, 2000), psychology (Efklides, 2008), and education (Ertmer & Newby, 1996); hence, a fuzzy concept to clarify. According to Flavell (1979), metacognition can be referred to as 'thinking about thinking', hence reaching beyond your cognition to understand what, why and how teachers (participants) do what they do. Metacognition (nested within educational research) consists of two domains namely:

1. metacognitive knowledge and
2. self-regulation, which will be discussed next.

The glue between these two domains is reflection (Ertmer & Newby, 1996),

Metacognitive knowledge

Metacognitive knowledge refers to participants' cognition and how it links to tasks (problem solving) performed in real-life and strategies being implemented (Schraw, 1998). Metacognitive knowledge consists of three kinds of metacognitive awareness domains:

1. declarative "about" knowledge,
2. procedural "how" knowledge, and
3. conditional "why and when" knowledge (Flavell, 1979).

Declarative knowledge about the person is the knowledge participants have about themselves as learners ('*teachers-as-learners*') and factors such as cognitive strengths and weaknesses, which could influence performance of both teachers and learners (Kallio et al., 2017; Schraw, 1998). Declarative knowledge is functional knowledge such as the ability to name, list or describe and recall what they know (about mathematical procedures, the curriculum content), what and how they teach mathematics in the context of the learners in their specific classrooms (regarding the best method to teach, using examples relevant to the learners' everyday life). These include knowledge of the best teaching practice in the context of the learners, and about factors that can affect teaching in a specific context. (Baker et al., 2011; Young & Fry, 2012). Declarative knowledge hinges on the PCK of participants at the beginning of the intervention, attesting to their ideas, beliefs, strengths and weaknesses in the teaching of intermediate phase mathematics.

Procedural knowledge about the task refers to the application of heuristics and strategies in teaching-learning (Kallio et al., 2018; Schraw, 1998). Procedural knowledge includes, but is not limited to, knowing how to teach a specific mathematics topic to reach a specific goal in a specific context (age/grade and environment), what skills and strategies to implement; the ability to identify and an awareness to apply appropriate methods (Bacher et al., 2011); indicates the ability to apply declarative and conceptual knowledge and recognize their own and learners' accomplishments (Yore & Treagust, 2006). This knowledge also supports teachers to distinguish between learners' strengths and weaknesses and how to respond to these. Participants applied procedural knowledge as they planned and implemented lessons on a PoP (puppetry).

Conditional knowledge directs and controls the application of knowledge, it includes declarative and procedural knowledge to choose from the available strategies the most appropriate strategy to apply knowledge for different purposes, referring to knowing when to apply declarative and procedural knowledge and to allocate resources to do so effectively (Dogan & Cephe, 2018; Schraw, 1998). Conditional knowledge is also about the ability/awareness to compare, relate and summarize principles and is an important aspect to learning. Participants applied conditional knowledge by teaching the lesson and reflecting thereon via reflective journaling.

Self-regulation

Individuals will only be able to apply self-regulation strategies when they are aware of their own cognition/thinking (strategies, decisions, and outcomes) (Flavell, 1979; Legg & Locker, 2009; Lerner et al., 2018). Self-regulation can be defined as purposively reflecting on our metacognitive knowledge for the sake of planning, monitoring, and evaluation for effective teaching-learning praxis in a specific context (Sadler-Smith et al., 2012; van der Walt et al., 2019). Actions that arise from intentional thinking are deliberate, informed and goal-directed, and refer to control processes such as self-regulation of one's thought processes (van der Walt et al., 2019). Participants self-regulated what they have learned from the intervention and transferred the teaching mathematics in the intermediate phase using puppets as a PoP during and after the intervention.

Reflection

Reflection is 'intentional' thinking about one's metacognitive knowledge and self-regulation of the development of teaching-learning processes' (van der Walt et al., 2019). Reflection drives metacognitive awareness. We learn by reflecting continuously, becoming metacognitively (consciously) aware of what they taught, how and why and where they taught it and if that teaching strategy worked well (Cornoldi, 2009; Sadler-Smith et al., 2012).

When teachers conceptualize teaching-learning praxis they implement both metacognitive knowledge and self-regulation through reflection (Cornoldi, 2009; Ertmer & Newby, 1996, van der Walt et al., 2019). Reflection facilitates teachers' thinking, doing and knowing about their own teaching praxis and their learners' learning (Cornoldi, 2009).

It should be noted that overall metacognitive awareness and teachers' expertise within teaching-learning mathematics improves vice versa, therefore increased exposure to apply metacognition in a flexible preposition, allowed teachers to be more aware of all areas of their own teaching-learning (Schraw & Dennison, 1994). Reflection was fostered throughout this intervention to make participants aware of how they teach mathematics, by constantly reflecting on their own teaching-learning and thinking of ways (and allowing for practice opportunities) to transfer newly gained knowledge on a PoP (puppetry) to their respective intermediate phase mathematics classrooms. Therefore, metacognitive awareness is viewed as a mediator for the purpose of this paper.

Metacognitive Awareness

In this research, general metacognitive awareness was promoted among participants as they were made aware of what metacognition entails and how it influences his/her teaching-learning praxis during (and after) the intervention. Reflective prompts regarding what they know about their own and learners' cognition, cognitive demands of different types of tasks and teaching-learning strategies available and appropriate to the task as well as learners' context (Efklides, 2008; Marton & Booth, 1997) accompanied the activities over the two days.

