Exploring Teachers' Experiences of Lesson Study for Integrating Information and Communication Technologies in Teaching

by

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ABSTRACT

This study explored teachers' experiences of integrating Information and Communication Technologies (ICTs) in teaching. Twelve (12) purposefully selected teachers from three different subject groups (Life Sciences, Economic and Management Sciences and Mathematics) in a high school in KwaZulu-Natal participated in a Lesson Study programme over seven months. During each phase, the emphasis was placed on the ICTs and their use in teaching. Developing teachers' ability to use ICTs in education is vital as it helps prepare learners to be effective participants in a technology-saturated society. The research is particularly important since previous approaches to help teachers integrate ICTs in teaching were short courses focusing on minor ICT integration aspects. Earlier forms of professional development were often theoretical, and teachers had difficulty applying what was learnt in the classroom. In contrast, Lesson Study provides a holistic approach to professional development.

This research took the form of a mixed-method, multiple case study embedded in the interpretivist paradigm. Qualitative data were collected using documents in the form of lesson plans, lesson observation notes, and written reflections; observation of lessons and interviews. The Lesson Study programme involved a cyclic process of goal setting, researching, planning lessons, presenting lessons, reflection and discussion, and revising lessons. The TPACK framework, the Theory of Planned Behaviour, and the Professional Development Evaluation framework, guided this research. Thematic analysis was used to analyse the data. Quantitative data were collected using the TPACK questionnaire. The data were analysed using SPSS software, and a paired t-test was carried out. A concurrent triangulation strategy was employed in this study. Qualitative and quantitative data were collected concurrently and then compared to determine if there were any similarities or differences.

The quantitative results indicated that involvement in the Lesson Study programme affected teachers approach to TPACK positively. Statistically significant results were reported for teachers' confidence in the areas of technological knowledge, technological content knowledge, technological pedagogical knowledge, and pedagogical knowledge. The findings and the results revealed that while teachers experienced challenges like high workload and learners' unfamiliarity with the use of ICTs for education, their confidence in integrating ICTs in teaching did improve. Factors positively affecting teachers' confidence were collegiality, and the reduction of teacher isolation due to the Lesson Study programme. A statistically significant *improvement was also noted in Technological Knowledge, Technological Content Knowledge, Technological Pedagogical Knowledge and Pedagogical Knowledge.*

Teachers' experiences of the Lesson Study programme was generally positive. They appreciated the structure that the process provided and considered Lesson Study to be a more effective form of professional development than other forms previously experienced. Key factors that played a role in teachers' experiences were the support from colleagues and school personnel. While the programme's duration was considered a challenge to teachers participating in the programme, teachers reported improved knowledge and skills that they were able to use in their classrooms.

Teachers' and learners' attitudes affected the way teachers perceived the programme. Also, teachers' perceived behaviour control was a significant factor in the way teachers participated in the Lesson Study process. Therefore, this study is significant because it contributes to the limited body of knowledge on Lesson Study, and the use of Lesson Study for integrating ICTs in teaching within a South African context. The study indicated that Lesson Study helped improve the social and professional climate at schools and was an effective form of professional development for integrating ICTs in teaching.

Keywords: ICT Integration, Professional Development, Teacher Experiences, Teacher Vulnerabilities, Lesson Study, Self-efficacy, Teacher Confidence

DECLARATION

The work described in this dissertation was carried out in the School of Education, Science and Technology Education Cluster, at the University of KwaZulu-Natal under Professor Nadaraj Govender's supervision.

Ethical clearance was granted for this study by the University of KwaZulu-Natal Research Office. The Ethics Clearance Approval number is HSS/2065/018D

This study represents the author's original work except where otherwise indicated and has not been submitted in any form for any other qualification to any tertiary institution.

Where use has been made of others' work, it has been duly acknowledged in the text.

Signed

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DEDICATION

This research is dedicated to friends and relatives who have played a positive role in my life, especially my amazing parents, Ashok and Omila Juggernath.

Happy 70th Birthday, Mum.

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LIST OF PUBLICATIONS

Peer-Reviewed Long Papers

Juggernath, A., & Govender, N. (2020). Natural Sciences Teachers' Beliefs as Barriers for Integrating ICTs in a Technology-rich Context. *African Journal of Research in Mathematics, Science and Technology Education, 24*(1), 105-115.

Govender, N. & Juggernath, A. (2020). Science Teachers' Critical Reflections of ICT Use in a Well-Resourced School (Long peer-reviewed paper). *Proceedings of the 28th Annual Conference of the Southern African Association for Research in Mathematics, Science and Technology Education, 14-16th Jan, 2020. Port Elizabeth.*

International Conference Papers

Juggernath, A. & Govender, N. (2019). Learner Perceptions and Attitude as Barrier Identified by Natural Science Teachers in Integrating ICTs in Technology-Rich Environments (Short paper). *Proceedings of the 27th Annual Conference of the Southern African Association for Research in Mathematics, Science and Technology Education*. *15-17th Jan, 2019. Durban.*

Govender, N. & Juggernath, A. (2018). Natural Science Teachers' Use of ICT (Short paper). *Proceedings of the 26th Annual Conference of the Southern African Association for Research in Mathematics, Science and Technology Education, 16-19th Jan, 2018. Gaborone, Botswana.*

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LIST OF ACRONYMS

BIUT	Beliefs Impacting the Usage of Technology
CAPS	Curriculum and Assessment Policy Statements
DBE	Department of Basic Education
DoE	Department of Education
ICT Integration	Information and Communication Technology Integration
ICTs	Information and Communication Technologies
NCS	National Curriculum Statements
OBE	Outcomes-Based Education
OECD	Organisation for Economic Co-operation and Development
PCK	Pedagogical Content Knowledge
PD	Professional Development
SAMR	Substitution, Augmentation, Modification, and Redefinition
STEM	Science, Technology, Engineering and Maths
TALIS	Teaching and Learning International Survey
TPACK	Technological Pedagogical Content Knowledge
TPD	Teacher Professional Development

1.1 INTRODUCTION

To meet the challenges of education in South Africa, teachers need to adapt and develop themselves professionally continually (Darling-Hammond, Hyler, & Gardner, 2017; Steyn, 2008). Also, teachers are faced with the challenges that the use of integrating Information and Communication Technologies (ICTs) pose. The use of ICTs, in teaching, requires the development of a new set of skills, attitudes and the development of new pedagogical approaches (Mathevula & Uwizeyimana, 2014). The choice of what technologies to use, how to use them, and the reasons for their use are problematic (Mbodila, Jones, & Muhandji, 2013). At times, teachers are forced to teach subjects that they are not qualified to teach (Cochran-Smith, Feiman-Nemser, McIntyre, & Demers, 2008; Du Plessis, Carroll, & Gillies, 2015). Teachers who feel unprepared to teach parts of the syllabus may teach it superficially or not at all. The requirement that teachers integrate ICTs by departments of education or circuit districts into their teaching poses further challenges. The Head of Digital Learning at the school where the study occurred reported to be aware of teachers' challenges in integrating ICTs into teaching and learning. The school was said to have spent large sums each year, on professional development courses for teachers, and these teachers often reported leaving those courses as unprepared as they were at the beginning. There was, therefore, a need for a form of teacher development that was holistic, relevant and able to provide ongoing support on the school sites.

The challenge faced by many teachers when trying to integrate ICTs in teaching generally lies in incorporating technology, pedagogy and content, rather than the use of the technology itself. (Koehler, Mishra, Akcaoglu, & Rosenberg, 2013). While teacher professional development may help teachers combine technology, pedagogy, and content to teach effectively with ICTs, traditional forms of professional development have been criticised for being ineffective (Darling-Hammond et al., 2017; Whitworth & Chiu, 2015). The solution could, therefore, lie in the form of professional development that been used widely in Japan, and has gained interest throughout the world (Schipper, de Vries, Goei, & van Veen, 2020; Cheung & Wong, 2014; Pedder & Xu, 2014). Lesson Study, a form of teacher professional development, involves teachers working collaboratively to develop and refine research lessons that could be used in their classes (Chassels & Melville, 2009; Fernandez, 2002; Fernandez & Yoshida, 2012).

