



Design Thinking: An Alternative for Educational ICT Integration Training?

Alan Felix¹ , Boitumelo Moreeng²  & Moeketsi Mosia¹ 

¹ Sol Plaatje University, Kimberley, South Africa.

² University of the Free State, South Africa.

ABSTRACT

Challenges to incorporating ICT in the classroom have been debated in various literature over the last few years. It is, therefore, important to seek different strategies to mitigate these challenges. Design thinking (DT) is considered an approach that can help improve teachers' Technological Pedagogical and Content Knowledge (TPACK). This study therefore examined teachers' experience when developing lessons using ICT using design thinking. This qualitative study was conducted in a primary school in South Africa. Data was collected from two social science (Geography) teachers using face-to-face interviews. Highlights from the study point to the following benefits namely, teachers can learn in collaboration, they can be supported by their peers, and they take part in high-order thinking practices to solve problems related to ICT integration. Therefore, it is recommended that a design thinking approach needs to be applied when teacher training workshops for ICT integration are offered. This study contributes to the existing literature on developing strategies to incorporate ICT in the curriculum of primary schools in South Africa.

Correspondence

Alan Felix
Email: felixal@cput.ac.za

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INTRODUCTION

The fast pace in the evolution of Information and Communication Technology (ICT) over recent years has had an impact on the development of teacher education. According to Fullan and Langworthy, the 21st-century learning environment should encourage teachers to confront learners with profound learning experiences.¹ It is therefore important that before teachers can use ICT, they must be competent and master the appropriate skills.² However, some teachers have seen the digital revolution in the classroom as a challenge but also experience other challenges.³ One of the challenges is that teachers were not trained comprehensively enough to mitigate the challenges of ICT to improve their Technological Pedagogical and Content Knowledge (TPACK).⁴

Teacher development for the integration of technology requires the provision of ongoing support and more than traditional approaches to training.⁵ Considering that teachers are at different levels of skill and perception, and have different attitudes to the integration of ICT, Stojšić *et al.* (2019) suggested that teacher training should be rigid to accommodate teachers and should be extensive to impart the skills and knowledge

¹ M. Fullan and M. Langworthy, *A Rich Seam: How New Pedagogies Find Deep Learning* (London: Pearson, 2014).

² Simin Ghavifekr *et al.*, "ICT Integration in Education: Incorporation for Teaching & Learning Improvement," *Malaysian Online Journal of Educational Technology* 2, no. 2 (2014): 24–45.

³ O. M. Solari, A. Demirci, and J. Van der Schee, "Geospatial Technology in Geography Education," in *Geospatial Technologies and Geography Education in a Changing World*, ed. O. M. Solari, A. Demirci, and J. Van der Schee (Tokyo: Springer, 2015).

⁴ A. A. Felix, "Integrating Geography Teaching and Learning Using Information and Communication Technology" (University of Free State, 2021).

⁵ Linda Darling-Hammond, Maria E Hylar, and Madelyn Gardner, "Effective Teacher Professional Development," 2017; Shengru Li, Shinobu Yamaguchi, and Jun-ichi Takada, "Understanding Factors Affecting Primary School Teachers' Use of ICT for Student-Centered Education in Mongolia," *International Journal of Education and Development Using ICT* 14, no. 1 (2018), 4.

across various levels and categories.⁶ Training in the development of teachers' TPACK, should be the focus of teacher development towards integrating teaching and learning using ICTs according to Dlamini and Mbatha and Kadhim.⁷ The notion of TPACK is to examine how teachers integrate a combination of technology, pedagogy, and content knowledge in their instruction and is seen as useful for the design of teacher development interventions involving technology utilisation.⁸ According to Nuangchalem, TPACK emerged and developed with the concepts of Shulman's Pedagogical Content Knowledge (PCK) as bases, that characterise teacher understanding and instruction explicitly employing integrated pedagogy as well as content.⁹ Research conducted by Erduran and Ince indicated that since the world is rapidly changing as a result of ICT developments, educators are concerned about how to implement online learning and that TPACK is considered valuable in a modern era of educational instruction.¹⁰

