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Assessing the Transformative Potential of Participatory Action Research (PAR) as a Catalyst for Empowering Mathematics Educators

Matshidiso Mirriam Moleko [1] & Mncedisi Christian Maphalala [1]
[1] Department of Curriculum & Instructional Studies, University of South Africa, Pretoria, South Africa.

ABSTRACT
This qualitative study explores the transformative potential of Participatory Action Research (PAR) as a catalyst for empowering mathematics educators. The study highlights the experiences of the ten (10) in-service teachers who engaged in a yearlong PAR community engagement project. The focus was empowering the senior phase mathematics teachers with skills and knowledge to innovate and transform their teaching practices. This study is underpinned by two theories, namely Critical Emancipatory Research (CER) and Community of Practice (CoP). Data were collected through focus group discussions and reflection sessions. Therefore, the study focused on how teachers perceived the PAR approach and its influence on their practices. The findings revealed that PAR can restore working relationships, reignite the passion for teaching mathematics, unlock teachers' full potential, and foster a sense of ownership and contribution within the educational field. Furthermore, PAR emerges as a powerful tool for providing meaningful learning experiences for mathematics educators. These findings advocate the strategic integration of PAR in promoting the scholarship of teaching and learning mathematics (SoTLM) and underscore its role in driving transformative change in educational practices.

Keywords: *Approach, Community of Practice, Participatory Action Research, Transformation*

Correspondence
Matshidiso Mirriam Moleko
Email:
molekmm1@unisa.ac.za

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INTRODUCTION
The field of Mathematics Education continues to grow significantly, due to its complex nature regarding teaching, learning, and the implementation of scholarly research into the transfer of mathematical knowledge.[1] It is one of the national priorities in South Africa (SA) as highlighted in the Executive Summary of the National Development Plan (NDP), which also indicates the demand for an increase in the number of students achieving above 50%.[2] Although the recommendations have been made to achieve this national goal – (i.e. an increase in the number of students achieving above 50%), experts have continued to decry the poor performance of South African learners in mathematics,

[1] Zdenka Kolar-Begovic, Ružica Kolar-Šuper, and Ljerka Jukic Matic, "Mathematics Education as a Science and a Profession.," *Online Submission*, 2017.
[2] National Planning Commission, "National Development Plan 2030: Our Future-Make It Work," 2012.

campared to their peers from other countries.[3] It is concerning that the Trends in International Mathematics and Science Study (TIMMS), found the average mathematics performance of South African learners to be well below the international benchmark.[4] The poor state of mathematics education in South Africa is further revealed by the low ranking of South African learners' mathematics performance in the bottom six of 63 participating countries.[5]

One of the contributing factors to the poor performance of learners in mathematics in SA is the teachers' limited understanding of the mathematical content, which is required to teach effectively.[6] The current critical challenges faced by teachers in SA and many other countries with emerging and developing economies relate to their lack of mathematical content knowledge (MCK), and the skills required to apply their knowledge in the classroom.[7] According to Rowland and Ruthven, the quality of teaching depends on the knowledge the teacher brings to the classroom, which in this case, seems to be a challenge considering the limited content knowledge of some teachers.[8] Therefore, it is reasonable to indicate that mathematics teachers who have a limited understanding of the content cannot teach mathematical concepts productively. According to Sibuyi, teachers with limited knowledge of the content, find it difficult to assist learners develop mastery of mathematical concepts.[9] Another major challenge is that higher education institutions do not adequately train mathematics teachers in other important aspects, such as promoting inclusive, accessible, and innovative teaching practices which are also crucial in teaching and learning.[10] Thus, many of these teachers rely on the professional development programs that are put in place by the Department of Education (DoE) to enrich their skills to teach mathematics effectively.

The DoE provides professional development programmes that mainly focus on content. Though the programmes improve the teachers' content knowledge (CK), they do not allow teachers to reflect on their experiences and practices. Furthermore, they occur only a few times a year, with no follow-ups being made to monitor/record the progress.[11] There is currently no official model of professional development that is tailor-made to foster continuous reflection and promote the sharing of experiences, practices, and collaboration amongst mathematics teachers. Reflection is an important practice that gives teachers opportunities to contemplate the work that they are doing, analyse, question their teaching methods, share their experiences, and learn from one another.[12] This means that "rather than rely on the authority of others, their own impulse, or unexamined previous practices, they as teachers continually examine and evaluate their attitudes, practices, effectiveness, and accomplishments."[13] Hence, this makes reflection an essential practice to foster teacher development and evolution. Therefore, the study aimed to explore the transformative potential of RAR as a catalyst for empowering mathematics educators for sustainable learning and development. The study thus contributes a new form of a secondary teacher professional development model for mathematics as a strategic approach for sustainable teaching and learning and for promoting SoTLM. The findings of

[3] M E Letsoalo, J K Masha, and R S Maoto, "The Overall Performance of Grade 12 Mathematics and Physical Science Learners in South Africa's Gauteng Province," *African Journal of Gender, Society & Development* 8, no. 1 (2019): 9.
[4] Mariette Visser, Andrea Juan, and Nosisi Feza, "Home and School Resources as Predictors of Mathematics Performance in South Africa," *South African Journal of Education* 35, no. 1 (2015).
[5] Nicholas Spaull, "South Africa's Education Crisis: The Quality of Education in South Africa 1994-2011," *Johannesburg: Centre for Development and Enterprise* 21, no. 1 (2013): 1–65.
[6] G Stols et al., "Perceptions and Needs of South African Mathematics Teachers Concerning Their Use of Technology for Instruction," *South African Journal of Education* 35, no. 4 (2015): 1–13.
[7] Stols et al., "Perceptions and Needs of South African Mathematics Teachers Concerning Their Use of Technology for Instruction."
[8] Tim Rowland and Kenneth Ruthven, "Introduction: Mathematical Knowledge in Teaching," in *Mathematical Knowledge in Teaching* (Springer, 2010), 1–5.
[9] Charles Duzephi Sibuyi, *Effective Teachers' Pedagogical Content Knowledge in Teaching Quadratic Functions in Mathematics* (University of Pretoria (South Africa), 2012).
[10] K. G. Seitisho, " A Strategy to Enhance the Teaching of Geometry in Grade 9: A Universal Design for Instruction Approach " (University of the Free State, 2022).
[11] Matheko Thabo Thamae, "The Teaching of Euclidean Geometry: A Universal Design for Learning Approach," 2022.
[12] Cias Thapelo Tsotetsi, "The Implementation of Professional Teacher Development Policies: A Continuing Education Perspective" (University of the Free State, 2013).
[13] Hibajene M Shandomo, "The Role of Critical Reflection in Teacher Education.," *School-University Partnerships* 4, no. 1 (2010): 101–13, 103.

the study may not only inform future professional development initiatives but also promote transformative teaching practices, drive meaningful change in mathematics education, and inform professional development in other fields.