Not only does metacognitive knowledge allow individuals to "know what they know", but self-regulation allows them to "manage" this knowledge via reflection. It should be noted that metacognitive awareness and teachers' expertise within teaching-learning mathematics improves, therefore increased exposure to apply metacognition in a flexible preposition, to allow teachers to be more aware of all areas of their own teaching-learning (Schraw & Dennison, 1994). Hence, metacognitive awareness (through a metacognitive methodology) served as a mediator of transference of new knowledge to new situations.

The Stages of the Zone of Proximal Teacher Development

Since the ZPTD allow teachers to generate knowledge–adding to what they already know about teaching–learning intermediate phase mathematics (metacognitive knowledge). Participants added to their current knowledge on intermediate phase mathematics and by self-regulating that knowledge, were able to assist each other during and after the intervention as well as to transfer the new knowledge gained, to their respective classrooms. According to Warford (2011), the ZPTD can be navigated according to four stages, namely:

1. self-assistance,
2. expert other assistance,
3. internalization, and
4. recursion.

These stages are presented in **Table 1**.

According to Fani and Ghaemi (2011), certain factors influence the ZPTD, namely colleagues, mentors, mediatory resources, contextual constraints, and tensions caused by stress eminent from an exam-driven educational system. Teachers often benefit from collaboration (as provided in our intervention), since it leads to social support, impacting teachers' willingness to transfer intervention materials in their teaching praxis (Williams, 2010). Improved application of new

Table 1. The link between the ZPTD and metacognitive awareness

Warford's (2011) stages of ZPTD
1. The self-assistance stage
links to metacognitive knowledge as participants were emerged in the teaching profession already and brought knowledge of person (themselves and their learners), tasks (what they have taught in intermediate phase mathematics thus far) and strategies (how they taught intermediate phase mathematics), to the intervention.
2. The expert-other stage
links to metacognitive knowledge and self-regulation as participant's awareness of person, task, and strategy domains, allowed them to share their insights and respective perceptions and experiences of teaching-learning intermediate phase mathematics in the various contexts in which they are immersed in (previously disadvantaged schools and communities), impacting their approaches to the teaching-learning of mathematics
3. The internalization stage
links with self-regulation, since participants managed their metacognitive knowledge to plan, adapt, and transfer a PoP (puppetry) to their respective learners. Hence, participants were in the position to manage their own cognitive abilities concerning the teaching-learning of intermediate phase mathematics and integrate a new approach to make learning more understandable, meaningful, and accessible for their learners.
4. The recursion stage
links to both self-regulation and reflection. Participants self-regulated their knowledge on how the lesson went through their reflections. They reflected on their overall teaching and how they experienced the power of teaching with a PoP, such as puppetry, was deemed as a workable teaching-learning strategy for future use and integration in intermediate phase maths.

knowledge is derived from practice opportunities and the awareness of its effect on the teaching-learning of various school subjects, making it more successful for future use by participant teachers.

The integration of metacognitive awareness and the ZPTD in this research adhered to these design principles as suggested by Warford (2011) in the sense that

(i) participants found learners' loss of interest in intermediate phase mathematics a cause for concern as well as contextual factors (such as being in previous disadvantaged schools), limited these participants' approaches to intermediate phase mathematics and

(ii) using a PoP (puppetry) as a means to engage these participants' learners, providing a different approach to teaching in their respective classrooms.

Participants also became (metacognitively) more aware of the role that reflection play in their teaching-learning which will be discussed in the findings of this paper. Therefore, the ZPTD is a model for teacher professional development as it provides "practice" opportunities where teachers apply theory to their teaching (De Beer & Kriek, 2018), necessitating metacognitive awareness and reflection.

THEORETICAL FRAMEWORK

Acknowledging the design of this intervention, the primary research question guiding this research was identified, as follows:

How does metacognitive awareness facilitate intermediate phase mathematics teachers' ZPTD and what metacognitive awareness facilitate growth?

Hence, social constructivism was identified as theoretical framework, stemming from constructivism as proposed by Vygotsky (1978). According to Vygotsky (1978), for humans (participants) to develop based on their perceptions of the world (i.e. learning of new concepts), language and culture plays a role (Kapur, 2018). Social constructivism extends this idea of Vygotsky (1978) even further, allowing for participants to socially construct knowledge (engaging in teaching-learning endeavors together) (Ernest, 1998, 2018; Vygotsky, 1978). According to Ernest (2018), social constructivism feature as a good philosophy for research endeavors in mathematics education. Social constructivism provides a theoretical foundation for knowledge construction underlying an objective and subjective nature occurring via social exchanges (conversations) (Ernest, 1998, 2018). Therefore, social constructivism in this research afforded participants the opportunity to learn new concepts (applying PoP–puppetry), using social exchanges to interpret their understanding of the experiences before, during and after the intervention. These participants (taking the stance of being learners themselves), used social exchanges and the 'culture of teaching intermediate phase mathematics', to embed the knowledge of teaching with PoP (puppetry) within their own cognitive structures collaboratively as a group (hence co-constructed) to apply it in the context of their respective classrooms. In order to promote social exchanges, reflective prompts were embedded in both the workshops. The teachers were introduced to metacognitive awareness (using a PowerPoint and examples from real life experiences). The aim was to facilitate the role that metacognitive awareness (including metacognitive knowledge, self-regulation and reflection) plays in transferring PoP to their own teaching-learning praxis and to promote conversational engagement among one another regarding these topics.

METHODOLOGY

A qualitative research design allows participants to attach meaning to their experiences of their own world, hence suited for research where unknown elements need explanation (Creswell, 2014). Due to the human element involved in qualitative studies, researchers' involvement is instrumental since data is mediated through a '*human instrument*' (participant) rather than through inventories, questionnaires, or machines (Simon & Goes, 2013). As researchers, our involvement throughout this research endeavor was to recognize the values, perceptions, experiences, and personal interests of participants. Since this research was based on participants' reflection on their experiences and perceptions, a generic qualitative research design was chosen, as written account of participants' experiences and perceptions provided rich data for the purpose of this study.