While many professional development programmes exist, few provide teachers with tools to practically integrate ICTs with content and pedagogy, and fewer still provide teachers with ongoing support (Darling-Hammond et al., 2017). The use of Lesson Study for teacher development in other learning areas within the South African context has yet to be further explored. In addition, teachers' perception of the use of Lesson Study to integrate ICTs in teaching and learning is still unknown.

The use of ICTs in teaching has proven to be problematic since it requires the development of new skills, attitudes and pedagogical approaches. Teachers are often unsure about how to use ICTs, what to use and the reason for its use in teaching and learning. An evaluation of Lesson Study using Guskey's (2002) professional development evaluation framework indicated that Lesson Study had the potential to be an effective way of helping teachers to integrate ICTs in teaching. This research thus aims to explore teachers' experiences of Lesson Study in integrating ICTs in teaching and learning within the South African high school context.

1.2 REVIEW OF LITERATURE

The focus of the research is on Lesson Study as a strategy for integrating ICTs in teaching within the South African high school context. Hence the literature covers ICT integration in South Africa, teacher professional development, theories, and frameworks used for ICTs in teaching and learning and Lesson Study.

Lesson Study has been introduced in various countries as a form of teacher professional development that involves a cyclic process of lesson planning, collaboration and reflection. Teacher professional development, often called staff development, has emerged as a valuable area of research over the past two decades and while the value it adds to the profession cannot be questioned, there seems to be little consensus on a single definition for professional development (Evans, 2002; Kyndt, Gijbels, Grosemans, & Donche, 2016). The Organisation for Economic Co-operation and Development (OECD) (2009) defines professional development as "activities that develop an individual's skills, knowledge, expertise and other characteristics as a teacher" (p. 49) meaning that any activity an individual undertakes whether it be formal or informal in order to become better as a teacher would constitute professional development. Hargreaves and Fullan (1992) echo these sentiments by stating that professional development is a form of in-service development that assists in improving teacher confidence and skills. Darling-Hammond, Hyler and Gardner (2017) describe professional development as "structured professional learning that results in changes to teacher knowledge and practices, and improvements in student learning outcomes" (p. 2) while the significant element is that it is the result of multiple changes accumulated through learning over some time (Mitchell, 2013). For this research, professional development is defined as *activities and processes that are undertaken by in-service teachers in order to improve their content knowledge, pedagogical and technological knowledge and skills and their ability to work effectively with colleagues.*

Professional development is often criticised for being ineffective (Darling-Hammond et al., 2017; Whitworth & Chiu, 2015). Current models of professional development include the Cascade approach where information cascades down from an expert in the field to the teacher in the classroom (Bett, 2016; Ono & Ferreira, 2010). While this approach was useful in that information could be disseminated to a large number of teachers in a short space of time, this approach has been widely criticised since it may result in a dilution or misinterpretation of the content or the stressing of non-essential components of the training. Other forms of professional development may involve conferences, workshops, seminars or courses (Shabani, 2016). These types of professional development involve having the teacher removed from class and being required to attend short training sessions. These are usually delivered by experts in the field but are often fragmented and offer little or no room for feedback or reflection. Further, they may be isolated or decontextualized to the classroom environment (Mokhele, 2017).

Effective professional development should be ongoing and provide opportunities for teachers to experience and reflect on activities (Cordingley et al., 2004). Constructivism and in particular, social constructivism has had a significant impact on teaching and learning in recent years (Shabani, 2016). Constructivism is a theory that attempts to explain how people-learners and teachers learn (Churcher, 2014). It suggests that people learn from their experiences and from reflecting on those experiences. Further, social-constructivist theories focus on the social structure in which learning happens, how the individual interacts with the environment and the significance which he/she ascribes to his/her experiences and reality (Trif, 2015), therefore, highlighting the importance of learning within a social context. Current approaches to student learning show a shift from a passive, positivistic approach to an active, constructive approach. Leu (2004) differentiated between previous approaches and current approaches to learners learning stating that previous approaches involved passive learning, rote memorisation and were teacher-centred while present approaches involved active, learner-centred learning and the use of higher order thinking skills.

However, this change has only partially filtered into teacher development programs in South Africa (Akyeampong, 2017; Johnson, Hodges, & Monk, 2000). Current approaches to professional development are anomalous since the document the Guidelines for Teacher Training and Professional Development in ICT (Department of Education, 2007) mention that effective professional development for ICT integration should be holistic and include a pedagogical dimension, a technical dimension and collaboration and networking dimension. The language used in the document implies a constructivist approach. Constructivism and in particular, social constructivism have had a significant impact on teaching and learning in recent years (Shabani, 2016). Constructivism is a theory that attempts to explain how people, learners and teachers, learn (Churcher, 2014). It is a learning theory that describes how learning happens and suggests that people learn from their experiences and from reflecting on those experiences. Constructivism, therefore, provided a framework that reinforced the use of Lesson Study as the basis of a professional development programme for the integration of ICTs by teachers in their teaching.

Current models of professional development or learning communities involve teachers working in isolation instead of within communities (Wenger-Trayner & Wenger-Trayner, 2015). Research has shown that successful professional development programs occur within learning communities and provide ongoing support enabling immediate and usable solutions that teachers may face (Darling-Hammond et al., 2017; Hannover Research, 2014). There is, therefore, a need for a holistic strategy, one that can help teachers effectively integrate technology, pedagogy and content knowledge. Frameworks such as the Technological Pedagogical Content and Knowledge (TPACK) (Mishra & Koehler, 2006) could serve as the foundation for suitable models.

Educational technology researchers have developed the constructs of Content (C), Technology (T) and Pedagogy (P) (Jimoyiannis, 2010) to explain the various components of knowledge associated with effective teaching with technology (Koehler & Mishra, 2009; Sheffield, Dobozy, Gibson, Mullaney, & Campbell, 2015). The addition of a technological component to Shulman's (1986) Pedagogical Content Knowledge model (PCK) gave rise to Mishra and Koehler's (2006) model called the Technological Pedagogical and Content Knowledge (TPACK) model. The TPACK model is widely used as an analytic framework to understand teachers use and integration of ICTs in teaching. In this model (Figure 1), there are three main components of teachers' knowledge: content, pedagogy, and technology. Equally crucial to the model are the interactions between and among these bodies of knowledge, represented as PCK (Pedagogical Content Knowledge), TCK (Technological Content Knowledge), TPK (Technological Pedagogical Knowledge), and TPACK (Technology, Pedagogy and Content Knowledge).

Mishra and Koehler (2009) explain that TPACK is the framework which shows the interaction of these bodies of knowledge to produce the types of flexible knowledge needed to integrate technology use into teaching successfully. Based on the TPACK framework (Koehler & Mishra, 2009), all three knowledge areas need to act in concert in order to teach with ICTs effectively. Research has indicated that understanding suitable pedagogical practices for using technology may be more important than the mastery of technology alone (Hannover Research, 2014). Hence the need for holistic professional development opportunities that incorporate all aspects of the TPACK framework. While the TPACK framework discusses what should be done in theory, little guidance is provided in practically applying the principles of the model (Sheffield et al., 2015). This research also attempted to establish whether Lesson Study as a practical application of TPACK does facilitate ICT integration. The TPACK framework was used as an appropriate framework for this research. While the TPACK framework was used to guide this research, two other frameworks were used to analyse the data generated. These were Ajzen's Theory of Planned Behaviour (1991) and Guskey's (2002) framework for evaluating professional development. These frameworks help guide that discussion around the research questions of the study.

Lesson Study has come under increasing attention, from educators around the world, from the year 2000 onwards especially in Japan (Cheung & Wong, 2014; Pedder & Xu, 2014; Wiburg & Brown, 2007). Lesson Study is a collaborative teaching approach where teachers work together in order to examine, learn from and reflect on what happens in a classroom (Ono & Ferreira, 2010). This approach usually comprises four to six teachers teaching the same grade or subject working through a cycle (see Figure 1.2). One cycle consisted of five parts. Part one was the research and goal setting stage which was followed by the planning of the lesson. The planning of the lesson was done as a group, so all participants were involved in the development process. The research lesson was then presented by one member of the group and observed by the other participants, first in one class. The penultimate part of a cycle involved reflecting on the lesson together. The reflection phase aimed to improve the lesson. Since the group developed lessons, no comment could be directed at individual teachers.