Koh *et al.* argue that Design Thinking (DT) can be employed to exploit TPACK to engage with contemporary learning skills, and teachers to improve their flexibility and adaptability in their teaching and learning approaches.¹¹ This was concurred by Mishra and Koehler who proposed the TPACK framework to foster Design Thinking in educators.¹² Based on Bloom's taxonomy (revised), DT could involve all cognitive activities, including memory, understanding, application, analysis, evaluation, and creativity.¹³ A study by Sarica *et al.*, indicated that technology integration lays more emphasis on design for implementation.¹⁴ This was also indicated by Lor who stated that in the quest for teacher preparation to strengthen teachers' TPACK, a shift needs to be toward utilising DT as a framework to incorporate ICT in teacher training.¹⁵ This, therefore, prompted the researcher to investigate the application of DT in teacher training, especially in a South African context. In the next section, a discussion of the literature review will include a short overview of ICT in education, which will be followed by a scope on the definition of ICT, then the challenges pertaining to ICT integration and teacher training, a description of Design Thinking and its processes; and a final paragraph on TPACK which framed the research.

LITERATURE REVIEW

ICT in education is viewed as electronic devices that the user may utilise for a wide variety of educational objectives and is used to facilitate and accelerate educational processes.¹⁶ According to Huang *et al.*, the information resources are designed to offer an authentic as well as engaging educational encounter for pupils and are therefore necessary for teachers to take up the experience to promote educational modernisation.¹⁷ Teachers with visionary thinking in terms of ICT integration will generate energy in the classroom and will be able to redesign their pedagogical methods within the classroom.¹⁸ ICT is defined as "the combination of networks, hardware, and software, and the means of communication, collaboration, and engagement that enable the processing, management, and exchange of data, information, and knowledge."¹⁹ Examples of

⁶ I. Stojšić, A. Ivkov-Džigurski, & O. Maričić, "The readiness of Geography teachers to use mobile devices in the context of immersive technologies integration into the teaching process," *Geographica Pannonica* 23, no. 2 (2019): 122-134.

⁷ Reuben Dlamini and Khanyisile Mbatha, "The Discourse on ICT Teacher Professional Development Needs: The Case of a South African Teachers' Union," *International Journal of Education and Development Using ICT* 14, no. 2 (2018); Alaa Jawad Kadhim, "Effective Use of ICT for Learning and Teaching Geography," *Aalborg Academy Journal of Human and Social Sciences* 1, no. 1 (2020): 15-42.

⁸ Siu-Cheung Kong, Ming Lai, and Yugen Li, "Scaling up a Teacher Development Programme for Sustainable Computational Thinking Education: TPACK Surveys, Concept Tests and Primary School Visits," *Computers & Education* 194 (2023): 104707.

⁹ Prasart Nuangchalem, "TPACK in ASEAN Perspectives: Case Study on Thai Pre-Service Teacher.," *International Journal of Evaluation and Research in Education* 9, no. 4 (2020): 993-99.

¹⁰ Ayten Erduran and Burcin Ince, "Identifying Mathematics Teachers' Difficulties in Technology Integration in Terms of Technological Pedagogical Content Knowledge (TPCK).," *International Journal of Research in Education and Science* 4, no. 2 (2018): 555-76.

¹¹ J. H. L. Koh, C. S. Chai, and B. Wong, *Design Thinking for Education: Conceptions and Applications in Teaching and Learning* (New York: Springer, 2015).

¹² Punya Mishra and Matthew J Koehler, "Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge," *Teachers College Record* 108, no. 6 (2006): 1017-54.

¹³ R.R. Lor, "Design Thinking in Education: A Critical Review of Literature," in *Conference Proceedings* (Bangkok, Thailand., 2017).

¹⁴ H. Ç. Sarica, D. Yildirim, and Y. K. Usluel, "A Content Analysis of ICT Integration in Education: Then and Now.," *Paper Presented at the 2016 AECT (The Association for Educational Communications and Technology) International Convention* (Las Vegas, NV, USA, 2016).

¹⁵ Lor, "Design Thinking in Education: A Critical Review of Literature. ."

¹⁶ H. Tripathi, *Educational Technology and ICT in Education* (India: Red'Shine International, 2019).