Participant Selection

10 participants (n=10) were involved in this research. Seven female and three male participants engaged in the intervention. Participants were between 20 and 55 years. Their teaching experience in mathematics ranged from three to 18 years. Two participants had 24 or less learners in their classroom, while the others faced 30 to more than 40 learners. Two participants reported multi-grade teaching (teaching more than one grade in the same classroom). Language of teaching-learning was English and/or Afrikaans. Note that two of the ten participants were foundation phase teachers, but due to the intricate workings of the rural school, where they were stationed, they taught intermediate phase mathematics in the absence of other teachers, serving as "back-up" teachers in the intermediate phase.

Design of Teacher Professional Development Intervention

The intervention was conducted on two consecutive Saturdays, indicated as convenient by teachers

(henceforth referred to as participants) themselves and both were half a day in duration. The following section pertains to the design of each day of the intervention, followed by the integration of the ZPTD and then metacognitive awareness as guiding framework.

Program for day one of the intervention

Supporting the notion of structure, the professional development intervention used for the purpose of this research, was scaffolded across the ZPTD as suggested by Warford (2011), stemming from Vygotsky's (1979) zone of proximal development (ZPD).

The metacognitive methodology encouraged teacher participants to be aware of and regulate their cognitive activities in planning for transferring new knowledge about PoP (puppetry) to their own classrooms. (Porthilho & Medina, 2016).

The aim of day one was to introduce the participant teachers to puppetry as a PoP, provide them with puppets, as well as the creating of metacognitive awareness of participants.

Participants were introduced to metacognitive awareness (metacognitive knowledge, self-regulation and reflection) via a PowerPoint presentation and relevant real-life examples. Links were established to the importance of reflective practice in teaching-learning as participants completed reflective prompts after each activity throughout the intervention, fostering metacognitive awareness (including reflection).

Participants were also introduced to cost-effective strategies for teaching-learning mathematics in the intermediate phase via a PowerPoint presentation on a PoP (puppetry) and were also afforded with a puppet of their choosing (**Figure 1**).

Participants engaged in working with the puppets by naming puppets, conceptualizing gimmicks for them and using De Bono's Hats as an activity to brainstorm on their expectations on the effectiveness of the integration of puppetry in intermediate phase mathematics. Participants were tasked to introduce their puppets to their respective intermediate phase mathematics classrooms and reflect via reflective prompts how learners perceived the experience and how teachers experienced the lesson themselves. Feedback was shared on the second Saturday of the intervention.

The puppets afforded to participants, also elicits the unique diversity in South Africa, hence participants could integrate these puppets with more ease in their respective, mathematics classrooms.

Program for day two of the intervention

Participants wrote relevant puppetry scripts and planned a lesson collaboratively. Participants transferred the knowledge gained in the intervention based on metacognitive knowledge and monitored and evaluated their lessons when they taught the lesson in their own schools by means of reflective journals. Participants were able to reflect in depth about the lesson itself before, during and after it was taught in combination with the application of a PoP (puppetry); they described their lived experiences, their strengths and weaknesses during the teaching of their lessons, surprises, frustrations and the impact of teaching-learning with a PoP (puppetry) in the future.

Figure 1. Puppets used in this intervention

Participants started by giving feedback on introducing their puppets (**Figure 1**) to their respective intermediate phase mathematics classrooms, sharing their reflective prompts with each other in the group. This part of the intervention was more hands-on as participants brought materials (such as the CAPS document, textbooks and subject files) along for adapted lesson study to commence.

An adapted lesson study activity

Traditional lesson study refers to classroom research in which a group of teachers examine their teaching-learning praxis of a single lesson which was planned collaboratively, presented by one person from the group and observed by the others and reflecting on the lesson to refine it for future use (Ono & Ferreira, 2010). An adapted version of lesson study was implemented since the participants were from the three participating schools–however some were colleagues at the same school. According to Ono and Ferreira (2010), lesson study is "an activity characterized as classroom-situated, context-based, student-focused, improvement-oriented, collaborative and teacher-owned". Due to constraints such as travelling and teaching multi-grade classrooms, participants were unable to observe or reflect on each other's lessons, hence not being able to adhere to all aspects of traditional lesson study. Adapted lesson study is key in reflection, fostering metacognitive awareness.

The aim of the workshop on the second day was that participants will engage collaboratively in puppetry script writing, where they will base this script on a lesson topic due to teach in the following three weeks. Since puppetry script writing is a complex task which should be scaffolded effectively in the presentation thereof, participants engaged in role play with their puppets, where indigenous South African stories were adapted and mathematised. Participants experienced what contextualizing and mathematising of mathematics topics/concepts/procedures through a script/narrative is infused with mathematical principles, concepts and procedures, based on the context of the school and its learners, making mathematics understandable, meaningful and inclusive (accessible) (van der Walt & Potgieter, 2018).

As participants engaged in collaborative adapted lesson study, they discussed the way in which they wrote scripts and planned their lessons pertaining to the specific topics due to teach in each participants' respective intermediate phase mathematics classroom. According to Darling-Hammond et al. (2009) and Ertesvåg (2011), when teachers collaborate, it becomes a powerful learning environment pertaining to their professional development, since they could reflect upon old and new practices within their school's context while sharing knowledge and expertise. Teachers combined old and new practices and created new and innovative ways of teaching-learning. Participants were tasked to teach the lesson with the integrated script and puppet in their respective intermediate phase mathematics classrooms and to reflect their lived experiences via a reflective journal. The teachers received guidelines (reflective prompts) for becoming reflective practitioners.