When this was done, the lesson could then be revised and taught to other classes. It has been used in the United States since 2001, in South East Asian countries, and there is a growing interest in it in the United Kingdom and Australia (Doig & Groves, 2011). The use of Lesson Study in South Africa has been limited, but there has been an increasing focus on its use in recent years (Bayaga, 2013; Mokhele, 2017). Most of the research has, however, focused on mathematics education. The most well-known study conducted in South Africa was completed in 2010 by Ono and Ferreira (2010) in order to assist with the implementation of Curriculum 2005. While some successes were reported, Lesson Study did not take off in the province. The reasons presented for this were, among others; that teachers were focused on curriculum coverage rather than dealing with misconceptions, teachers failed to take the initiative, and there was a perception that there was a strict division of responsibility at different post levels (Ono & Ferreira, 2010).

Research into a holistic strategy that incorporates all aspects of the TPACK framework in South Africa is limited. Further, a preliminary search on Google and Google Scholar yielded no results for the use of Lesson Study to integrate ICTs in teaching in South Africa indicating that hardly any or limited research on Lesson Study to integrate ICTs in teaching within the South African context currently exists.

1.3 LOCATION OF THE STUDY

This study was located within a qualitative and quantitative research framework (mixed method-design QUAL-quant) to make sense of the complexities faced by the teachers from their point of view.

The school chosen for the study was well-resourced in the Pinetown area of KwaZulu-Natal. The staff at the school were working on integrating ICTs into teaching and learning. The teachers participating in the study had access to ICTs that were used in teaching. Due to the small number of schools, with adequate resources, available and those that are currently attempting to integrate ICTs into teaching and learning, research was conducted at one school.

1.4 OBJECTIVES

The objectives of this study were:

1. To explore how teachers' confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study.

2. To gain an insight on teachers' experiences in using Lesson Study as a strategy to develop their competence in integrating information and communication technologies (ICTs) in their teaching.

3. To determine why teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in the way they do?

1.5 RESEARCH QUESTIONS

The following research questions framed this study:

1. How do teachers' confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study?

2. What are teachers' experiences in using Lesson Study as a strategy to develop their competence in integrating information and communication technologies (ICTs) in their teaching?

3. Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do?

1.6 RESEARCH METHODOLOGY

The purpose of the study was to explore teachers' experiences of Lesson Study for integrating information and communication technologies in teaching and not to provide an objective assessment of the use of Lesson Study (as may have been the focus of pragmatic or post-positivistic research). This focus represents the interpretative paradigm as understanding rather than critiquing or generalising was the aim (Goldkuhl, 2012). It is clear from the objectives of the study that the focus is on understanding and describing the behaviour of teachers (interpretivist) rather than the practical implications of the research or to solve real-world problems (pragmatist) (Kivunja & Kuyini, 2017). The purpose of this research was not to study the impact of Lesson Study in a general context. It was, instead, explicitly focussed on the teachers from the school chosen for the research. The focus was on the teachers' experiences and the factors that played a role in their context. The aim was, therefore, not generalisation but understanding teachers' experiences in their natural setting.

Interpretative research is guided by naturalistic enquiry. Therefore, phenomena cannot be separated from the social context and must be explored within the natural setting. This means that contextual variables may also play a role in the data generated (Goldkuhl, 2012; Kivunja & Kuyini, 2017). The purpose is to interpret and explore meanings rather than to generalise.

Interpretive researchers presume that people create meaning of the world around them as they interact with it. Therefore, the job of the interpretive researcher is to develop an understanding of phenomena by looking at the meanings that participants give to them. This means that the interpretative researcher makes sense through their cognitive processes and thinking resulting in the assumption of a subjectivist epistemology (Kivunja & Kuyini, 2017). The researcher and the participants are also assumed to be engaged in an interactive process, therefore, meaning "that the researched subjects ("the participants") are interpreters and co-producers of meaningful data" (Goldkuhl, 2012, p. 140).

Interpretive research is therefore based on the belief that reality is socially constructed and knowledge is negotiated within social setting and cultures (Kelly, Dowling, & Millar, 2018). This means that truth is not associated with objective reality but a subjective one. Since this is the case, the result is that multiple valid truths can exist. Therefore, interpretivism framed this research.

An exploratory mixed-method case study following the Concurrent Triangulation Design was conducted (Creswell, 2017; Hanson, Creswell, Clark, Petska, & Creswell, 2005). Qualitative and quantitative data were collected concurrently and then compared to determine if there were any similarities or differences. This method was chosen to strengthen any weaknesses present in the primary sources of data. Creswell (2017) mentions that while the data should ideally be weighted equally, one form of data may be given priority. The quantitative data in this study was used to support the findings from the qualitative data, and therefore the qualitative data was given priority.

The data were collected separately and then compared to data from other sources. Data from multiple sources were used for triangulation and also helped expand the quantitative data through the qualitative data. The qualitative aspect of the research focussed on non-numeric data (Maxwell, 2008). Non-numeric data in this study consisted of interviews, observations, and documentary analysis. While most of the research conducted was qualitative, it was deemed necessary to administer the TPACK Likert questionnaire (Appendix D1), thus the quantitative aspect of the research. The TPACK questionnaire was used to determine teachers' confidence in each aspect of the TPACK framework at the beginning of the study. The TPACK Likert questionnaire was then administered at the end of the study, and a comparison of teachers' scores was made using the paired t-test. The paired t-test was used to identify whether the means of the two sets of data were different from each other and thereby help determine whether the use of Lesson Study played a role in improving teachers' confidence in using ICTs in teaching and learning.

1.6.1 Sampling

Purposive sampling (Cohen, Manion, & Morrison, 2013) was used to identify and select participants so that rich data could be gathered from limited resources (Etikan, Musa, & Alkassim, 2016; Palinkas et al., 2015). A school working on integrating ICTs into teaching, and learning was used. The teacher-participants were required to have access to Information and Communication Technologies (ICTs) that could be used in teaching. ICT tools used by teachers in the study included laptops, projectors, interactive boards, and pupils required to have tablets capable of connecting to the school WiFi. A presentation was done at the school explaining the research, and Heads of Learning Areas were invited to include their departments in the study. After the presentation, 38 teachers volunteered to be part of the study. The selection criteria used for teachers in the main study consisted of two principal criteria. At least four teachers from the same learning area had to be available to participate in a Lesson Study group, and the teachers from that learning area were using or attempting to use ICTs in their teaching. As a result of applying these criteria, four groups of four teachers from Life Sciences, Economic and Management Sciences, Mathematics and English resulted.

During the first cycle, the subject head of the English department resigned to take up a position at another school. The remaining English teachers requested to withdraw from the study due to increased workload and changes to the leadership structure within the department. Their withdrawal was accepted since teachers were entitled to withdraw at any time during the study. This condition was stipulated in the ethics approval document. The result of the withdrawal meant that the teachers participating in the study consisted of four Life Sciences teachers, four Mathematics teachers, and four Economic and Management Sciences teachers.

1.6.2 Data collection Methods

Quantitative data were collected using the questionnaire by Schmidt, Baran, Thompson, Koehler, et al. (2009). The questionnaire consisted of 28 questions based on the TPACK framework with no negative questions. A five-point Likert scale was used for all the items ranging from strongly "disagree" (1) to "strongly agree" (5). For example, teachers were asked to indicate using the five-point scale, whether they could choose technologies that enhanced the teaching approaches for a lesson. The content areas contained in the original questionnaire consisted of mathematics, social studies, science, and literacy and was designed for primary school teachers. The content areas were adapted to suit the current research. Some questions were grouped while others were removed. For example, the following items: "I have sufficient knowledge about science"; "I have sufficient knowledge about literacy"; "I have sufficient knowledge about mathematics", and "I have sufficient knowledge about social studies" were replaced with "I have sufficient knowledge about the subject I teach". The modified questionnaire was then piloted with 22 teachers from the same school for reliability. The questionnaire was handed out to the teachers involved in the pilot study and of the 22 handed out 20 were returned. The returns represented a response rate of 91%.