¹⁷ R. Ed Huang, Ed Kinshuk, and Jon K. Price, *ICT in Education in Global Context: Emerging Trends Reports 2013 - 2014*. (Berlin: Springer, 2017).

¹⁸ Jo Fu, "Complexity of ICT in Education: A Critical Literature Review and Its Implications," *International Journal of Education and Development Using ICT* 9, no. 1 (2013): 112-25.

¹⁹ RSA DoE (Republic of South Africa. Department of Education), "White Paper on E-Education: Transforming Learning and Teaching through Information and Communication Technologies (ICTs).," 2004.

tools/technologies that may be utilised for the integration of ICT include information recording technologies, such as DVDs, flash disks, cell phones, CDs, and tablets; technologies that can be used to communicate through sound or image, such as digital cameras, microphones, cell phones, podcasts, interactive whiteboards, tablets; and technologies to broadcast information, such as laptops, computers, data projectors, television, radio, podcasts, mp3 files, and tablets.²⁰ According to Tondeur, these ICT tools can contribute to the knowledge society, and teachers are inevitably presented to face the demand to incorporate ICT educational practices.²¹ Using ICTs within the classroom will offer teachers a chance to expose learners to self-directed and student-centered learning, provide creative learning environments, promote collaborative learning, assist with developing critical thinking skills, support teaching by streamlining access to content (resources), and support visual learning.²²

Despite the immense potential of using ICTs, there are many challenges for teachers when they want to integrate ICTs into their classrooms. Most of these were well documented in various literature over the past five years and include teacher perspectives and attitudes towards ICT, lack of knowledge of ICTs, lack of resources, and training in the incorporation of ICT.²³ Mlambo *et al.* conducted a study about pedagogic or didactic training that indicated a shortage of adequate training chances for especially in-service educators in utilising ICT.²⁴ The training issues are complex because of the several components, and it cannot be a once-off; additional professional development and support are needed.²⁵ Especially support from or in the school environment to maximise the training outcomes,²⁶ peers need to assist one another for example, and this will enable teachers to collaborate, which will be a critical support element.²⁷ The benefits of working in a collaborative environment are asserted by Li *et al.* and they added that in such a context, the results will be an enduring proficient ICT incorporation.²⁸

Therefore, Henriksen, suggested that DT propose a structure that engages with practical problems, as in this case with the training of in-service teachers.²⁹ Design Thinking was first used in the private sector (goods and product design), and in the technological era, there was a change of mindset from objects to human-orientated facets, to understand and interact with various stakeholders such as in education.³⁰ Although DT is viewed through diverse lenses by theorists, Retna describes it as a cognitive frame for solving problems relevant to the “conceptual age” in which innovation, as well as creativity, are key providers for increased technological efficiency in the classroom.³¹ According to Scheer *et al.*, in an educational context, DT is defined as dynamic and non-linear, and engages in an iterative approach through five steps, as illustrated in the figure below.³²

²⁰ B. Segoe and T. Mays, “Media, Educational Resources, and ICT in the Teaching of Social Sciences.,” in *Chapter in Teaching Social Sciences: Intermediate and Senior Phases* (South Africa: Wasserman; Oxford, 2017); Dlamini and Mbatha, “The Discourse on ICT Teacher Professional Development Needs: The Case of a South African Teachers’ Union.”

²¹ J. Tondeur *et al.*, “The Physical Placement of Classroom Technology and Its Influences on Educational Practices,” *Cambridge Journal of Education* 45, no. 4 (October 2, 2015): 537–56, <https://doi.org/10.1080/0305764X.2014.998624>; Sudhir Sudam Kaware and Sunil Kumar Sain, “ICT Application in Education: An Overview,” *International Journal of Multidisciplinary Approach & Studies* 2, no. 1 (2015): 25–32; Bushra Meaad Ramadan *et al.*, “Intellectual Capital, Knowledge Management and Social Capital within the ICT Sector in Jordan,” *Journal of Intellectual Capital* 18, no. 2 (2017): 437–62.

²² Felix, “Integrating Geography Teaching and Learning Using Information and Communication Technology.”