Data Collection Procedures

The professional development intervention provided sufficient opportunity for reflection, considering that teachers' need to be supported to rethink their own teaching-learning praxis (Girvan et al., 2016; Nel & Luneta, 2017).

Data was collected before, during and after the intervention by means of the following:

1. Semi-structured open-ended interviews: focused on participants' perceptions on a PoP (puppetry) and metacognitive awareness prior to the intervention.
2. Reflective prompts conducted after each activity throughout the intervention. focused on participants' perceptions of a PoP (puppetry) and metacognitive awareness and how they experienced it throughout the intervention.
3. Observations of participants during the two workshops while they engaged in lesson planning and integration of workshop materials to transfer to their respective teaching-learning praxes.
4. Reflective journals were submitted three weeks after the intervention, providing us with insight on participants' lived experiences on teaching (and learning) with a PoP (puppetry) and their reflections on this experience.

Data Analysis Procedures

The qualitative data obtained for this study, was analyzed by means of content analysis. According to Creswell (2014), content analysis allowed for the strengthening of participants' voices behind their perceptions and experiences, from which rich data emerged, supporting the apparent meaning for the purpose of this research. Data was coded and categorized under themes pertaining to each ZPTD stage (based on the nature of each stage) to identify participants' metacognitive awareness across the ZPTD as shown in **Table 2**.

Furthermore, for the findings emerging from the data analysis to be ethically sound, the following trustworthiness and validity strategies were employed.

Trustworthiness and Validity

Since ethics and trustworthiness is the cornerstone of a sound research endeavor. Trustworthiness and validity are but an element of any research design which should be carried out with great care in order to ensure the ethical correctness of the data collected. Trustworthiness and validity in this study were ensured by applying the following strategies as proposed by McMillan and Schumacher (2014):

1. Various data collection instruments and multiple literature sources were triangulated to confirm findings–in the case of our research, four different data collection instruments spread across four phases of data collection occurring before, during and after our intervention.
2. Data were recorded (voice recording device) during semi-structured open-ended individual interviews to allow accurate transcriptions of data provided by participants–allowing us as researchers to write up the accounts of the

Table 2. Themes identified from findings

Themes identified	Linking themes to a particular ZPTD stage
Prior experiences with teaching-learning	Stage 1: Self assistance and metacognitive knowledge
Beliefs of meaningful teaching-learning and PoP	Stage 2: Expert other assistance and metacognitive knowledge
Personal teaching-learning heuristics and PoP	Stage 3: Internalization and self-regulation
Lived experiences in teaching-learning with PoP	Stage 4: Recursion, self-regulation, and reflection

participants and being able to allocate themes upon working with the analyzing of the data.

3. Participants checked the transcription of their interviews (verbatim accounts), ensuring that an accurate account of the data was captured–making the rigor in which the data was transcribed, accurate and free of researcher bias.

These strategies allowed us to adhere to the ethical standards of a sound study, meaning that we can contribute even further to the growing body of scholarship on the topics identified within this study, hence allowing for the following findings to emerge.

FINDINGS

Note that although the data was collected prior, during, and after the intervention, the findings emerging from these four stages are dependent on one source of data each (i.e., stage 1–interviews; stage 2–reflective prompts; stage 3–observations; and stage 4–reflective journaling. The reason for this was (based on our exploration of how each stage unfolded across the two-day intervention), that these data sources were

(a) most appropriate to employ based on the nature of each stage and the unique design of the intervention and

(b) using four sources of data to gain an understanding of participants' *metacognitive awareness across the ZPTD* and triangulating these four sources to strengthen the rigor and trustworthiness of the data.

In this findings and discussion section, data will be reported on under the headings of each stage instead of the umbrella of each theme as identified in table 2 to ease the link between the findings and metacognitive awareness as scaffolded across the ZPTD for the sake of the reader.

Stage 1: Self Assistance & Metacognitive Knowledge

The following format will be used to report on findings based on participant responses: P1:10 [Participant 1:Line 10] related to stage 1.

During this stage, the findings stemmed from the semi-structured open-ended individual interviews before the intervention, hence hinging on participant perceptions. The self-assistance stage was used as point of departure of participants' actual level of development regarding metacognitive awareness and PoP (puppetry). The input they had given in these interviews was based on prior experiences with and beliefs of teaching-learning of intermediate phase mathematics, such as:

> "… I like doing funny things usually, and I like making everything creative–pictures, and simplifying it. I give myself to the learners and make sure they are empowered" [P1:30, P4:299, P9:915].

Participants reflected on how mathematics as a subject is interpreted for learners to understand it, therefore finding and using multiple ways to represent information to accommodate all learners (Bantwini, 2019), since

> "… I try to bring in new ideas, new ways to solve problems, see different approaches towards teaching" [P2:123 and P8:793].

Declarative knowledge featured here, since participants identified their strengths and weaknesses, influencing their performance (Kallio et al., 2017; Schraw, 1998), eliciting their ideas when teaching intermediate phase mathematics before the intervention since,

> "… I [participant] believe in repetition. I believe in not moving forward until the entire class understands" [P3:194 and P10:1056].

Stage 2: Expert Other Assistance & Metacognitive Knowledge

During this stage, the findings stemmed from the reflective prompts during the intervention, hence hinging on participant experiences. The format P1:3 [Participant 1:Reflective prompt set 3] will be used to report on the findings for this stage.