The reliability of the TPACK questionnaire was also confirmed in studies by Schmidt, Baran, Thompson, Koehler, et al. (2009), and Albion, Jamieson-Proctor, and Finger (2010), among others. Cronbach Alpha reliability coefficients in the original questionnaire are between 0.78 and 0.93. The results obtained from the questionnaire were analysed at the beginning to determine teachers' confidence in using ICTs in teaching and learning. The results of the questionnaire were then entered to SPSS Statistics software version 26 and analysed.

Over approximately seven months, two lesson study cycles per learning area (a total of six complete cycles) were then conducted during which a new lesson was developed and revised per subject per cycle. The validated TPACK questionnaire was then administered again. A comparison of the teachers' scores at the beginning and end of the study was made to determine if the Lesson Study programme affected teachers' use of ICTs in teaching and learning.

A Lesson Study cycle consisted of the five stages (see Figure 1.2 below). Stage one was the research and goal setting stage which was followed by the planning of the lesson, done as a group. The research lesson was then presented by one member of the group and observed by the other participants. The penultimate stage of the cycle involves reflecting on the lesson. When this was done, the lesson was revised

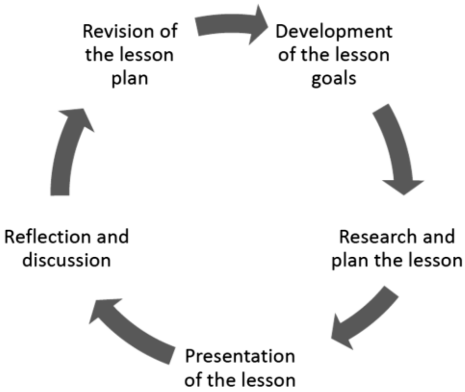

Figure 1.1: The Lesson Study cycle (Juggernath, original work)

Data was collected during the planning phase by recording the discussions that took place, and the process followed by the participants in designing the lessons in each learning area. Lesson planning occurred at a predetermined meeting period when all participants were available. As per the Lesson Planning Sheet (Appendix C2), the content, pedagogy, and ICTs used were detailed. The written plan of the lesson was also used as data. Specialised professional development in the use of ICTs was required in some cases after this stage. The courses on the use of ICTs were developed by the Information Technology Manager and were readily available to all staff at the school. The lesson was then presented and video recorded. The teachers later met together to observe the video recorded lesson and made notes. The Technology Integration Assessment Rubric (Harris, Grandgenett, & Hofer, 2010) (within Appendix C3, designed for use with the TPACK framework, was used by the teachers as part of the observation schedule. A reflective session was then held, where the lesson was discussed, and observation notes were taken in for additional data. After the two full cycles per learning area are complete, individual semi-structured interviews were conducted. The interview was initially piloted with a colleague to ensure that the actual interview occurred smoothly. Seidman (1998) points out that interviewing is one of the best instruments for qualitative data generation. Running the pilot assisted in checking the appropriateness of the questions, estimating the time needed and assess whether the questions were useful in fulfilling the purpose of the study (Van Teijlingen & Hundley, 2002). Thus data were collected using the TPACK questionnaire, semi-structured interviews, lesson observations, participant observations and document analysis in the form of lesson plans, observation notes and teacher reflections.

1.6.3 Data Analysis

The quantitative data analysis was conducted in line with the instructions provided on the TPACK questionnaire. The instructions stated that each item response is scored with a value of 1 assigned to "strongly disagree", all the way to 5 for "strongly agree". For each construct, the participant's responses were averaged. For example, the six questions under TK (Technology Knowledge) were averaged to produce one TK (Technology Knowledge) score.

Qualitative data analysis involves organising, accounting for and making sense of data in terms of the participants' definitions of the situation, noting patterns, themes, categories and regularities (Cohen et al., 2013). Thematic analysis (Braun, Clarke, & Weate, 2016) was used to analyse that qualitative data. The thematic analysis describes a set of techniques used to analyse documented data and develop themes (Vaismoradi, Jones, Turunen, & Snelgrove, 2016). The key feature is the process of methodical coding, probing for meaning and the provision of an explanation of reality through the themes (Vaismoradi et al., 2016). It involved taking the data that was collected and organising it so that some form of understanding or explanation could be developed.

Seidel (1998) developed a model to explain the basics of qualitative data analysis. The model consists of 3 parts: Noticing, Collecting, and Thinking about things. These parts are interlinked, and cyclical meaning that the data analysis process is not a static, linear process; instead, it is dynamic. Qualitative data analysis in qualitative research consists of three simultaneous flows of action, namely: data reduction, data display, and conclusions (Miles & Huberman, 1994). These actions are present both during and after data collection.

Data reduction is the process of organising, simplifying, extracting, and transforming the data to make it more accessible (Miles & Huberman, 1994). It is reduced to help understand the data. The qualitative data were collated and organised in preparation for data analysis. Data from the documents used by the teachers in the Lesson Study process and the lesson observations were analysed. The interviews were transcribed fully to ensure that critical information was not lost if only. While this process was very time consuming, it allowed for multiple opportunities to listen to the data before beginning the actual analysis. Each participant was allocated a code for identification later. This code was kept confidential. The code was available to only two other people, the research supervisor and the participant. Once the recordings were transcribed, they were listened to again and compared with the transcriptions and notes. Summaries of the data, which included the demographic data of each participant, were then made. During this process, preliminary themes were identified.

The purpose of data displays is to organise the data in a way that the data can be easily analysed so that conclusions can be drawn (Miles & Huberman, 1994). The final component analysis process involves concluding. Miles and Huberman (1994) stress that definitive findings should not be made during the data collection process. Any preliminary results would have to be verified during the process.

Yin (2009) describes various means of linking data to a proposition such as pattern-matching or coding, time series analysis or logic models. Pattern matching is the process where different parts of the same study could be linked to a theoretical proposition (Yin, 2009). The strategy employed for this study was coding, and the data were examined for recurring ideas, patterns of beliefs and words or phrases. The transcripts were divided into smaller segments to identify patterns in the data. When all the data was available in a word-based format, the data could be analysed systematically and methodically (Miles & Huberman, 1994).

Miles and Huberman (1994) describe four advantages of coding data. Coding helped reduce a large amount of data into smaller, more manageable units. It allows for more focused fieldwork since the researcher can begin analysis during data collection. It helps promote cross-case research and finally, helps develop an understanding of the interactions of the participants.

A thematic analysis was used to determine the common issues and central themes that arose. When the data were coded, data was taken out of the original context and put together under each code. Examples of data on the same topic were put together to search for patterns.

These patterns were then sorted into themes. The transcript was then studied again to see if any overlapping pieces could be combined, resulting in the final list of codes that were used to code the rest of the data. The analysis of the data, collected from the interviews, documentary analysis, and observations were essential to the reporting of the results since it provided detailed information on teachers' experiences of Lesson Study for integrating ICTs in teaching. The coding reflected patterns related to Lesson Study for integrating ICTs in education, the teachers, the events they experienced, and issues that emerged.

The codes that emerged from the data were organised into themes. A sample of a transcript was given to a colleague to code. The codes were compared, and inconsistencies were discussed.

When consensus was reached, the coding of the data continued, and themes were developed. The themes were interpreted in light of the relevant literature available. The interpretation of themes was followed by the writing of the research finding and the drawing of conclusions

While the qualitative and quantitative results were reported differently, these results were integrated wherever possible. In doing so, a broader, cross-study integration of the findings among the three subject areas was made possible allowing for discussion on the research questions and the relationship with the themes and conclusions across all data collected.

All the data, documentation and results of the questionnaire were carefully and systematically analysed since it was necessary for exploring teachers' experiences of lesson study for integrating ICTs in teaching.

1.7 TRUSTWORTHINESS / VALIDITY AND RELIABILITY

1.7.1 Validity and reliability of the questionnaire

Quantitative data were collected using the questionnaire by Schmidt, Baran, Thompson, Koehler, et al. (2009). The questionnaire consisted of 28 questions based on the TPACK framework

The modified questionnaire was piloted with 22 teachers from the same school for reliability. The questionnaire was handed out to the teachers involved in the pilot study and of the 22 handed out 20 were returned. The returns for the pilot represented a response rate of 91%.