LITERATURE REVIEW

Participatory Action Research as an Educational Enquiry

A positivistic approach in research beholds researchers as powerful, competent, and knowledgeable people than the "participants/researched".[14] In this mode of research, the participants (i.e. people who participate in the study/research) are viewed as subjects and are "treated as molecules in the laboratory or as mere respondents whose task is to provide the researcher with data".[15] Furthermore, in a traditional positivistic approach, the individuals' conceptions of the world are regarded as insignificant in scientifically based research.[16] Contrary to a positivistic approach, several postmodern approaches, including PAR, inform this study. Like other postmodern approaches, the PAR approach refutes the prospect of objective knowledge's existence.[17] It acknowledges the existence of multiple realities which are dependent on the different experiences, contexts, and schools of thought. The collaborative nature of PAR creates multiple realities, making room for the selection of working solution(s). Thus, PAR appreciates the diverse skills, knowledge and experiences that the "participants" have. These varied skills, knowledge and experiences make them equal to the researcher within the PAR framework. Hence Martin et al. stress the point that the participants should be referred to as co-researchers in a PAR mode of inquiry.[18]

In participatory action research, the society members and inquisitors work together to achieve a similar purpose. This means that PAR inspires a community of practice wherein teachers who work together over a certain period eventually, "develop a shared repertoire of resources: experiences, stories, tools, ways of addressing recurring problems - in short a shared practice".[19]

The co-researchers (also known as participants/researched) are therefore perceived as capable humans who can identify and implement solutions to address their problems.[20] This means that their status is elevated and equated with that of the researcher who is often perceived as a more knowledgeable other. Although PAR is often used mainly as a form of research design for generating raw data, its collaborative, empowering, and participatory nature has prompted a shift in its use. This shift is seen recently wherein some researchers and scholars adopt or use it as a lens to guide their studies, as well as an approach to educational inquiry.[21] PAR as an educational enquiry is essential for leveraging the collective wisdom of the researchers, "participants", and communities under study, thus achieving more meaningful findings and recommendations. Often, the research that is conducted in educational settings, leaves out the teachers who have a wealth of knowledge and experience that can be better shared by them, since they are involved in day-to-day teaching and learning activities and

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[14] Sechaba Mahlomaholo, *Re-Membering the Organic Intellectual in the Mirror* (Potchefstroom: Noordwes-Universiteit, Potchefstroomkampus (Suid-Afrika), 2009).
[15] Blossom B Shangase, "Strategies for the Implementation of Further Education and Training Learner Attainment Improvement Plan" (University of the Free State (Qwaqwa Campus), 2013), 10.
[16] T. Meko, "A Framework to Enhance Parental Engagement in Schools" (University of Free State, South Africa, 2013).
[17] Molebatsi Milton Nkoane, "Critical Emancipatory Research for Social Justice and Democratic Citizenship," *Perspectives in Education* 30, no. 4 (2012): 98–104.
[18] Staci B Martin et al., "Participatory Action Research and Co-Researching as a Tool for Situating Youth Knowledge at the Centre of Research.," *London Review of Education* 17, no. 3 (2019): 297–313.
[19] Etienne Wenger, "Communities of Practice: The Key to Knowledge Strategy," in *Knowledge and Communities* (Routledge, 2009), 3–20.
[20] Tsotetsi, "The Implementation of Professional Teacher Development Policies: A Continuing Education Perspective."
[21] Pranee Liamputtong and Zoe Sanipreeya Rice, "Participatory Research and Theoretical Lenses," in *Handbook of Social Inclusion: Research and Practices in Health and Social Sciences* (Springer, 2021), 1–17; Francesca Robertson et al., "Participatory Action and Dual Lens Research," *Qualitative Research Journal* 17, no. 4 (2017): 283–93; Ahna Ballonoff Suleiman et al., "Applying a Developmental Lens to Youth-Led Participatory Action Research: A Critical Examination and Integration of Existing Evidence," *Youth & Society* 53, no. 1 (2021): 26–53; Bunmi Isaiah Omodan and Nontyatyambo Pearl Dastile, "Analysis of Participatory Action Research as a Decolonial Research Methodology," *Social Sciences* 12, no. 9 (2023): 507; Poul Rohleder et al., "Through a Personal Lens: A Participatory Action Research Project Challenging Myths of Physical Disability and Sexuality in South Africa," in *The Routledge Handbook of Disability and Sexuality* (Routledge, 2020), 378–90.

processes. Thus, in her study, Moleko encourages researchers to undertake PAR studies in educational settings to give the teachers opportunities to narrate their experiences and to share the best practices.[22] Making teachers the co-researchers and active knowledge co-constructors in the research process is not only good for elevating their status, but also for making them realise the contribution they are making in the field, celebrating their achievements, and gaining the skill and knowledge that they can use, even beyond the researcher's existence when the study has been concluded. Based on these perspectives, therefore, PAR in the educational setting is rooted in the principles of collaboration, empowerment, and social justice.

In terms of collaboration, PAR as an educational enquiry requires the stakeholders to work collaboratively to address their issue(s).[23] This collaboration promotes engagements and interactions that are necessary to produce the working solutions and new knowledge that will bring about positive impact and transformation.[24] According to Shangase, collaboration is important because it sparks debates that are essential to produce solutions to problems.[25] Through collaboration, the possibilities of obtaining multiple, working solutions to the problem are probable and high, as opposed to an individual working alone.[26] Therefore, it is through such collaborations that teachers can combine their experiences, share ideas, and learn from one another.