Participants' metacognitive knowledge was deepened, activating improved reflection on their teaching praxis, while sharing it with knowledgeable others (other participants and intervention facilitators), since puppetry can create:

> "…a fun atmosphere for teaching that is not limited, as a puppet would assist with interaction among fellow classmates" [P6:1].

Therefore, these participants can be deemed as reflective practitioners to a certain extent. Reflective practitioners are merely one of the teaching factors that are part of their array of strategies to teach their intermediate phase mathematics learners in a meaningful way. Participants also observed that:

> "…Puppets are teaching aids that can be used to overcome teaching problems, not only in maths but in other subjects and with [for] other teachers" [P8:1].

Participants reflected critically on the advantages, which a PoP (puppetry) might afford them, since:

> "… Learners will be curious, it will be a novel experience and may encourage their own creativity and metacognition" [P9:1].

They also began to question the effectiveness of such a pedagogy:

> "… What if we used the puppet too often and learners got bored?" [P10:P3],

implicating participants as 'active' in their own learning as encouraged through reflective practice (Clarke & Hollingsworth, 2002, p. 950).

Stage 3: Internalization & Self-Regulation

During this stage, the findings stemmed from the observations during the intervention, hence hinging on participants' lived experiences and integration of new knowledge as obtained within the capacity of this intervention. The format P1 [Participant 1] will be used to report on the findings for this stage.

Participants' application of newly attained knowledge for demonstration purposes where the intervention allowed for a practice situation, leading to internal growth of participants' teaching praxis and self-regulation of their cognition. This stage informed participants as to how they were going to apply PoP (puppetry) in their classrooms and when by consulting peers and collaborating with us as facilitators (expert others). Participants seemed to be *uneasy* at first when enacting the scripts in their collaborative groups. Three scripts were enacted, and feedback based on each enactment were asked from the "audience". Positive comments were made such as

> "… I liked the way in which you used your voice to portray the donkey" [P2].

Critical feedback was also obtained in some instances such as

> "… remember that the puppet should not be "dead", keep it alive on your hand" [P3].

Based on feedback like this, participants continue to investigate their own actions and lived experiences (Mathew et al., 2017). Reflective practices

> "is a process that facilitates teaching, learning and understanding, and it plays a central role in participants' [teachers'] professional development" (Mathew et al., 2017).

Therefore, it seems that participants experienced a growth in their teaching-praxis as they were able to identify certain pitfalls when teaching with a PoP such as puppetry.

Stage 4: Recursion, Self-Regulation, & Reflection

During this stage, the findings stemmed from the reflective journals after the intervention, hence hinging on participant lived experiences. The format P1:10 [Participant 1:Line 10] related to three will be used to report on the findings for this stage. During the recursion stage, participants had another opportunity to engage with a PoP (puppetry), allowing for a smoother utilization of their newly gained knowledge (self-regulation), since:

> "…I [participant] first started by looking at how the learners responded to the puppet then I looked at my script and if there were thing that worked and what did not work and immediately dotted it down so that I could make changes. I also went to the learners' assessment exercises and looked at their results" [P1:5].

Participants felt at times that it was difficult and acknowledged that they needed more practice, since:

> "…teachers can also be barriers to learning. Therefore, it is of importance for teaching to analyze their teaching prior, during and after lessons. In that case diagnosis can take place to allow for tracking of problems which can then be solved" [P1:5].

The way in which participants reflected on their teaching praxis was more detailed as described in their reflective journals, then initially reported on during their semi-structured individual interviews prior to the intervention:

> "…Puppetry will create an expectancy from learners to learn from puppets and stories. This effective method will become more routine and resourceful for me as a teacher. Using the puppets creates a sense of introspection and reliance on critical and creative thinking that is beneficial to making more meaningful lessons in mathematics" [P9:15].

This stage allowed for all the newly gained knowledge obtained, developed and integrated by participants to "fit into the bigger picture", since participants:

> "…appreciated the opportunity and hope that many more schools incorporate this [puppetry] to teaching in classrooms across all subjects" [P1:16; P3:16]

and

> "…I [participants] will be using these workshop resources for a long time from now…They are that resourceful" [P1:16; P4:16; P7:16; P9:16].

Table 3. Main (key) areas related to each stage

Themes identified	ZPTD stage	Brief overview of theme/stage
Prior experiences with teaching-learning	Stage 1: Self assistance and metacognitive knowledge	These experiences informed us that these participants have a willingness, which they gained throughout the intervention, hinging on identifying areas of strengths, and weaknesses pertaining to their own PCK as they discovered what they know (and do not know) about teaching-learning with PoP (puppetry) in the intermediate phase mathematics classroom
Beliefs and reflection on meaningful teaching-learning and PoP	Stage 2: Expert other assistance and metacognitive knowledge	According to Camburn and Han (2015), participants who reflect are more likely to report a change to their professional practice. This notion is asserted by Girvan et al. (2016) stating that although reflection is paramount in teachers' praxis, change is a gradual process relating to the development of innovative practices (such as a PoP–puppetry). Participants' collaboration with each other allowed them to reflect on and realize what their beliefs are to teach meaningfully, always taking their learners into account.
Personal teaching-learning heuristics and PoP	Stage 3: Internalization and self-regulation	In both stages 2 and 3, procedural knowledge, where participants' knowledge about integrating a PoP (puppetry) into their own teaching-learning, based on their own school context surfaced. Participants applied their own heuristics and strategies (self-regulation) to plan their own lessons, although they collaborated with each other throughout this experience (Kallio et al., 2018). Collaboration in this sense might have assisted them with innovative ideas, although each participants' classroom context differs.
Lived experiences in teaching-learning with PoP	Stage 4: Recursion, self-regulation, and reflection	Actual application of new knowledge as gained in the intervention by applying it in their respective classrooms, lead to a "practice opportunity". Participants was able to identify strengths and weaknesses in the planning of their lessons with PoP (puppetry) before (in relation to after) the actual teaching-learning thereof took place. Participants' accounts of how their respective lessons occurred were more in-depth, showing a possible increase in the way they thought of their teaching-learning (i.e. being more metacognitively aware thereof.