The reliability of the TPACK questionnaire was also confirmed in studies by Schmidt, Baran, Thompson, Koehler, et al. (2009), and Albion et al. (2010), among others. Cronbach Alpha reliability coefficients in the original questionnaire are between 0.78 and 0.93. The analysis of the Cronbach alpha for the questionnaire indicated values between 0.78 and 0.89. Acceptable Cronbach alpha values above 0.7 are considered acceptable (Taber, 2018). Therefore, the Cronbach alpha for the questionnaire is highly acceptable.

1.7.2 Trustworthiness

Quantitative research talks of validity and reliability while Qualitative researchers speak of trustworthiness, which is merely answering the question 'Can the findings be trusted? (Korstjens & Moser, 2018). The trustworthiness or rigour of a study refers to the confidence that can be placed on the data collected, interpreted, and generally ensuring the quality of research (Lincoln & Guba, 1985). Lincoln and Guba (1985) developed a set of criteria to ensure the trustworthiness of a study. These are credibility, transferability, dependability, and confirmability.

Credibility refers to checking if the findings represent participants' original data and is a correct interpretation of the participants' unique views and were achieved by prolonged engagement and persistent observation. The participants of each Lesson Study groups served as additional observers to help triangulate the findings. Triangulation helps to provide a convergence of data that improves credibility (Bowen, 2009). Supporting results across different types of data can help reduce the impact of bias through the use of other methods for examining data.

The lesson observations and the transcripts of interviews were given to the respective participants for comment. Participants were asked to verify that the transcripts were accurate and reflected what happened during the interview and the lesson. All participants were involved and participated in the Lesson Study process, including the lesson observation that was made possible through the recording of lessons.

Transferability relates to the degree to which the results of qualitative research can be transferred to other settings or contexts with other participants (Korstjens & Moser, 2018). Transferability was facilitated through a highly detailed description of the research situation and methods.

Dependability was ensured through the participants' involvement in the whole process, such as confirming that the reported findings represent the data as received from them. Dependability was established using an audit trail through proper documentation and storage of raw data, and field notes. A colleague and another researcher analysed the data to compare results.

Confirmability: This is concerned with ensuring that data and interpretations of the findings are not figments of the researcher's imagination, but authentic (Tobin & Begley, 2004). Another researcher cross-checked the data and analyses and through triangulation to achieve conformability. A comparison was made with a colleague in terms of the coding process. The list of codes and a part of the transcript was given to the colleague. The colleague was then asked to code the transcript of an interview. The identity of the participant whose transcript was coded was not revealed. A comparison was drawn between the codes. Where inconsistencies were found, a discussion took place to understand the rationale behind these inconsistencies.

Once a consensus was reached, the researcher used the revised codes to continue with the data analysis.

Reflexivity is described as the process of critical self-reflection as a researcher (biases, preferences, preconceptions), and the research relationship (relationship to the respondent, and how the relationship affects participant's answers to questions) (Korstjens & Moser, 2018). In addition to allowing the participants the opportunity to comment on the data, triangulation was used to limit the effect of researcher bias (Shenton, 2004). Triangulation involves using two or more methods to collect data on the same topic and using multiple participants. Triangulation helped corroborate findings and, equally as necessary, helped identify inconsistencies which could lead to more complex discoveries (O'Connor & Gibson, 2003). Various methods were used to collect data in this study: the use of a questionnaire; semi-structured interviews, lesson observations and document analysis. Detailed reflexive notes were taken, and a conscious effort was made not to impose meanings on the findings.

1.8 STRUCTURE OF THE STUDY

This dissertation is organised into seven chapters. Chapter One provides an overview of the study and the importance of the use of Lesson Study for the integration of ICTs in teaching. An overview of the research methods, methodology, and ethical considerations. Lesson Study and the Lesson Study cycles were discussed.

In Chapter Two, ICT integration within the South African context is presented. The discussion on ICT integration focussed on crucial definitions, guiding policies within South Africa, and barriers that teachers face while trying to integrate ICTs in their teaching. As a critical factor affecting ICT integration was reported to be the lack of teacher professional development, teacher professional development is discussed next. This is followed by a theoretical justification for the use of Lesson Study as a potential solution to the challenges teachers face when trying to integrate ICTs into their teaching. Finally, the guiding frameworks are presented, followed by a summary of the chapter.

Chapter Three begins with a justification for the choice of the interpretative paradigm, followed by the research design and methodology used to answer the research questions. Sampling procedures and data generation and data analysis methods are described.

Chapter Four contains the qualitative data that were generated primarily through the semi-structured interviews but included other forms of qualitative data generated through observations and document analysis. The findings of the data are presented.

Chapter Five contains the results of the qualitative data obtained from the TPACK questionnaire.

In Chapter Six, both qualitative and quantitative data that were generated are analysed and discussed together.

Chapter Seven contains the conclusions and recommendations, and the dissertation ends with the references and the appendices.

CHAPTER 2

2.1 INTRODUCTION

In Chapter Two, ICT integration within the South African context was presented. The discussion on ICT integration focussed on crucial definitions, guiding policies within South Africa, and barriers that teachers face while trying to integrate ICTs in their teaching. As a critical factor affecting ICT integration was reported to be the lack of teacher professional development, teacher professional development was discussed next. This was followed by a theoretical justification for the use of Lesson Study as a potential solution to the challenges teachers face when trying to integrate ICTs into their teaching. Finally, the guiding frameworks are presented, followed by a summary of the chapter.

2.2 TEACHER PROFESSIONAL DEVELOPMENT INITIATIVES

South Africa is in the age of the 4^{th} industrial revolution, and the use of ICTs in the classroom and the world is becoming a significant consideration. Nationally, there has been an increasing progression towards technology integration in the classroom. While some schools have adequate ICTs, many are currently not preparing learners for a world outside the school (Barakabitze et al., 2019). As Fullan (2011a) points out, giving a child, an electronic device does not make him more knowledgeable or intelligent. Schools have attempted to develop teachers to use ICTs for teaching effectively; however, much of this professional development has focused on the use of ICT resources (Le Thi, 2020; Meyer & Gent, 2016). The result is teachers who are competent in the use of ICT resources but are unsure of how to use these ICTs in their teaching.

Current teacher professional development courses focus on the ICT devices, rather than a holistic approach incorporating pedagogy and content with the technology. In an attempt to increase the use of ICTs in teaching, policymakers tend to rely on simple, seemingly magical or academic solutions to complex problems, the so-called silver bullet (Fullan, 2011a). Fullan (2011a) lists four of these silver bullets or as he terms them "wrong drivers" These are: "External, punitive accountability (vs capacity building); Individual (vs group) solutions; Technology (vs pedagogy); Ad hoc (vs systemic) policies" (p. 5).

While most teachers are confident about teaching content, choosing the correct approach to delivering the content and even selecting suitable ICT tools to use, the challenge lies in incorporating all three elements to teach effectively using ICTs (Koehler, Mishra, Akcaoglu, & Rosenberg, 2013). The solution may rest in ongoing teacher professional development courses; however, opportunities that exist are usually one-day courses with little room for feedback or continuing support (Whitworth & Chiu, 2015). Research has shown that this form of ad-hoc teacher development is ineffective (Garet, Porter, Desimone, Birman, & Yoon, 2001; Gulamhussein, 2013; Seferoglu, 2010; Smith & Gillespie, 2007). What constitutes effective teacher professional development involves blending all the features of learning that most improve learning and teaching (Darling-Hammond et al., 2017; Cordingley, Bell, Rundell, Evans, & Curtis, 2004). These are that professional learning takes place over time – and is not a one-off event, happens in real classrooms with real learners and involves an element of collaborative enquiry or experiment between teachers who are trying to solve a problem or improve an approach.