Moleko argues that the only way people can improve their situations is when they are empowered and enlightened.[27] Thus, PAR as an educational enquiry provides a space for mutual debates and information sharing that leads to empowering the individuals. The shared debates play a critical role in facilitating understanding on the part of the teachers, regarding their challenges. It is only when teachers are empowered that they can fully take charge of their situation. In line with this assertion, Sharp avows that teachers who are empowered, develop the sufficiency to improve the teaching and learning process.[28]

Tlali postulates that classrooms must be regarded as vital spaces wherein social justice is exemplified and exercised.[29] In accordance, Shangase emphasises the need for social justice values to be integrated across the curriculum.[30] One way to promote social justice in our schools, as suggested by Tsotetsi, is for principals as school leaders to create spaces that value and celebrate diversity (spaces where everybody is acknowledged for their existence and contribution and is given a fair chance to participate and express themselves in a manner in which they feel comfortable).[31] This, therefore, means that the principals should perceive teachers as capable speaking beings, worthy to be encouraged to share their varied and unique practices, perspectives, and experiences.[32]

Collaboration, participation, inclusion, empowerment, and social justice are some of the PAR key principles that make it a distinct, transformative, and powerful action-oriented inquiry towards social transformation.[33] These principles are essential to drive meaningful change within educational

[22] Mirriam Matshidiso Moleko, "Enhancing the Functionality of Supplemental Instruction for First-Year Mathematics Students at a Higher Education Institution" (University of the Free State, 2014).
[23] John Ranatane Phori, "Enhancing Collaborative Skills among Members of the School Governing Body" (University of the Free State, 2016).
[24] Kholeka Constance Moloi, "The Complexity of Dealing with Change in the South African Schooling System: 20 Years into Democracy," *African Identities* 12, no. 3–4 (2014): 264–82.
[25] Shangase, "Strategies for the Implementation of Further Education and Training Learner Attainment Improvement Plan."
[26] Chris Silvia, "Evaluating Collaboration: The Solution to One Problem Often Causes Another," *Public Administration Review* 78, no. 3 (2018): 472–78.
[27] Moleko, "Enhancing the Functionality of Supplemental Instruction for First-Year Mathematics Students at a Higher Education Institution."
[28] Paul Sharp, *Diplomatic Theory of International Relations*, vol. 111 (Cambridge University Press, 2009).
[29] Moeketsi Freddie Tlali, "Enhancing Synergy: A Strategic Interrogation of the Intersection between Social Justice and the Creation of Sustainable Learning Environments," *Journal of Educational Studies* 12, no. 1 (2013): 61–75.
[30] Shangase, "Strategies for the Implementation of Further Education and Training Learner Attainment Improvement Plan."
[31] Tsotetsi, "The Implementation of Professional Teacher Development Policies: A Continuing Education Perspective."
[32] H Campanella, "Emancipatory Research Ppt Presentation," *Understanding Emancipatory Research*, 2009.
[33] Stephen Kemmis, "Critical Theory and Participatory Action Research," *The SAGE Handbook of Action Research: Participative Inquiry and Practice* 2, no. 2008 (2008): 121–38.

settings. PAR values experiential knowledge in addressing problems, and envisaging and implementing alternatives.[34]

THEORETICAL FRAMEWORK

The study was underpinned by two theories, namely CER and CoP. CER contends that knowledge is constructed by human beings through their experiences, further maintaining that the search for knowledge must be based on a quest to hone the quality of human life.[35] In line with this, CER, therefore, requires people to embrace their experiences and regard them as "resources" that they can use to develop themselves and improve their lives. CER further requires people with a common vision to collaborate to share insights and experiences and learn from one another.[36]

Likewise, a CoP theory accentuates the idea of people working together and learning from what they have done together.[37] CoP often develops around issues that matter to the people working together.[38] Consequently, the practices of these people reflect their understanding of what is imperative in their context. CoP constitutes three elements, namely, purpose, people, and practice.

CER is rooted in the principles of social justice.[39] It challenges existing power structures, addresses systemic inequalities, and promotes emancipation and empowerment among marginalised individuals or groups.[40] CER provides a framework for understanding how PAR can empower mathematics teachers to innovate and transform their teaching practices.

CoP Theory posits that learning occurs within social contexts where individuals engage in shared practices, collaborate, and collectively construct knowledge.[41] In the context of this study, CoP theory provides a lens through which we can understand how participation, engagement and collaboration in a PAR community of practice influence teachers' professional growth and learning.

CER and CoP were deemed suitable for this study due to their common advocacy of fostering inclusion, engendering the appreciation of diversity in terms of different perspectives, and promoting participation, empowerment, social justice, and interdependence whilst striving to form an evolving, decent community practice. The study, therefore, seeks to confirm or refute Mahlomaholo's assertion that doing CER research creates opportunities for teachers to work together, learn from one another, and be passionate about what they do. [42]

Context of the Study

This study was part of the bigger PAR project, conducted in the Free State, Motheo district, wherein ten (10) grade 9 mathematics teachers from different schools in one cluster were involved. These teachers were involved in the PAR project from its inception when they worked with the researcher in her PhD study at the time. The project continued even after the researcher's PhD completion, and her name in this study is Dr. Zaqa (*nom de plume*). The teachers were therefore selected to participate in this study because of their knowledge of participatory action research and having applied it on their own when the researcher was no longer with them. The schools where these teachers taught were close to the researcher's residence, making it easy for the researcher to access the schools. Furthermore,

[34] Flora Cornish et al., "Participatory Action Research," *Nature Reviews Methods Primers* 3, no. 1 (2023): 34.
[35] Joy Higgs et al., "Becoming Critical and Creative in Qualitative Research," in *Being Critical and Creative in Qualitative Research* (Hampden Press, 2007), 1–10.
[36] Delisile Immaculate Hlomuka, "Foundations for Learning Campaign: A Framework for Effective Implementation of the Campaign towards Sustainable Learning Environment" (University of the Free State, 2014).
[37] Jen Harvey et al., "Cultivating a Community of Practice Model to Support and Encourage Innovative T&L Practices to Engage Practitioners and Enhance Student Success," *Irish Journal of Academic Practice* 9, no. 2 (2021): 3.
[38] Shannon L Sibbald et al., "Building a Virtual Community of Practice: Experience from the Canadian Foundation for Healthcare Improvement's Policy Circle," *Health Research Policy and Systems* 20, no. 1 (2022): 95.
[39] Tlali, "Enhancing Synergy: A Strategic Interrogation of the Intersection between Social Justice and the Creation of Sustainable Learning Environments."
[40] Sechaba Mahlomaholo, "Critical Emancipatory Research and Academic Identity," *Africa Education Review* 6, no. 2 (2009): 224–37.
[41] Bernadette Mercieca, "What Is a Community of Practice?," *Communities of Practice: Facilitating Social Learning in Higher Education*, 2017, 3–25.
[42] Mahlomaholo, "Critical Emancipatory Research and Academic Identity."

these teachers were passionate about the PAR project and were willing to participate in studies that were related to it.