²³ Mahdum Mahdum, Hadriana Hadriana, and Maria Safriyanti, “Exploring Teacher Perceptions and Motivations to Ict Use in Learning Activities in Indonesia.,” *Journal of Information Technology Education* 18 (2019); Samwel Dick Mwapwele *et al.*, “Teachers’ ICT Adoption in South African Rural Schools: A Study of Technology Readiness and Implications for the South Africa Connect Broadband Policy,” *The African Journal of Information and Communication* 24 (2019): 1–21.

²⁴ Shepherd Mlambo, Joshua Ebere Chukwuere, and Clever Ndebele, “Perceptions of Pre-Service Teachers on the Use of ICTs for Instructional Purposes,” *Journal of Gender, Information and Development in Africa (JGIDA)* 7, no. 2 (2018): 77–101; Mwapwele *et al.*, “Teachers’ ICT Adoption in South African Rural Schools: A Study of Technology Readiness and Implications for the South Africa Connect Broadband Policy.”

²⁵ Chuanmei Dong, “Preschool Teachers’ Perceptions and Pedagogical Practices: Young Children’s Use of ICT,” *Early Child Development and Care* 188, no. 6 (2018): 635–50.

²⁶ Simin Ghavifekr *et al.*, “Teaching and Learning with ICT Tools: Issues and Challenges from Teachers’ Perceptions.,” *Malaysian Online Journal of Educational Technology* 4, no. 2 (2016): 38–57.

²⁷ Michael Arnold *et al.*, “The Practitioner: How Successful Principals Lead and Influence.,” *International Journal of Educational Leadership Preparation* 2, no. 1 (2007): n1.

²⁸ Shengru Li *et al.*, “The Influence of Teachers’ Professional Development Activities on the Factors Promoting ICT Integration in Primary Schools in Mongolia,” *Education Sciences* 9, no. 2 (2019): 78.

²⁹ Danah Henriksen, Sarah Gretter, and Carmen Richardson, “Design Thinking and the Practicing Teacher: Addressing Problems of Practice in Teacher Education,” *Teaching Education* 31, no. 2 (2020): 209–29.

³⁰ Stefanie Panke, “Design Thinking in Education: Perspectives, Opportunities and Challenges,” *Open Education Studies* 1, no. 1 (2019): 281–306.

³¹ Kala S Retna, “Thinking about ‘Design Thinking’: A Study of Teacher Experiences,” in *Teachers’ Perceptions, Experience and Learning* (Routledge, 2019), 4–18.

³² Andrea Scheer, Christine Noweski, and Christoph Meinel, “Transforming Constructivist Learning into Action: Design Thinking in Education.,” *Design and Technology Education* 17, no. 3 (2012): 8–19.