While other teacher professional development strategies like the cascade model or the coaching model exist (Bett, 2016; Cordingley et al., 2015), Lesson Study, a teacher professional development strategy used widely in Japan, has gained interest throughout the world (Schipper, de Vries, Goei, & van Veen, 2020; Cheung & Wong, 2014; Pedder & Xu, 2014). Lesson Study is a form of professional development where teachers work together to plan classroom lessons, observe the teaching and learning experience during the lesson, analyse the content and delivery, and then make changes in the lesson to make it better (Chassels & Melville, 2009; Fernandez, 2002; Fernandez & Yoshida, 2012). Lesson Study has proven to be an effective strategy particularly in Mathematics education (Cajkler, Wood, Norton, Pedder, & Xu, 2015; Fernandez & Yoshida, 2012; Ono & Ferreira, 2010). Teachers involved in Lesson Study have reported several substantial gains like the reduction of feelings of isolation and an eagerness to get involved in interactive activities (Cajkler et al., 2015). Also, Lesson Study results in a deepening of the content knowledge (CK), pedagogical knowledge (PK) and pedagogical content knowledge (PCK) of teachers (Gutierez, 2015) and together with the technological components, it was proposed that ICT integration in teaching and learning could occur as a holistic approach.

While many professional development programmes exist, few provide teachers with tools to be able to integrate ICTs with content and pedagogy practically, and fewer still provide ongoing support to teachers (Darling-Hammond et al., 2017). The use of Lesson Study for teacher development in other learning areas within the South African context has yet to be explored.

Further, teachers' experiences of the use of Lesson Study for the Integration of ICTs in teaching and learning is still largely unknown.

The use of ICTs in teaching has proven to be problematic since it requires the development of new skills, attitudes and pedagogical approaches. Teachers are often unsure about how to use ICTs, what to use and the reason for its use in teaching and learning (Barakabitze et al., 2019). This study explored teachers' experiences of Lesson Study in integrating ICTs in teaching and learning within the South African high school context. The following subsections examine ICT integration in South Africa. The guiding policies, definitions of ICT and ICT integration, and factors affecting ICT integration are discussed. A critical factor reported to impact on ICT integration is the preparedness of teachers to integrate ICTs in teaching. Professional development of teachers was therefore discussed.

2.3 ICT INTEGRATION WITHIN THE SOUTH AFRICAN CONTEXT

In order to explore the use of Lesson Study for ICT integration within the South African context, it was necessary to consider the definitions of ICTs and ICT integration to determine what constitutes effective ICT integration. Also, the factors that affect the integration of ICTs in teaching needed to be considered. Therefore, this section began by establishing acceptable definitions of ICTs and ICT integration, followed by factors that affect the use of ICTs in teaching, including the key policies that guide the implementation.

2.3.1 Defining ICTs and ICT Integration

The term Information Technology (IT) was first used in the 1980s to indicate the union of computer and communication technology. In the 1990s, the term Information and Communication Technology/Technologies (ICT) was more widely used to replace IT, which gave more significant emphasis on the communication aspect. ICT is generally accepted to indicate information and communication technology or information and communications technology and is seen to be an evolution of the term IT which refers to its usage in business and other areas dealing with programming and database design.

Defining ICT is a challenge, primarily since its definition is often related to the context in which it is used (Zuppo, 2012). There are several definitions of information and communication technologies, but the more important ones refer to the devices and infrastructures that enable the transfer of information using digital means (Zuppo, 2012). Some of these definitions are presented below.

Christensson (2010) states that ICT refers to technology that assists in the provision of information using telecommunications. This definition places greater emphasis on the communication aspect of ICT. These definitions generally encompass different types of software and applications for communication like WhatsApp and Facebook. All these are collectively called technology. Govender and Khoza (2017) describe ICTs as all technologies used to process, store, and access information, communicate and to support e-learning activities. Since the study was conducted in South Africa, it is important to also consider how ICTs are defined in guiding policies. The White paper on e-Education in South Africa (2004, p. 15) defines ICT as

> *the convergence of information technology and communication technology. ICTs are the combination of networks, hardware, and software as well as the means of communication, collaboration and engagement that enable the processing, management, and exchange of data, information, and knowledge.*

In recent years, significant interest has been generated in the use of ICTs in education in both structured environments like in classrooms and informal environments like at home.

In this study, ICTs refer to any form of electronic technologies that are used to facilitate communication among groups or individuals and promote the sharing, management, and processing of information and knowledge.

2.3.2 ICT Integration

In order to explore teacher's experiences of Lesson Study for the integration of ICTs in teaching, it is necessary first to define what ICT integration is and also, what constitutes effective ICT integration. In South Africa, the concept of ICT integration is linked to the e-Education policy developed by the government. E-Education is defined as

> *the use of ICTs to accelerate the achievement of national education goals. e-Education is about connecting learners and teachers to each other and professional support services and providing platforms for learning. e-Education will connect learners and teachers to better information, ideas and one another via effective combinations of pedagogy and technology in*

support of educational reform. It supports larger systematic, pedagogical, curricular and assessment reforms that will facilitate improved education and improved use of educational resources such as ICT (Department of Education, 2004, p. 14).

e-Education thus deals with the use of educational resources, which in this case refers to ICTs, in conjunction with appropriate pedagogy to help support educational reform and help improve teaching and learning.

It further states that e-Education is more than just developing ICT skills like the ability to use computers. It is about being able to

apply ICT skills to access, analyse, evaluate, integrate, present and communicate information;

create knowledge and new information by adapting, applying, designing, inventing and authoring information; and

function in a knowledge society by using appropriate technology and mastering communication and collaboration skills (Department of Education, 2004, p. 14).

While the extract above tends to stress higher-order skills, early definitions of ICT integration can also simply be defined as the use of ICTs to emphasize, enhance or extend skills (Pisapia, 1994). A consistent definition for ICT integration is difficult to locate and this in itself is problematic. The White Paper on e-Education (2004) mentions that "ICTs, when successfully integrated into teaching and learning, can ensure the meaningful interaction of learners with information (p. 14)" but fails to define what "successfully integrated" means. The Guidelines for Teacher Training and Professional Development in ICT (Department of Education, 2007) states that ICT integration is the use and fusion of several competencies, such as pedagogical competencies and skills, and content knowledge, and is not merely limited to acquiring ICT skills. The document goes on to state that once these competencies are acquired learning and the learning environment can be improved. This document also fails to provide a clear definition of ICT integration.

The Professional Development Framework for Digital Learning equates ICT integration to digital learning and states that Digital Learning represents a more modern form of ICT integration. It further states that

> *Digital learning (which encompasses e-learning and mobile learning) describes learning that uses appropriate digital tools and resources to strengthen a teacher's teaching and a learner's learning experience resulting in more effective achievement of curriculum learning objectives.*

The above extract attempts to explain what effective ICT integration is. While the extract explains how ICTs could be integrated and the proposed outcome of the use of ICTs, it does not provide a concrete definition of ICT integration. The critical aspect of ICT integration is the integration. Integration is not clearly defined above; however, integration and use are often used interchangeably in the literature.

An earlier definition by Gaible and Burns (2005) state that ICT integration

> *refers to the use of computers and the Internet to support teaching and learning across the curriculum. Integrated use of technology may involve students working with computer productivity tools to complete science projects or searching the Internet to find poetry—but it is always tied directly to student mastery of their school subjects (p. 18).*

It is evident from the extract above that the word "integration" is used interchangeably with "use". For this study, however, the concept of integration will be used as defined by Margaret (2005). Integration, generally, refers to the use of ICTs, together with a change in pedagogy away from the utilitarian use, to a learner-centred approach (Margaret, 2005). A further challenge when considering ICT integration is differentiating between practical use and integration. Puentedura (2010) developed the Substitution, Augmentation, Modification, and Redefinition model in an attempt to categorise the different levels of ICT integration.