METHODOLOGY

The study aimed to explore the transformative potential of PAR as a catalyst for empowering mathematics educators. The study used an interpretive paradigm and involved 10 grade 9 mathematics teachers from 10 high schools in the Free State Province, Motheo district. Since the study aimed to gain a deeper understanding of PAR as a potential transformative catalyst for empowering mathematics educators, an exploratory case study was employed. The design was used to explore and generate new insights from the 10 teachers involved in the study. Focusing on a few participants provided rich and detailed data from the teachers. A homogenous purposive sampling was used to select 10 grade 9 mathematics teachers with similar characteristics (Etikan, Musa & Alkassim, 2016). Two workshops were conducted, in which open-ended surveys were administered, one focus group discussion and two reflection sessions were conducted. The focus group discussion was conducted to give the grade 9 mathematics teachers, who were purposively selected, the opportunity to discuss the issues in depth. The free attitude interview (FAI) technique facilitated the discussions. Conversely, the reflection sessions were conducted to allow teachers to share their experiences, thus, making them feel understood and heard.[43] Each teacher was allowed to reflect on their experiences regarding the PAR project. The feedback evaluation form was also used to gather data from teacher attendees on aspects such as quality, workshop content, facilitation, and organization. However, since the study aimed to highlight the teachers' experiences who engaged in a yearlong PAR community engagement project, the data related to their experiences regarding PAR was extracted from the evaluation forms.

Data Analysis

Transcripts from the audio-recorded focus group discussion, reflection sessions, and data from the open-ended evaluation forms were analyzed. A thematic analysis generated themes from the recorded discussions and open-ended evaluation forms. Braun and Clarke's six steps of data analysis, namely, "familiarisation of data, generation of codes, combining codes into themes, reviewing themes, determining the significance of themes and reporting the findings," were followed.[44] CER and CoP were used to make sense of the data.

The ten grade 9 experienced mathematics teachers who participated in the study, provided rich insights and data triangulation through three data collection instruments. The use of FAI during the focus group discussion prompted teachers to discuss in-depth their views on the transformative potential of PAR as a catalyst for empowering them. Participatory action research is a cyclical process that involves the following stages, "diagnosing, action planning, taking action, evaluating, and specifying learning." [45] Therefore, the data reported in this article were taken from the reflection/evaluation phase.

Ethical Considerations

Permission to conduct the study was obtained from the Department of Education and the schools where the study was conducted. The ethical clearance certificate (UFS-HSD2016/1194) was obtained to conduct the study. The consent forms were given to the teachers to sign them. The focus group discussions and reflection sessions were audio-recorded. The pseudonyms were used to hide the identity of the participants and the schools. Data were stored in a computer, which was encrypted with a password.

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[43] I Meulenberg-Buskens, "Free Attitude Interview Technique," *London: Unpublished Notes*, 2011.
[44] Virginia Braun and Victoria Clarke, "Using Thematic Analysis in Psychology," *Qualitative Research in Psychology* 3, no. 2 (2006): 77–101.
[45] Moses Tetui et al., "Experiences of Using a Participatory Action Research Approach to Strengthen District Local Capacity in Eastern Uganda," *Global Health Action* 10, no. sup4 (2017): 1346038.

PRESENTATION OF FINDINGS AND DISCUSSIONS

The subsequent sections provide the findings and discussions. Six themes, which characterise the transformative potential of PAR as a catalyst for empowering mathematics teachers, are outlined and discussed in these sections. Since the participants were allowed to express themselves in languages they felt comfortable communicating, some of the expressions from other languages are translated into English in this section. The English translation in this article is abbreviated as ET.

Restoring the Working Relationships

During the focus group discussion wherein the participants discussed how the newly formed PAR community engagement project had benefited them, the following remarks were maded:

> ***Teacher 7:*** *"Honestly speaking, the PAR project has brought us together as a team. We no longer work in silos…".*
> ***Teacher 5:*** *"…I find it easy to go to any colleague and ask for assistance. Even if it means asking the colleague to teach the topic that I am not comfortable to teach…".*

The participants seemed to be in accord with the PAR project's role in helping them work together (as a team). According to Teacher 7's comments, it seems that before the formation of the PAR project, teachers worked individually. This is confirmed by the phrase, "We no longer work in silos." The term "honestly," as used by Teacher 7, indicates the truth that he wanted to share regarding his observation and experience of the effects of PAR, which has brought them together to work as a team. Teacher 7's comments are an example of CER and CoP, which advocate working collaboratively to achieve the identified goal.

As a result of working together, the participants could help one another. The statement *"I find it easy to go to any colleague and ask for assistance," stated by Teacher 5,* indicates that when people work together as a team, they not only assist one another but also rely on one another for knowledge acquisition and sharing. Furthermore, they find it easy to approach one another for help. One attribute of working collaboratively and relying on one another, namely, "teaching substitution," is also revealed by Teacher 5 in her utterance, *"Even if it means asking the colleague to teach the topic that I am not comfortable to teach".* This means that teachers who work as a team develop trust and compassion for one another.

While still discussing the benefits of the PAR project in terms of restoring the working relationships, Teachers 2 and 9 also remarked as follows:

> ***Teacher 2:*** *"…PAR project made us realise that we need one another. I used to operate with the mentality ya hore hake batle ho tenana le batho mosebetsing (ET: that I do not want to bother other people at work). But I realised that working with other people really helps".*
> ***Teacher 9:*** *"…We view each other as champions…"*

Another important aspect of working as a team and having good working relations, as suggested by Teacher 2, is that the PAR project stimulated a sense of dependency and a need to work with others. Based on what Teacher 2 said, it seems before the start of the PAR project, she thought that asking for help from other colleagues was a nuisance to them. This mentality caused her to isolate herself and work on her own. CER discourages this mentality since it deprives one of an opportunity to learn from others.[46] Therefore, the PAR project made her appreciate the beauty of working with others, hence the comment*, "But I realized that working with other people really helps."* According to Moleko, working together is essential for growth and development.[47] Collaborative working also affords individuals working together opportunities to tap into one another's strengths and feed off the positive energy necessary to move forward and achieve success.