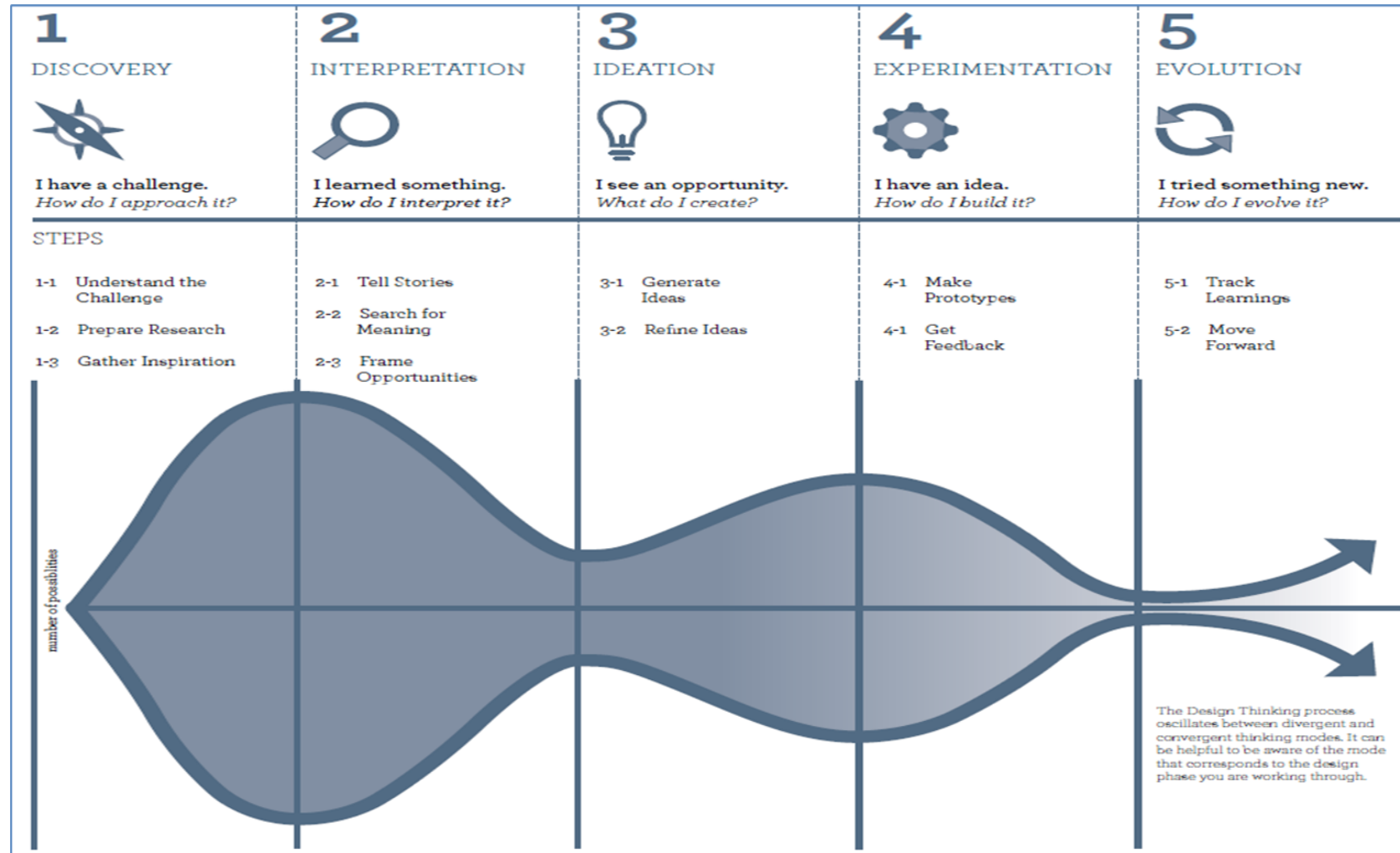


Figure 1: Design Thinking Process³³

³³ Annette Diefenthaler et al., "Thinking & Acting Like a Designer: How Design Thinking Supports Innovation in K-12 Education," *Wise & Ideo* 6, no. 3 (2017): 2018.

The IDEO approach includes the following five stages; discovery, interpretation, ideation, experimentation, and evolution.³⁴ According to Mueller-Roterberg, the steps include the following: the discovery stage - which builds a foundation for one's idea; the interpretations stage – which is needed to transform your ideas with peers; the ideation stage – to generate ideas and brainstorm; the experimentation stage – to bring ideas to life (develop prototypes and sharing ideas); and then the evolution stage – develop the concepts, planning next steps and to document the process.³⁵ According to Henriksen *et al.*, the idea of 'learning by design' emphasises its place on participating in the design process which is significant for constructing comprehension of a particular issue.³⁶ Design Thinking goes beyond the use for only learners, it also possesses the capability to enhance teachers' professionalism.³⁷ As indicated by Chai *et al.*, before teachers engage in design activities with their learners, they must first be knowledgeable of design principles.³⁸

The research was directed by the Technological Pedagogical Content Knowledge (TPACK) framework of Mishra and Koehler.³⁹ It is described, by Bostancıoğlu and Handley as the expertise required of educators when they must judge the potential implementation of any given technology in an educational context. TPACK can be employed to analyse the incorporation of ICTs in their pedagogical practices.⁴⁰ Educators must blend their subject matter and pedagogical techniques with the use and limitations of technological resources to develop good teaching.⁴¹ These three foundational knowledge areas are also referred to as technological knowledge, pedagogical knowledge, and content knowledge.⁴² According to Moreno *et al.*, the TPACK model characterises an advancement in teacher development regarding their technological, pedagogical, and content skills.⁴³