DISCUSSION

Table 3 provides a brief discussion of the main (key) areas related to each stage, which will be elaborated on, next.

Overall, it seems as if participants had shown growth (relating to their metacognitive awareness) since before, during and after the intervention, as supported by the ZPTD. This indicates that participants (being knowledgeable in their field of teaching) developed potentially (proximal development). Interventions reported by De Beer and Kriek (2018) implemented the principles of ZPTD as described by Warford (2011) for professional development of science teachers in South Africa. These authors reported enhanced transference and application of new knowledge by participants and derived design principles for future professional development endeavors. Their work link to that of Kennedy (2014) namely

(i) identification of problems central to teaching-learning that is subject related and

(ii) devising a pedagogy that can assist teachers in infusing these new ideas into their teaching praxis.

De Beer and Kriek (2018) and Kennedy (2014) confirms the notion of the importance of metacognitive awareness interwoven into professional development according to the ZPTD.

Participants obtained valuable teaching (and learning) insights during our intervention, allowing them to integrate this new knowledge with their existing praxis [conditional knowledge], leading to actual application in their respective intermediate phase mathematics classrooms. Conditional knowledge featured as teaching strategies employed by participants, where they applied the knowledge gained in the intervention, for the purpose of their classroom. Hence combining declarative and procedural knowledge (Dogan & Cephe, 2018; Schraw, 1998). Participants' experiences after the intervention, reflects growth which might implicate that the quality of the intervention impacted positively on their metacognitive awareness pertaining to a PoP [puppetry] which they transferred in their respective classrooms and school contexts.

Limitations of This Research

The following limitations were identified in this research:

1. The findings may not be sufficient to generalize from. Since there only participated 10 teachers, the sample for this study was small in comparison to large scale (usually quantified) studies in educational research.
2. The researchers were not present when participants presented their lessons, hence we are reliant on their reflective journals' data.

Participants received a reflective journal with prompts to assist them in the capturing of their experiences and perceptions. It might have added more value to be present while these participants taught their lessons and maybe recording their lessons which they can disseminate at another workshop or work session at their respective schools as part of the adapted lesson study approach fostered in this research.

3. Time limitations to implement newly gained knowledge was too few. We would suggest for future research endeavors, to allow participants more time to implement puppetry into their classrooms and to become more accustomed to teaching-learning with puppets. This might contribute to less anxious teachers, implementing puppetry as they had a six-month time frame (for instance) to practice (and gain experience) on the integration of puppetry in the intermediate phase mathematics classroom.

CONCLUSION & RECOMMENDATIONS

The research in this paper contributed to the growing body of knowledge on metacognitive awareness and teacher professional development for intermediate phase mathematics teachers in the South African context. Since participants were able to reflect metacognitively (based on their perceptions and lived experiences) on the teaching-learning with a PoP (puppetry), the results of this generic qualitative study might distil design principles from this intervention for future research (or teaching) endeavors. The participants also developed across the stages of the ZPTD (Warford, 2011) across the four stages deemed key in planning and implementing professional development interventions, as reported in this paper. Participants' development where they obtained valuable teaching-learning strategies facilitated by capable others, served as a means to investigate the theory-practice divide in mathematics education. Therefore, this research may feature as a springboard from which collaboration among intermediate phase mathematics teachers may be improved and sustained in their respective schools, since participants became metacognitively aware of the important role of reflection in their teaching (and own learning).

We recommend that research exploring a three-fold relationship between metacognitive awareness, the ZPTD and intermediate phase mathematics, should be conducted at a larger scale as time limitations (forming part of this master's degree study), probably impacted on possible follow-up interviews which could have been conducted with participants. Follow-up interviews could have contributed to the descriptions and meaning behind participant experiences. Classroom visits could also have strengthened data collection of this paper, as it could feature as extended participant support as well as a measure to view whether participants tended to revert to traditional teaching-learning in the intermediate phase mathematics classroom. Research on a PoP (puppetry) could also focus more broadly on the teaching-learning of mathematics not just in the intermediate phase, but across various phases in the South African schooling system.

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REFERENCES

Ahlcrona, M. F., & Östman, A. (2018). Mathematics and puppet play as a method in the preschool teacher education. *Creative Education*, *9*(10), 1536-1550. https://doi.org/10.4236/ce.2018.910113

Bantwini, B. D. (2010). How teachers perceive the new curriculum reform: Lessons from a school district in the Eastern Cape Province, South Africa. *International Journal of Educational Development*, *30*(1), 83-90. https://doi.org/10.1016/j.ijedudev.2009.06.002

Bantwini, B. D. (2017). Analysis of teaching and learning of natural sciences and technology in selected Eastern Cape province primary schools, South Africa. *Journal of Education, 67*, 39-64.

Bantwini, B. D. (2019). Developing a culture of collaboration and learning among natural science teachers as a continuous professional development approach in a province in South Africa. *Teacher Development, 23*(2), 213-232. https://doi.org/10.1080/13664530.2018.1533491

Bertram, C. (2011). What does research say about teacher learning and teacher knowledge? Implications for professional development in South Africa. *Journal of Education, 52*, 3-26.

Botha, A., & Herselman, M. (2016). Rural teachers as innovative co-creators: An intentional teacher professional development strategy. In *Proceedings of CONF-IRM 2016*.