[46] Shangase, "Strategies for the Implementation of Further Education and Training Learner Attainment Improvement Plan."
[47] Moleko, "Enhancing the Functionality of Supplemental Instruction for First-Year Mathematics Students at a Higher Education Institution."

The extracts above indicate that PAR fosters collaboration amongst the teachers. As a result of working together and learning from one another, the teachers developed positive attitudes towards one another. This positive attitude eventually led to a point where teachers viewed one another as experts and knowledgeable, hence the comment, *"We view each other as champions".* In pursuing success, CER requires the teachers to view one another as capable humans.[48]

The above extracts indicate the transformative potential of PAR as a catalyst to restore human working relations. The PAR project encourages collaborative working and allows teachers to assist one another. Through the PAR project, the teachers could depend on one another and develop a working trust with one another. Through working together, teachers can appreciate one another's strengths and support one another. Good relations predict the team's success.[49] Thus, Tsotetsi emphasises establishing a dedicated team to achieve success.[50] However, the team will not be able to achieve success if the working relations are not good. The participants' remarks above confirm this claim.

Reigniting the Passion for Teaching Mathematics

The focus group discussions revealed some interesting points which the teachers highlighted, regarding how their passion and love for teaching mathematics were ignited. The teachers shared the following:

> ***Teacher 8:*** *"…haesale re qala ka this PAR project ke ikutlwa ke le morolo. I can't wait to go to class…" (ET: Ever since we started with the PAR project, I feel rejuvenated…)*
>
> ***Teacher 1:*** *"…I look forward to going to class after our meetings. I just cannot wait to share new strategies with my learners…"*
>
> ***Teacher 4:*** *"…ke hore o ya ikutlwa hore o titjhere, o tseba ditaba tsa hao…" (ET: You can feel that you are a teacher and you know your story)*
>
> ***Teacher 6:*** *"…ekare ke hona ke qalang ho ruta maths. Ke ya classing ke thabile ebile ke le confident" (ET: …it feels like I have just started to teach maths. I go to class feeling happy and …)*

The teachers' statements above indicate the PAR project's role in reigniting their passion and love for mathematics. Teacher 8's statement, *"haesale re qala ka this PAR project ke ikutlwa ke le morolo". (I can't wait to go to class),* shows the positive influence that the PAR project had on him. Before the project started, the teacher seemed not very motivated to attend class. The lack of motivation on the part of mathematics teachers can result from many factors, including the learners' poor performance.[51] However, the PAR project afforded the teachers opportunities to share their experiences and best practices. This enlightenment pleased and motivated the teacher, hence, the comment, *"…ke ikutlwa ke le morolo (I feel energised) to even go to class".* Teacher 1 echoed the same sentiment. As a result of learning new teaching strategies from the project, she (Teacher 1) could not wait to go to class to teach her learners. CER espouses the notion of knowledge sharing in advancing teachers' skills, knowledge and confidence.[52] Teachers who are confident and fully empowered develop the eagerness to go to class to teach learners, as signified by Teacher 1.

The comment *"ke hore o ya ikutlwa hore o titjhere, o tseba ditaba tsa hao"* (ET: "*You can feel that you are a teacher, and you know your story"*) made by Teacher 4 signifies the empowering, educative and enlightening nature of the PAR project. What was interesting to note was the fact that the PAR project not only provided opportunities for teachers to share knowledge and experiences but also transformed how they perceived themselves, revitalised their spirits and positively impacted their attitudes. This was evidenced through Teacher 6 whose remark was as follows: *"ke hona ke qalang ho*

[48] Campanella, "Emancipatory Research Ppt Presentation."
[49] Catherine Gabelica et al., "The Effect of Team Feedback and Guided Reflexivity on Team Performance Change," *Learning and Instruction* 34 (2014): 86–96.
[50] Tsotetsi, "The Implementation of Professional Teacher Development Policies: A Continuing Education Perspective."
[51] Gökçe Dişlen Dağgöl, "The Reasons of Lack of Motivation from the Students'and Teachers'voices," *The Journal of Academic Social Science* 1, no. 1 (2024): 35–45.
[52] Tsotetsi, "The Implementation of Professional Teacher Development Policies: A Continuing Education Perspective."

ruta maths. Ke ya classeng ke thabile ebile ke le confident" (ET:" I have just begun to teach maths. I go to class feeling happy and …"). What the teachers (i.e., Teachers 8,1, 4 & 6) are saying here supports the assertion by Mahlomaholo that PAR has the power and potential to bring about enlightenment, empowerment, and transformation.[53]

The extracts above demonstrate the power of the PAR project in reigniting the mathematics teachers' passion for and love of teaching. This passion is depicted in the teachers' state of happiness, willingness to go to class, eagerness to teach and feeling as if they were teaching mathematics for the first time. The positive dispositions that were ignited by the PAR project contributed to successful teaching.

Unlocking the Teachers' Full Potential

During the reflection meeting wherein, the participants discussed how the newly formed PAR project had benefited them, the participants shared the following sentiments:

> ***Teacher 8:*** *"…I also make sure that I am on my A game. I do not want to appear as if I do not know my story or do not belong…"*
> ***Teacher 5:*** *"…I do not just take and apply what I have learnt in the project. I also do my research now and learn more about the other ways of teaching mathematics…"*
> ***Teacher 2:*** *"…The project made me go out of my way to learn new things…"*

The teachers' remarks indicate that the mathematics teachers held meetings where they discussed the content and the strategies for teaching and challenged them to be and do better. According to Teacher 8, the frequent meetings challenged him to a point where he realised he needed to be prepared for the meetings since he was also expected to contribute. Since he found himself in a space dominated by people he deemed knowledgeable and who equally regarded him as someone knowledgeable, he had no choice but to empower himself to "fit in" that team of competent teachers. Being in a space that challenged him intellectually made him realise the need to work hard and get out of his comfort zone, hence the comment, *"I also make sure that I am on my A game."*

The project challenged the teachers to become independent in their own space. The statements *"The project made me go out of my way to learn new things"* and *"I also do my research now and learn more about the other ways of teaching mathematics",* drawn from Teachers 2 and 5, respectively, indicate that the project instilled a sense of independence in teachers. Teachers did not only apply the strategies that they learned during the workshops and meetings, but they also discovered other strategies on their own. The project thus instilled motivation in teachers to further search for enriching information that contributes to their growth. Thus, PAR inspired the teachers to be their best versions and to strive to become experts in what they do (i.e. teaching mathematics the best way).