METHODOLOGY

A participatory action research (PAR) design was implemented in the study based on the considerations of the principles of the framework and the purpose of the study. With PAR's qualitative features, the researcher could reveal the individual's emotions, perspectives, and behaviors.⁴⁴ MacDonald further stated that considering that the participant actively makes well-informed choices at every research stage, to bring social transformation, a particular action is a specific objective.⁴⁵ With PAR, power-sharing is addressed which deals collaboratively addressing challenges to achieve development.⁴⁶

As stated by Holloway and Wheeler, in a qualitative approach, researchers can extract in-depth and high-quality information from participants, and therefore this approach aligns with the study.⁴⁷ Qualitative research explores the sense and meaning of social interaction, as well as its narrative, experiential, and formal aspects.⁴⁸ Therefore, the researcher aimed to obtain these characteristics from the participants under investigation.

Wright-St Clair stated that participants must be chosen based on their knowledge and experience, a purpose sample was therefore used which consisted of two Geography teachers at a primary school in the

³⁴ Diefenthaler et al., "Thinking & Acting Like a Designer: How Design Thinking Supports Innovation in K-12 Education."

³⁵ C. Mueller-Roterberg, *Handbook of Design Thinking: Tips and Tools for How to Design Thinking* (Hochschule Ruhr West., 2018).

³⁶ Henriksen, Gretter, and Richardson, "Design Thinking and the Practicing Teacher: Addressing Problems of Practice in Teacher Education."

³⁷ Koh, Chai, and Wong, *Design Thinking for Education: Conceptions and Applications in Teaching and Learning*.

³⁸ Ching Sing Chai, Joyce Hwee Ling Koh, and Chin-Chung Tsai, "A Review of Technological Pedagogical Content Knowledge," *Journal of Educational Technology & Society* 16, no. 2 (2013): 31–51.

³⁹ Mishra and Koehler, "Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge."

⁴⁰ Poonam Arya, Tanya Christ, and Wen Wu, "Patterns of Technological Pedagogical and Content Knowledge in Preservice-Teachers' Literacy Lesson Planning.," *Journal of Education and Learning* 9, no. 5 (2020): 1–14.

⁴¹ Chai, Koh, and Tsai, "A Review of Technological Pedagogical Content Knowledge."

⁴² Teemu Valtonen et al., "Emerging Imbalance in the Development of TPACK-A Challenge for Teacher Training," *Education and Information Technologies* 28, no. 5 (2023): 5363–83.

⁴³ Javier Rodríguez Moreno, Miriam Agreda Montoro, and Ana Maria Ortiz Colon, "Changes in Teacher Training within the TPACK Model Framework: A Systematic Review," *Sustainability* 11, no. 7 (2019): 1870.

⁴⁴ Digby Macdonald, *Transient Techniques in Electrochemistry* (Springer Science & Business Media, 2012).

⁴⁵ Macdonald, *Transient Techniques in Electrochemistry*.

⁴⁶ Allyson Calder, Gisela Sole, and Hilda Mulligan, "Co-Design of an Educational Resource with Female Partners of Male Stroke Survivors to Support Physical Activity Participation," *International Journal of Environmental Research and Public Health* 19, no. 24 (2022): 16856.

⁴⁷ I. Holloway and S. Wheeler, *Qualitative Research for Nurses* (Oxford: Blackwell Science, 1996).

⁴⁸ S. Gravett, Action research and transformative learning in teaching development. *Educational Action Research*, 12, no.2 (2004): 259-272.

Northern Cape (South Africa).⁴⁹ Furthermore, the participants were chosen based on availability and proximity, and occupied the roles of co-researchers, since they had firsthand classroom experience.⁵⁰

Since the project used a qualitative approach, multiple data collection methods were utilised.⁵¹ The data was gathered using free-attitude interviews and observing the lesson preparations. A workshop on Design Thinking was held to show teachers the fundamentals of DT and how to develop a lesson using a DT approach. Teachers were interviewed during and after the workshops. The participants also developed lessons using a DT approach to incorporate ICT into their geography lessons.