Camburn, E. M., & Han, S. W. (2015). Infrastructure for teacher reflection and instructional change: An exploratory study. *Journal of Educational Change, 16*(4), 511-533. https://doi.org/10.1007/s10833-015-9252-6

CDE. (2007). Doubling for growth addressing the maths and science challenge in South Africa's schools. *Centre for Development and Enterprise*. https://www.africaportal.org/publications/doubling-for-growth-addressing-the-maths-and-science-challenge-in-south-africas-schools/

Chigonga, B., & Mutodi, P. (2019). The cascade model of mathematics teachers' professional development in South Africa: How well did it suit them? *EURASIA Journal of Mathematics, Science and Technology Education, 15*(10), em1761. https://doi.org/10.29333/ejmste/109261

Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education*, *18*(8), 947-967. https://doi.org/10.1016/S0742-051X(02)00053-7

Coe, K., Frick, L., & Carl, A. (2010). Lesson study in continuing professional teacher development: A South African case study. *Acta Academica*, *42*(4), 206-230.

Cornoldi, C. (2009). Metacognition, intelligence and academic performance. In H. S. Waters, & W. Schneider (Eds.), *Metacognition, strategy use, and instruction* (pp. 257-277). Guilford Press.

Creswell, J. W. (2014). *A concise introduction to mixed methods research*. SAGE.

Darling-Hammond, L., Wei, R. C., Andree, A., Richardson, N., & Orphanos, S. (2009). Professional learning in the learning profession: A status report on teacher development in the US and abroad. *National Staff Development Council*. https://edpolicy.stanford.edu/sites/default/files/publications/professional-learning-learning-profession-status-report-teacher-development-us-and-abroad.pdf

DBE. (2011). Mathematics intermediate phase. Grade 4-6. CAPS. *South Africa Department of Basic Education. Curriculum Assessment Policy Statement*. http://www.dsj.co.za/export/sites/dsj/downloads/dsj_pdfs/Curriculum/IP-MATHEMATICS-GR-4-6-web.pdf

De Beer, J., & Kriek, J. (2018). Teacher professional development interventions that enable transfer of competencies in the science classroom. In *Proceedings of the 9th Annual Conference on Mathematics, Science and Technology Education* (pp. 22-26).

Dogan, S. H., & Cephe, P. T. (2018). A suggested syllabus for creative drama course in ELT. *Dil ve Dilbilimi Çalışmaları Dergisi* [*Journal of Language and Linguistic Studies*], *14*(2), 305-324.

Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. *European Psychologist*, *13*(4), 277-287. https://doi.org/10.1027/1016-9040.13.4.277

Ernest, P. (1998). *Social constructivism as a philosophy of mathematics*. SUNY Press.

Ernest, P. (2018). *The philosophy of mathematics education today*. Springer. https://doi.org/10.1007/978-3-319-77760-3

Ertesvåg, S. K. (2011). Improving teacher collaboration: The role of classroom characteristics and individual factors on teachers' collaboration: A latent growth curve approach. In *Proceedings of the International Congress for School Effectiveness and Improvement* (pp. 4-7).

Ertmer, P. A., & Newby, T. J. (1996). The expert learner: Strategic, self-regulated, and reflective. *Instructional Science, 24*(1), 1-24. https://doi.org/10.1007/BF00156001

Fani, T., & Ghaemi, F. (2011). Implications of Vygotsky's zone of proximal development (ZPD) in teacher education: ZPTD and self-scaffolding. *Procedia-Social and Behavioral Sciences, 29*, 1549-1554. https://doi.org/10.1016/j.sbspro.2011.11.396

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

Fourie, A. (2009). *Puppetry as an educational tool: An explanatory study on the perceptions of foundation phase educators and learners* [Master's thesis, Tshwane University of Technology].

Frey, B. B. (2018). *The SAGE encyclopedia of educational research, measurement, and evaluation*. SAGE. https://doi.org/10.4135/9781506326139

Girvan, C., Conneely, C., & Tangney, B. (2016). Extending experiential learning in teacher professional development. *Teaching and Teacher Education, 58*, 129-139. https://doi.org/10.1016/j.tate.2016.04.009

Haiyan, Q., Walker, A., & Xiaowei, Y. (2017). Building and leading a learning culture among teachers: A case study of a Shanghai primary school. *Educational Management Administration & Leadership*, *45*(1), 101-122. https://doi.org/10.1177/1741143215623785

Hunzicker, J. (2011). Effective professional development for teachers: A checklist. *Professional Development in Education*, *37*(2), 177-179. https://doi.org/10.1080/19415257.2010.523955

Jansen, J., & Taylor, N. (2003). Educational change in South Africa 1994-2003: Case studies in large-scale education reform (No. 28250, p. 1). *The World Bank*. http://documents.worldbank.org/curated/en/129941468778149162/pdf/282500PAPER0Ed1outh0Africa01Public1.pdf

Kallio, H., Virta, K. P., Kallio, M. P. M., Virta, A., Hjardemaal, F., & Sandven, J. (2017). The utility of the metacognitive awareness inventory for teachers among in-service teachers. *Journal of Education and Learning, 6*(4), 78-91. https://doi.org/10.5539/jel.v6n4p78

Kallio, H., Virta, K., & Kallio, M. (2018). Modelling the components of metacognitive awareness. *International Journal of Educational Psychology*, *7*(2), 94-122. https://doi.org/10.17583/ijep.2018.2789

Kapur, R. (2018). *The significance of social constructivism in education*. https://www.researchgate.net/publication/323825342_The_Significance_of_Social_Constructivism_in_Education/link/5aac7f260f7e9b4897bc9b68/download

Kennedy, A. (2014). Understanding continuing professional development: the need for theory to impact on policy and practice. *Professional Development in Education, 40*(5), 688-697. https://doi.org/10.1080/19415257.2014.955122

Keogh, B., Naylor, S., Maloney, J., & Simon, S. (2008). Puppets and engagement in science: A case study. *Nordic Studies in Science Education, 4*(2), 142-150. https://doi.org/10.5617/nordina.289

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press. https://doi.org/10.1017/CBO9780511815355

Legg, A. M., & Locker, L., Jr. (2009). Math performance and its relationship to math anxiety and metacognition. *North American Journal of Psychology, 11*(3), 471-486.