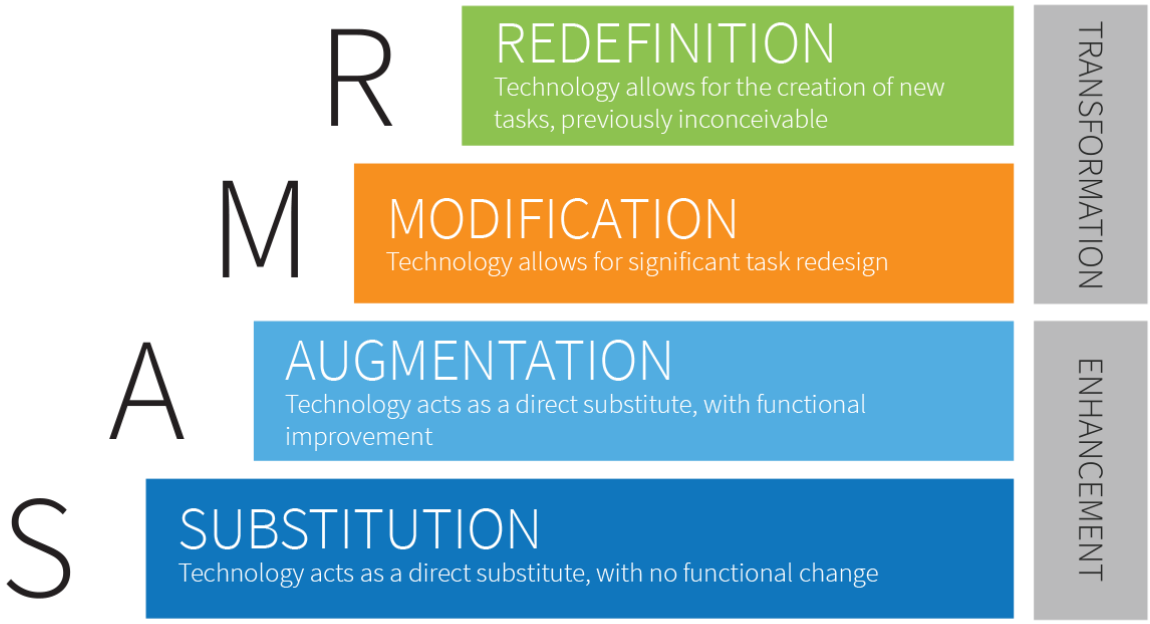

Figure 2.1 The SAMR model (Puentedura, 2010)

Substitution is regarded as the simplest form of technology integration. This is where the technology used acts as a direct substitute. A simple example would be essay writing. An essay could be written by hand or using a word processing programme. In this case, the task is the same and technology is simply being used as a substitute.

Augmentation is where the task remains the same, but the technology used allows for some functional improvement. An example could be where an essay is written using Google Documents allowing for some collaborative work to occur.
In the above two levels, the technology is simply used to enhance the lessons and may not necessarily result in long term academic gains.

Modification results in a significant task redesign through the use of technology. In the case of the essay, a learner could publish a Blog with videos, pictures and text to convey an argument, thereby allowing comment from a wider audience and allowing for more in-depth analysis.

The last stage of the SAMR model is called Redefinition. This stage represents the pinnacle of technology integration which results in the creation of new tasks that were previously inconceivable without the use of technology, like digital storytelling to present an argument that others can comment on or analyse.

While the SAMR model describes the different levels of technology integration, it does not state that effective learning will occur only through the use of only modification and redefinition (Puentedura, 2010). Instead, it considers all forms of ICT usage as technology integration. While the SAMR model provides a simple but effective way to describe how technology could be integrated into lessons, it was used in this study to help teachers realize higher levels of ICT integration than they had previously achieved. By achieving higher levels of ICT integration, teachers would be able to demonstrate professional learning.

Due to the varied range of teachers' technological skills, ICT integration in the context of this study will occur when a holistic approach is employed in teaching. This means that content, pedagogy and the ICTs need to be considered together when attempting to integrate ICTs in teaching. The use of ICTs for routine tasks may be considered ICT integration if there is a clear link between the content and the pedagogy. An example of this is the use of Microsoft Excel to capture experimental data in Physical Sciences. While recording the data on Microsoft Excel is similar to recording on paper, it does serve as a substitution. While substitution is the lowest level of ICT integration, it is still ICT integration.

After the establishment of suitable definitions for ICTs and ICT integration, it is necessary to consider the factors the affect ICT integration in teaching. Implementation of innovations in teaching would not be possible unless clear policies guide the implementation. The following sub-section looks at the policies guiding ICT integration in South Africa.

2.4 POLICIES GUIDING ICT INTEGRATION IN SOUTH AFRICA

Effective technology integration in schools requires operative planning and policymaking (Barakabitze et al., 2019). A crucial element is a National policy since

> *They provide a rationale, a set of goals, and a vision of how education systems run if ICT is integrated into teaching and learning process, and they are beneficial to students, teachers, parents and the general population of a given country (Ghavifekr & Rosdy, 2015, p. 176).*

ICT integration in South African public schools is guided by the following key policies set out by the Department of Education and the current ICT in education policy was initially hinted at in the South African Schools Act of 1996. Up until 2004, no policy on ICT in education existed in South Africa. Since 2004, the White Paper on e-Education: Transforming Learning and

Teaching through Information and Communication Technologies (ICTs) has served as the governing policy on e-Education in South Africa. The strategic goal of the policy is that

> *every South African manager, teacher and learner in the general and further education and training bands, will be ICT capable (that is, use ICTs confidently and creatively to help develop the skills and knowledge they need as lifelong learners to achieve personal goals and to be full participants in the global community) by the year 2013 (Department of Education, 2004, p. 17).*

In the South African context, the concept of e-Education revolves around the use of ICTs to accelerate the achievement of national education goals by providing platforms for learning and providing teacher and learners with access to better information (Department of Education, 2004).

At the national level in South Africa, the e-Education policy required the Department of Education to develop a national framework for ICT competencies for all role players at the institution level and review training programmes that enable teachers to use ICT and create accreditation for teachers with an ICT focus. Districts were required to provide schools with technical and professional support while at the institution level, school managers and administrators are required to encourage the use of ICT as a teaching tool (Department of Education, 2004).

The Guidelines for Teacher Training and Professional Development in ICT (Department of Education, 2007) is the other main policy document that outlines the ICT in education policy. This document identifies ICT knowledge, skills, values and attitudes required by teachers to implement the national curriculum effectively.

The KZN DoE adopted an e-strategy (2015 -2019) at the KwaZulu-Natal Education Summit that was held in April 2015. The White Paper informed the e-Education Strategy document on e-Education, the National Development Plan, the Integrated Strategic Planning Framework for Teacher Education and Development in South Africa and Action Plan 2014: Towards the realization of Schooling 2025 (Department of Education, 2015). The Action plan has, among the 27 Schooling 2030 goals, three goals that refer to e-Education and ICT use.

The e-Education policy has made significant strides in developing and supporting ICT systems in institutions. However, it falls short of achieving the main strategic target of influencing and changing classroom practice; therefore, the translation from policy to practice has not occurred. (Barakabitze et al., 2019; Mathevula & Uwizeyimana, 2014). One of the reasons for the lack of translation of policy to practice could be related to inadequate training of teachers to integrate ICTs in their teaching. This and other factors that affect the integration of ICTs in teaching are discussed further.

2.5 FACTORS ASSOCIATED WITH ICT INTEGRATION IN TEACHING

A discussion of the factors affecting ICT integration is essential as this is believed to play a role in the way teachers experience Lesson Study for integrating ICTs in teaching. Research has shown that the factors affecting teachers use of ICTs in teaching can be classified into two broad categories, intrinsic and extrinsic factors (Hew & Brush, 2007). While several models that show the relationship among the factors that affect teachers' use of ICTs in their teaching, the Beliefs Impacting the Use of Technology (BIUT) (Juggernath & Govender, 2020) represents a comprehensive model that shows the relationship among extrinsic, intrinsic, and beliefs.