The analysis of data was done using critical discourse analysis (CDA). Tambunan *et al.* defined CDA as a framework with a multiple-theoretical perspective.⁵² Therefore, it is deemed as a suitable analysis since CDA focuses on exploring and emphasising the relationship between language and power. Gee, pointed out that CDA is a tool well-suited for analysing written and spoken language against the wider background of social, and cultural relations, structures, and processes.⁵³

FINDINGS AND DISCUSSION

After the workshop, the teachers developed ICT-integrated geography lessons in collaboration. During the interviews, the data revealed two themes: higher-order thinking and collaborative support.

Higher-order thinking

The support that teachers give to one another in the planning of the activities allows them to engage in problem-solving activities. Lor indicated that DT activities encompass various of Bloom's revised taxonomies and provide teachers with opportunities to improve their TPACK.⁵⁴ The teachers find the DT training valuable and supportive to strengthen their TPACK skills for developing geography activities. This was indicated by the response of teacher one during and after the training: "This was nice and in-depth. It did help. We could work together. You don't have to do the planning over again. You are doing more research on the geography topic and the ICTs when using DT."

This was supported by teacher two: "We have done all the steps, and you can see the development of the lesson. You need to think about what you are doing."

The teachers find DT beneficial since it enables collaborative lesson construction, and collectively constructs knowledge. It was evident from the phrases that using DT allowed the teachers to elevate their cognitive thinking when planning their lesson activities on a specific topic. According to the DT steps the teachers need to think in a higher order because they design the lessons using each of the five steps which include, discovery, interpretation, ideation, experimentation, and evolution. Since they worked together on the activities, they found it helpful because they could support each other in the thinking process of designing their lesson. Since the team also had to determine the best-suited technologies for the topic or activity, it will increase their TPACK knowledge, and they could also see how the lesson evolved which will give them more confidence to use the approach again.

Furthermore, DT serves as a mindset for resolving problems, and teachers could increase their creativity and innovation to develop a high-quality product in the form of their lessons.⁵⁵ Not only will they be able to improve the lessons, but teachers will also improve their adaptation and learning skills.⁵⁶ During the lesson preparation, the teachers engage in defining problems, generating ideas, and planning where they follow an iterative cycle that involves creating, testing, and evaluating their lesson plans.⁵⁷

⁴⁹ V. Wright-St Clair, Doing (interpretive) phenomenology. In Stanley, M. & Nayar, S. (Eds.). *Qualitative research methodologies for occupational science and therapy*. Routledge: Abingdon, Oxon, 2015.

⁵⁰ R. Pellissier, *Business Research Made Easy* (Cape Town: Juta, 2007).

⁵¹ Irene Vasilachis de Gialdino, "Ontological and Epistemological Foundations of Qualitative Research," in *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, vol. 10, 2009.

⁵² R.W. Tambunan et al., "Critical Discourse: Applying Norman Fairclough Theory in Recep Tayyip Erdoğan's Balcony Speech.," in *Proceedings of ISELT FBS Universitas Negeri Padang*, 2018, 174–83.

⁵³ J.P. Gee, *What Video Games Have to Teach Us about Learning and Literacy* (New York: Palgrave Macmillan, 2007).

⁵⁴ Lor, "Design Thinking in Education: A Critical Review of Literature. ."

⁵⁵ Vakkas Yalçın and Şule Erden, "The Effect of STEM Activities Prepared According to the Design Thinking Model on Preschool Children's Creativity and Problem-Solving Skills," *Thinking Skills and Creativity* 41 (2021): 100864.

⁵⁶ Doris B Chin et al., "Educating and Measuring Choice: A Test of the Transfer of Design Thinking in Problem Solving and Learning," *Journal of the Learning Sciences* 28, no. 3 (2019): 337–80.

⁵⁷ Chin et al., "Educating and Measuring Choice: A Test of the Transfer of Design Thinking in Problem Solving and Learning."