The extracts above depict the transformative potential of PAR as a catalyst for unlocking the teachers' potential. The PAR project inspired the teachers to believe in themselves and further propelled them to continue self-improvement. The project challenged the teachers to step out of their comfort zones, inspired them to embrace the challenges, and consistently strive for growth.

Fostering a Sense of Ownership

The reflection meetings revealed fascinating insights from the teachers who truly showed ownership of the PAR project. These teachers shared the following insights:

> ***Teacher 3:*** *"The way this project has opened my eyes, I find myself even volunteering to assist other teachers who are teaching mathematics in other schools."*
> ***Teacher 10:*** *"The project has helped us achieve good results in mathematics. I have also realised that the teachers' morale has gone up. The project has really motivated the teachers. This is why I try my level best to make sure that the project continues even when Dr Zaqa is no longer coming to us on a regular basis as she used to."*

[53] Mahlomaholo, *Re-Membering the Organic Intellectual in the Mirror*.

Teacher 3's enthusiasm shows that the PAR project equipped him with knowledge and skills that made him feel competent. As a result of feeling competent and confident, he felt the need to assist others. The statement "*I find myself even volunteering to assist other teachers who are teaching mathematics in other schools"* indicates that Teacher 3 developed a deep sense of responsibility due to being equipped and competent. The researcher deduced when Teacher 3 made this remark that self-awareness is a key ingredient of self-assessment and a change of behaviour. As a result of being aware of his growth, Teacher 3 could self-assess, thus realising that he was sufficiently competent and knowledgeable to extend a helping hand to others. In their study, London, Sessa, and Shelley also discovered that self-awareness could influence people's behaviour and the kind of people they want to become.[54]

As a result of seeing the project's positive effects in terms of helping the school to "*achieve good results in mathematics and lifting the teachers' morale",* Teacher 10 felt the need to ensure the continuation of the project. According to Teacher 10, Dr Zaqa started the PAR project, which later became a resounding success. The active involvement of the mathematics teachers in this project contributed to its success. As a result, Teacher 10 felt the need to ensure that the project continued even after Dr Zaqa (researcher) was no longer working with them regularly, as she used to. This resonates with Moleko's assertion regarding CER; it allows the participants to learn and empower themselves.[55] Moreover, it allows them to continue the project even when the researcher is absent.

The extracts above signify PAR's potential to develop a sense of ownership in teachers. When participants (teachers in this context) freely participate and feel accepted in the team, they develop a sense of ownership.[56] Knowledge and skills make it possible for teachers to develop a sense of responsibility and a need to empower others. It is certain from the above extracts that the creation of a culture of ownership has the potential to develop a deep sense of responsibility and cause teachers to take pride in their contributions.

While still discussing how PAR developed their sense of ownership, some teachers remarked on another significant role of PAR. Their commentaries were as follows:

> ***Teacher 9:*** *"I did not realise how much knowledge we have as teachers. It is just that we are not given a chance like we are now to share our experiences and practices which I believe would change our teaching space."*
>
> ***Teacher 3:*** *"I am now using PAR in my study because I have noticed that it is the type of research tool that I can use to bring the teachers to share their experiences. This gives them an opportunity to make a contribution in the field."*

Teacher 9's remark indicates that it was only until they gathered through the PAR project that she realised what a wealth of knowledge they possessed as mathematics teachers. The PAR project was, therefore, an eye-opener for her; she experienced a "light bulb moment" when she became aware that they were sitting with the knowledge required to make a significant contribution to the field of mathematics education. The statement, "It is just that we are not given a chance like we are now to share our experiences and practices, which I believe would change our teaching space*,"* corroborates this. The teacher's realisation is supported by Jordan's assertion that PAR can allow people who experience the problem to develop an understanding of their situation and thus empower themselves to transform it.[57]

Teacher 3, who had enrolled for her Masters' degree after her involvement in the PAR project, echoed the same sentiments regarding the PAR project. The project motivated her to use PAR as a research design for her study. During her involvement in the PAR project, she realized that the best

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[54] Manuel London, Valerie I Sessa, and Loren A Shelley, "Developing Self-Awareness: Learning Processes for Self-and Interpersonal Growth," *Annual Review of Organizational Psychology and Organizational Behavior* 10, no. 1 (2023): 261–88.
[55] Moleko, "Enhancing the Functionality of Supplemental Instruction for First-Year Mathematics Students at a Higher Education Institution."
[56] Donna M Mertens, "Transformative Mixed Methods Research," *Qualitative Inquiry* 16, no. 6 (2010): 469–74.
[57] Steven Jordan, "Who Stole My Methodology? Co-Opting PAR," *Globalisation, Societies and Education* 1, no. 2 (2003): 185–200.

way to fully involve the teachers in the research studies was by using PAR. Ono and Ferreira avow that knowledge is socially constructed and that it is through mutual debating and deliberations that the people who share the common intention of addressing an issue can provide various solutions to the problem.[58] Thus, through its embodiment of multiple realities, CER endorses the notion of including all stakeholders in the decision-making processes to provide multiple solutions to the problem.[59] When multiple solutions have been provided, the most ideal and the best solution can be identified to address the issue(s). The statement "*I have noticed that it is the type of research tool that I can use to afford teachers opportunities to share their experiences",* signifies that the teacher believes that PAR has the potential to motivate teachers to contribute to their field (mathematics education). This is in accordance with Tsotetsi's sentiment that PAR has the potential to assist teachers in recognising their power and the valuable contribution they can make.[60]

The extracts above affirm PAR's role in affording teachers the opportunities to make contributions. PAR enables people to realise the power and significance of working together and appreciating the collective effort. A Sotho idiom says, *"Letshwele le beta pooho,"* meaning people who work together can overcome any situation, even the toughest one. This idiom serves as the embodiment of these extracts. In support of this idiom and the extracts above, Nkoane espouses the idea of people working collaboratively to translate their knowledge into actions aimed at addressing their problems.[61]

DISCUSSION

The findings is characterised by six key themes; restoring the working relationships, reigniting the passion for teaching mathematics, unlocking the teachers' full potential, and fostering a sense of ownership, highlight the impact of PAR in fostering an empowered and collaborative teaching environment.