Lerner, R. M., Brindis, C. D., Batanova, M., & Blum, R. W. (2018). Adolescent health development: A relational developmental systems perspective. In N. Halfon, C. B. Forrest, R. M. Lerner, & E. M. Faustman (Eds.), *Handbook of life course health development* (pp. 109-121). Springer. https://doi.org/10.1007/978-3-319-47143-3_6

Lindqvist, G. (1996). The aesthetics of play. A didactic study of play and culture in preschools. *Early Years, 17*(1), 6-11. https://doi.org/10.1080/0957514960170102

Lortie, D. C. (1975). *Schoolteacher: A sociological study*. University of Chicago Press.

Luneta, K. (2012). Designing continuous professional development programmes for teachers: A literature review. *Africa Education Review*, *9*(2), 360-379. https://doi.org/10.1080/18146627.2012.722395

Marton, F., & Booth, S. A. (1997). *Learning and awareness*. Psychology Press.

Mathew, P., Mathew, P., & Peechattu, P. J. (2017). Reflective practices: A means to teacher development. *Asia Pacific Journal of Contemporary Education and Communication Technology*, *3*(1), 126-131.

Meijs, C., Prinsen, F. R., & de Laat, M. F. (2016). Social learning as approach for teacher professional development; how well does it suit them? *Educational Media International*, *53*(2), 85-102. https://doi.org/10.1080/09523987.2016.1211333

Mestry, R., Hendricks, I., & Bisschoff, T. (2009). Perceptions of teachers on the benefits of teacher development programmes in one province of South Africa. *South African Journal of Education*, *29*(4), 475-490. https://doi.org/10.15700/saje.v29n4a292

Minott, M. A. (2010). Reflective teaching as self-directed professional development: Building practical or work-related knowledge. *Professional Development in Education*, *36*(1-2), 325-338. https://doi.org/10.1080/19415250903457547

Ono, Y., & Ferreira, J. (2010). A case study of continuing teacher professional development through lesson study in South Africa. *South African Journal of Education*, *30*(1), 59-74. https://doi.org/10.15700/saje.v30n1a320

Overholt, K. (2010). *The incorporation of puppetry into reading instruction* [Master's thesis, The College at Brockport].

Potgieter, E. (2020). *Pedagogies of play to develop intermediate phase mathematics teachers' metacognitive awareness* [Unpublished master's dissertation]. North-West University.

Sadler-Smith, E., Zhang, L. F., Sternberg, R. J., & Rayner, S. (2012). Metacognition and styles. In L.-F. Zhang, R. J. Sternberg, S. Rayner (Eds.), *Handbook of intellectual styles: Preferences in cognition, learning, and thinking* (pp.153-172). Springer.

Schraw, G. (1998). Promoting general metacognitive awareness. *Instructional Science*, *26*(1-2), 113-125. https://doi.org/10.1023/A:1003044231033

Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology, 19*(4), 460-475. https://doi.org/10.1006/ceps.1994.1033

Shimamura, A. P. (2000). Toward a cognitive neuroscience of metacognition. *Consciousness and Cognition, 9* (2 Pt 1), 313-323. https://10.1006/ccog.2000.0450

Simon, M., Goes, J. (2013). *Dissertation and scholarly research: Recipes for success*. Dissertation Success, LLC.

Stronge, J. H. (2007). *Qualities of effective teachers*. Association for Supervision and Curriculum Development.

van der Walt, M. S., & Potgieter, E. (2018). *Tshimologo: A new dawn for self-directed learning and mathematics education* [Paper presentation]. The UNISA/ISTE Conference on Mathematics, Science and Technology Education. Kruger National Park, South Africa.

van der Walt, M., Potgieter, E., & Jagals, D., (2019). The affordances of indigenous knowledge in mathematics education. In J. De Beer (Ed.), *The decolonisation of the curriculum project: The affordances of indigenous knowledge for self-directed learning* (pp. 181-222). AOSIS. https://doi.org/10.4102/aosis.2019.BK133.07

Voogt, J., & Knezek, G. (2008). *International handbook of information technology in primary and secondary education*. Springer Science & Business Media. https://doi.org/10.1007/978-0-387-73315-9

Vygotsky, L. S. (1967). Play and its role in the mental development of the child. Soviet Psychology, 5(3), 92-104. https://doi.org/10.2753/RPO1061-040505036

Vygotsky, L. S. (1978). *Mind in society*. Harvard University Press.

Vygotsky, L. S. (1979). Concrete human psychology. *Soviet Psychology, 27*(2), 53-77. https://doi.org/10.2753/RPO1061-0405270253

Warford, M. K. (2011). The zone of proximal teacher development. *Teaching and Teacher Education*, *27*(2), 252-258. https://doi.org/10.1016/j.tate.2010.08.008

Williams, M. L. (2010). Teacher collaboration as professional development in a large, suburban high school. *Digital Commons*. https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1094&context=cehsdiss