Collaborative support

Another finding in the study was that collaborative support was increased when the teachers worked together on the development of their lessons and activities using a DT approach. Teacher one confirmed by stating: “*The assistance was good from my peers. I did not feel alone. It boosts my confidence when working with it.*”

Teacher two echoed were of the same accord by asserting: “*It helps both of us in working together. What I like best is that we can work together. You know I am a bit slow.*”

Using Design Thinking in lesson preparation, the teachers can learn from one another and this will benefit them in acceptance of innovation and improve their practices in developing lessons.⁵⁸ The assistance from teacher one, who was more knowledgeable about ICT integration, was well received by teacher two, who was less knowledgeable. The teachers could work collaboratively on the problem to integrate ICT into the lessons. Since DT is a collaborative process assistance from peers can help to improve the confidence of teachers to use ICT when developing lessons.

Interdisciplinary collaboration lends itself to the incorporation of various viewpoints from within the school, which enables teachers to look at the problems differently and innovatively to provide solutions.⁵⁹ According to Magistretti *et al.*, by bringing people together, when using DT, wicked problems can be resolved much easier.⁶⁰ Teachers can turn their abstract ideas about the lesson into something tangible, as DT makes it possible for design-orientated thinkers to experiment with it, uncover new opportunities, communicate ideas with others, and receive feedback from them.

RECOMMENDATIONS

For future training interventions, a Design Thinking process will be useful for in-service teachers as well as pre-service teachers because the collaborative aspect of DT can assist in mitigating the challenges with ICT integration. It will assist teachers to develop ideas and practical solutions not in isolation, but with the help of peers which will increase not only their knowledge (with regards to ICT integration) but also their self-confidence. Using a DT approach teachers will improve their higher-order thinking skills and produce high-quality lessons using ICT.

CONCLUSION

In this paper, the influence of Design Thinking on teacher development to integrate ICT into teaching and learning was examined. Various challenges to the integration of ICT in the classroom have been well-documented and extensively researched. Teachers are struggling to integrate ICT although they have been trained on it. Using a Design Thinking approach to teacher training could be useful to develop their TPACK and make it easier because the problems can be solved in a collaborative process.

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⁵⁹ Claudio Dell’Era et al., “Four Kinds of Design Thinking: From Ideating to Making, Engaging, and Criticizing,” *Creativity and Innovation Management* 29, no. 2 (2020): 324–44.

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ABOUT AUTHORS

Dr. Alan Felix is currently a Geography/Social Science lecturer at the School of Education, Sol Plaatje University, South Africa. He obtained his academic and professional qualifications from various institutions of higher learning, including his PhD in Curriculum Studies from the University of Free State. His area of interest ranges from Geography education, rural education, and ICT-related research. He teaches various undergraduate and postgraduate modules currently and co-supervises three Masters's students. He is also the Head of Department for the Human Science Teaching department and serves on various committees at the university.

Dr. Boitumelo Moreeng is currently a Senior Lecturer and HoD (Social Sciences and Commerce Education) in the Faculty of Education, University of the Free State, South Africa. He is a former HSS Discipline Coordinator and the Director for Initial Teacher Education at the same university. He also served as a Senior Lecturer at the School of Education, Sol Plaatje University. He is a published academic, and a supervisor for postgraduate students (M & D) and postdoctoral fellows. He works mainly within transformative research paradigms. His specialty areas are Curriculum Studies, History, and Social Sciences Education.

Dr. Moeketsi Mosia is a seasoned academic, professional and leader with extensive experience in mathematics, mathematics education, and machine learning. As the Director of the Centre for Teaching, Learning and Programme Development at Sol Plaatje University, he has made a significant impact on the academic landscape. Prior to this role, he was the Head of the Department, teaching mathematics, mathematics education, probabilistic machine learning and Data Science with R programme. Throughout his career, Dr Mosia has been associated with multiple South African universities as an academic and research fellow. He has effectively supervised numerous Masters and PhD students to successful completion. As a scholar, he has published various research articles in both international and national peer-reviewed journals. He holds a Master of Science in Mathematical Statistics and a PhD in Mathematics Education, with a focus on integrating multiple software to enhance understanding of Euclidean Geometry. Moeketsi’s research interests are diverse, encompassing Learning Analytics, Probabilistic Machine Learning, and Student Learning in Higher Education. Additionally, as a certified Artificial Intelligence Cloud Engineer, he is committed to staying at the cutting edge of technological advancements within his domain.