The findings reveal that restoring working relationships is a key feature of PAR and demonstrates its role in fostering trust and cooperation among mathematics teachers. Lorini argues that CER promotes the collective engagement of all stakeholders and reaches a consensus to retain underperforming learners by creating more time for them to master the concepts they had failed to master.[62] Within the CER framework, this restoration aligns with creating conditions that negate exclusion, social injustice, and a lack of participation, which are challenges learners face and ultimately lead to poor performance.[63] Therefore, CER encourages educators to openly share their experiences and challenges by engaging in collaborative PAR activities and fostering mutual understanding and solidarity. This collaborative approach is further reinforced by the CoP framework, which emphasises the importance of shared learning and collective identity. Wenger et al. define communities of practice as: *"…groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an on-going basis"*.[64] Staempfli et al. contend that communities of practice flourish with diverse forms of voluntary participation, from peripheral to active or core membership.[65] Flexible participation should be allowed, as involvement

[58] Yumiko Ono and Johanna Ferreira, "A Case Study of Continuing Teacher Professional Development through Lesson Study in South Africa," *South African Journal of Education* 30, no. 1 (2010).
[59] Mertens, "Transformative Mixed Methods Research"; Tlali, "Enhancing Synergy: A Strategic Interrogation of the Intersection between Social Justice and the Creation of Sustainable Learning Environments."
[60] Tsotetsi, "The Implementation of Professional Teacher Development Policies: A Continuing Education Perspective."
[61] Nkoane, "Critical Emancipatory Research for Social Justice and Democratic Citizenship."
[62] Emiliano Lorini, "In Praise of Belief Bases: Doing Epistemic Logic without Possible Worlds," in *Proceedings of the AAAI Conference on Artificial Intelligence*, vol. 32, 2018.
[63] Ndaba Xolisile and Dube Bekithemba, "Critical Emancipatory Research Approach to Enhance Performance Among Progressed Learners in Life Sciences," *Mediterranean Journal of Social Sciences* 12, no. 4 (July 8, 2021): 53, https://doi.org/10.36941/mjss-2021-0027.
[64] Etienne Wenger, Richard Arnold McDermott, and William Snyder, *Cultivating Communities of Practice: A Guide to Managing Knowledge* (Harvard business press, 2002), 4.
[65] Adi Staempfli et al., "Improving Professionalism through Reflection and Discourse in Communities of Practice: The Key Situations in Social Work Model and Project," *The Journal of Practice Teaching and Learning* 14, no. 2 (December 13, 2016): 6–26, https://doi.org/10.1921/jpts.v14i2.940.

may change, as well as nourishing practitioners' motivation to learn about the domain of the CoP and to share their knowledge with others, which sustains participation. This highlights the fact that educators should develop stronger professional bonds through regular interactions and shared goals, thus leading to a more cohesive and supportive educational community.

Reigniting the passion for teaching mathematics highlights how PAR can revitalise teachers' enthusiasm for their subject. In a study by Stapleton, the author, as the researcher, played a facilitative role in their PAR study.[66] The aim was to improve the lives of teachers by treating them as professionals and valuing their perspectives, expertise, and time. This approach involved giving teachers the autonomy to design their projects, which led to their excitement and motivation to execute these projects with minimal assistance from the researcher. Despite their heavy workloads, the teachers showed eagerness and enthusiasm for the project. The researcher sought to capture teachers' emotions about the project, contrasting them with their feelings toward their regular jobs. CER suggests that empowerment comes from recognising and challenging the socio-political dimensions of education. The CER approach is an emancipatory experience that provides space for the free contribution of ideas, cordial relationships, tolerance of individual ideas, common consensus, love, and hope.[67] Therefore, by involving teachers in the research process, PAR provides a platform for them to critically reflect on their teaching practices and the broader educational context. This reflective practice reignites their passion and commitment to teaching mathematics. Similarly, CoP supports this by fostering a culture of continuous learning and innovation. As active participants in their community, teachers are inspired by shared knowledge and practices, leading to renewed motivation and engagement in their teaching.

The findings reveal how unlocking the teachers' full potential through PAR facilitates professional growth and self-efficacy among mathematics educators. Participation in PAR means that research is not done on people but with them, whereas action refers to concrete problem-solving.[68] This, therefore, brings about participants' empowerment through collective action. Taliep et al. position social transformation, empowerment, agency, and activism within a critical PAR framework as a transformative research approach.[69] CER also emphasises the importance of agency and empowerment in transforming educational practices.

Xin and Brion-Meisels describe critical participatory action research (CPAR) as a research approach that centres on democratic participation, agency, and collective capacity-building.[70] They aver that it may be one way to improve teachers' professional development and increase their feelings of agency and well-being. Engaging in CPAR has the potential to foster teachers' positive relationships, build their critical consciousness, and improve their feelings of civic empowerment. Through participatory research, teachers gain the confidence to experiment with new teaching strategies and methodologies. This process enhances their pedagogical skills and empowers them to take on leadership roles within their schools. The CoP framework further complements this by promoting a culture of mentorship and support. As members of a community of practice, teachers benefit from their peers' collective wisdom and experience, enabling them to unlock their full potential. Cambridge, Kaplan & Suter also state that CoPs are set up to achieve eight goals.[71] These are to connect people who might not otherwise have the opportunity to interact, either frequently or at all; provide a shared context for people to communicate and share information, stories and personal

[66] Sarah R Stapleton, "Teacher Participatory Action Research (TPAR): A Methodological Framework for Political Teacher Research," *Action Research* 19, no. 2 (2021): 161–78.
[67] Moleko, "Enhancing the Functionality of Supplemental Instruction for First-Year Mathematics Students at a Higher Education Institution."
[68] Soile Juujärvi and Virpi Lund, "Participatory Action Research as a Practice of Empowerment in Deprived Communities," in *Association for Moral Education Conference Proceedings*, vol. 41, 2016, 1–13.
[69] Naiema Taliep et al., "Community-Based Participatory Research (CBPR) as an Emancipatory Modality Promoting Social Transformation, Empowerment, Agency, and Activism," in *The Palgrave Handbook of Innovative Community and Clinical Psychologies* (Springer, 2022), 497–519.
[70] Rongyu Xin and Gretchen Brion-Meisels, "Teachers' Experiences with Agency and Well-Being during a Critical Participatory Action Research Project," *Educational Action Research* 32, no. 1 (2024): 72–89.
[71] Darren Cambridge, Soren Kaplan, and Vicki Suter, "Community of Practice Design Guide: A Step-by-Step Guide for Designing & Cultivating Communities of Practice in Higher Education," *National Learning Infrastructure Initiative at EDUCAUSE (Http://Www. Educause. Edu/Nlii)*, 2005, 2–8.

experiences in a way that builds understanding and insight; enable dialogue between people who come together to explore new possibilities, solve challenging problems and create new, mutually beneficial opportunities; stimulate learning by serving as a vehicle for authentic communication, mentoring, coaching and self-reflection; capture and diffuse existing knowledge to help people improve their practice by providing a forum to identify solutions to common problems and a process to collect and evaluate best practices; introduce collaborative processes to groups and organisations, as well as between organisations to encourage the free flow of ideas and exchange of information; help people organise around purposeful actions that deliver tangible results; and generate new knowledge to help people transform their practice to accommodate changes in needs and technologies.

The findings reveal that fostering a sense of ownership illustrates how PAR encourages teachers to take ownership of their professional development and the educational outcomes of their students. This is confirmed by Beal et al., who argue that PAR provides communities with a sense of ownership, making interventions more sustainable after the project cycle has ended.[72] CER advocates a participatory approach, where teachers are not passive recipients but active contributors to the educational process. PAR cultivates a sense of ownership and responsibility by involving teachers in decision-making and problem-solving activities. This empowerment leads to more innovative and contextually relevant teaching practices. CoP supports this by creating an environment where teachers feel valued and integral to the community. The shared ownership of goals and outcomes fosters collective responsibility for student success and continuous improvement in teaching practices.

The transformative potential of PAR in empowering mathematics educators is evident through the themes of restoring working relationships, reigniting the passion for teaching, unlocking teachers' full potential, and fostering a sense of ownership. Integrating CER and CoP frameworks provides a comprehensive understanding of how PAR can catalyse meaningful change in educational settings.

RECOMMENDATIONS

The study recommends the inclusion of other important stakeholders in mathematics teaching as part of the PAR projects. Such inclusion is essential in enriching and diversifying ideas and experiences. Furthermore, inclusive stakeholder engagement is important in heightening a sense of ownership and acceptance. The study recommends the adoption of the PAR principles to guide the formation of professional mathematics teacher communities. The recurring poor performance in mathematics necessitates teachers to collaborate and share collective wisdom that will enable them to address poor performance.

CONCLUSION

The study aimed to share mathematics teachers' reflections and experiences on the transformative potential of PAR as a catalyst for their empowerment. The findings of the study revealed PAR's potential to restore working relationships. The working relationships were seen to be restored through teachers' collaborative working, freely asking for help from one another, depending on one another and valuing one another's strength, knowledge, and expertise. Hence, there were possibilities for team teaching and teachers exchanging/swapping lessons. One of the study's findings shows PAR's potential to reignite the passion and love for teaching mathematics. Passion reignition was seen through the teachers' state of feeling revitalised, an eagerness and willingness to go to class to teach mathematics, and teachers' heightened confidence and happiness. The study further revealed the role of PAR in unlocking the teachers' full potential. The full potential, which was unlocked, was evidenced by their confidence, belief in themselves, pursuit of continuous self-improvement, stepping out of their comfort zones, and embracing challenges. Another revelation emerging from the study was PAR's potential to foster/develop a sense of ownership in teachers. This was evidenced by the teachers' free participation, a sense of feeling accepted in the group, and a developed sense of responsibility. Furthermore, PAR enlightened the teachers about their capacity to contribute to the field of

[72] Catherine Beal et al., "Lessons Learned on Participatory Action Research (PAR) to Adoption of CSA Options with an Emphasis on Gender and Social Inclusion Across the 5 CCAFS Regions," 2021.

mathematics education and developed a desire in them to contribute to it, while some teachers pursuing studies used PAR as their research designs. The study's findings cannot be generalised because the teachers who participated in this study came from one cluster. The findings of this study call for the strategic integration of PAR in promoting the scholarship of teaching and learning mathematics, thereby underscoring its role in driving transformative change in educational practices, particularly in teacher development. The findings necessitate further studies to be conducted in different school settings to encourage teacher participation, develop a sense of teacher agency, and allow teachers' voices to inform policy and practice in an endeavour to promote SoTLM.

This study promotes the notion of listening to the voices of the teachers and regarding them as essential to the methodological expectation of research that propagates, among other things, empowerment, collaboration, social justice and inclusion. The study's findings have confirmed Mahlomaholo's assertion that doing CER research creates opportunities for teachers to work together, learn from one another and be passionate about their work.[73]

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ABOUT AUTHORS

Dr. Matshidiso Mirriam Moleko is a Senior Lecturer at the University of South Africa in the College of Education. She is a member of AMESA, SAARMSTE and SAERA.

Prof. Mncedisi Maphalala **is** a Full-Professor in the Department of Curriculum and Instructional Studies at Unisa (College of Education). He is a former Director: of the Centre for Excellence in Learning and Teaching (CELT) at the Durban University of Technology and a former Dean in the Faculty of Education at the University of Zululand. He holds a D.Ed in curriculum studies from the University of Zululand. His career in Higher Education spans over 19 years as a Research Professor (North-West University), Professor at the University of Zululand and UNISA and Institutional researcher at the University of the Witwatersrand. He has also previously worked for the KZN Department of Education (as a teacher, HOD and Deputy Principal); between May and August 2015, he was a Visiting Scholar at the University of North Dakota (USA). Prof Maphalala is an established researcher who holds an NRF C2 rating. He has edited books and special journal issues and published a number of book chapters and research articles in peer-reviewed journals. Prof Maphalala has presented research papers at various local and international conferences. As a postgraduate supervisor and mentor, Prof Maphalala has supervised to completion several Masters and doctoral candidates. He has conducted a number of large-scale commissioned research projects by external organisations such as the South African Institute of Distance Education (SAIDE), Human Sciences Research Council (HSRC), and Council on Higher Education (CHE). He has served on the Umalusi Research Forum, a sub-committee of the Umalusi Council, for a four-year term. His research interests are teacher education, self-directed learning, blended learning, Scholarship of Teaching & Learning and Curriculum studies.