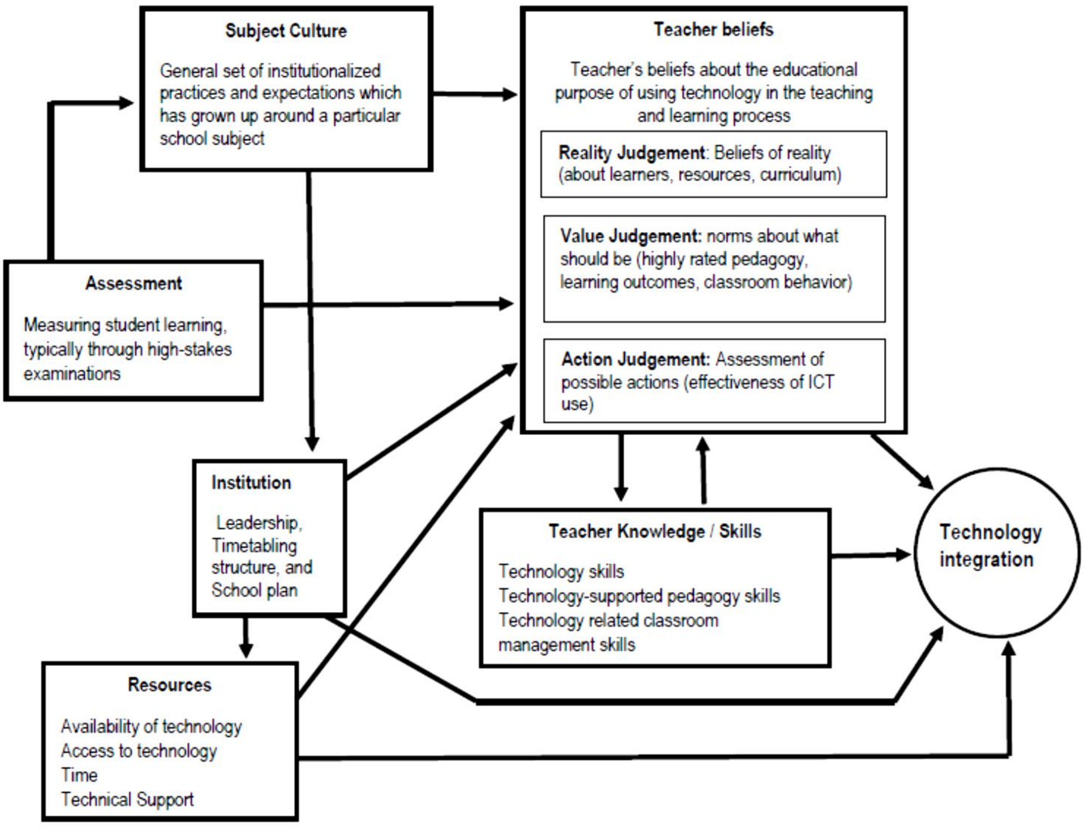

Figure 2.2. Beliefs Impacting the Use of Technology (BIUT) model (Juggernath & Govender, 2020)

The BIUT model (Juggernath & Govender, 2020) shows that teachers' use of ICTs is affected by extrinsic factors like resources, institutional leadership and support, timetabling and, intrinsic factors like teacher beliefs about the use of ICTs, and teachers perceived knowledge and skills. While the BIUT model is useful for showing the relationship among barriers that teachers face while trying to integrate ICTs in their teaching, it may also be useful in identifying potential barriers that may face while engaging in professional development programmes focussed on ICT integration.

While resources are listed as a significant barrier, in the BIUT model, challenges due to the availability of resources were expected to be minimal in this study. ICT infrastructure and the lack of ICT resources are often cited as a critical external or extrinsic factor that impedes the integration of ICTs in teaching (Bingimlas, 2009; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Prasad, Lalitha, & Srikar, 2015). The school where the research was conducted was a well-resourced school with good ICT infrastructure. Therefore, the availability of resources was not considered to be an impeding factor in using Lesson study to help teachers integrate ICTs in their teaching. However, several other factors were predicted to be a challenge for teachers. The first is the availability of time to participate in professional development activities, as the school where the study was conducted required all teacher to be involved in the co-curricular programme.

2.5.1 Lack of time as a barrier

Apart from normal teaching duties, teachers need adequate time to plan for the addition of ICTs into their lessons. In a recent study (Raman & Yamat, 2014), it was found that simply planning an ICT integrated lesson alone required at least three hours. Further,

> *the teachers faced problems either in preparing the lessons or in conducting the lessons within a limited time. Moreover, the teachers need additional time to set up all the ICT tools in the classrooms. So, the teachers felt that they could accomplish the required tasks during their lesson hours instead of setting up the ICT tools (Raman & Yamat, 2014, p. 16).*

When the opportunity for and time available to plan for the integration of ICTs into the lessons is not available, teachers may choose not to integrate since it is the easier option. Further, when opportunities are available for teachers to develop their knowledge and skills, high teacher workload may negatively affect participation. (Ogegbo, Gaigher, & Salagaram, 2019) stated that the lack of time for collaborative activities and high teacher workload were significant factors that negatively affected teachers' participation in a Lesson Study programme.

Schools often spend money on new technologies without allocating time for preparing teachers for the use of these technologies. Bingimlas (2009) stated that "educational technological materials may be available in schools, but teachers cannot use them because of a lack of pedagogical or skills-related (practical) training in how to use these ICT resources" (p. 242).

Therefore, while resources may be available, they may not be used effectively or not at all since teachers are not sufficiently prepared for the integration of these resources in their teaching. Also, some software requires a large amount of time to be used optimally. If this time is not available, regular interruptions of the lesson can occur due to lack of knowledge of the technology used, and this can reduce lesson time (Prasad et al., 2015).

2.5.2 Teachers' vulnerabilities and lack of new knowledge

Teachers are required to deal with "digital natives" (Prensky, 2001), a term coined to describe learners who live in a technology-focused world, daily and parents who expect children to be exposed to the most current content and technology available. Traditionally, teachers were

> *told what, when, and how to teach. They were required to educate every student in exactly the same way and were not held responsible when many failed to learn. They were expected to teach using the same methods as past generations, and any deviation from traditional practices was discouraged by supervisors or prohibited by myriad education laws and regulations. Thus, many teachers simply stood in front of the class and delivered the same lessons year after year. (Sharma, 2017, p. 63)*

With the introduction of technology, teachers are faced with changing roles and a shift in power within the classroom. This may result in tension between the learners who may know how to use technology and teachers who may not be familiar with the use of technology. Knowledge about technologies available today was not available to teachers during their formal teacher education; however, knowledge of ICTs and technology integration is becoming essential thus forcing teachers to reflect on their roles within the classroom (Barakabitze et al., 2019).

For many, using technology in teaching is not always a preferred method of teaching. Many teachers have indicated a preference for traditional teaching since the current examinations that learners take for promotion purposes involve writing with minimal or no use of ICTs and therefore teachers feel compelled to train learners to learn and respond in this manner (Balanskat, Blamire, & Kefala, 2006). Traditional teaching usually focuses on the mastery of knowledge instead of higher-order skills related to the integration of ICTs. The impact of new experience (e.g. using ICT) will be resisted if it conflicts with teachers' beliefs about the nature of their job (Juggernath & Govender, 2020). Therefore if teachers see no need to change their current professional practice, they may not accept the use of ICT in their teaching (Cox, Cox, & Preston, 2000).

2.5.3 Teacher self-efficacy

Bandura described self-efficacy as one of the most important factors contributing to a teachers behaviour stating that teachers' beliefs of their abilities to be able to achieve a required outcome will directly affect whether they will attempt the activity or not (Bandura, 1997, p. 3).

He defined self-efficacy as "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives" (Bandura, 1997, p. 71) while perceived self-efficacy was defined as

> *people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances. It is concerned not with the skills one has but with judgments of what one can do with whatever skills one possesses(Bandura, 1986, p. 391)*

These beliefs influence the thoughts, actions, feelings and self-motivation of teachers. According to Bandura (1997), self-efficacy is generally acquired through four sources. These are enactive mastery experience or past performance; vicarious experience, or observing others perform; verbal or social persuasion, or encouragement from others; and physiological cues, or physical or emotional conditions.

While this study had a minor focus on self-efficacy, it was predicted that it would affect the uptake and acceptance of the Lesson Study model. Of the four sources of self-efficacy, past experience has the most significant influence on confidence. Bray-Clark and Bates (2003) mentioned that past experience contributes to enactive mastery and "enactive mastery is perhaps the most influential source of efficacy beliefs because it is experiential in nature and is rooted in past performance accomplishments." (2003, p. 16)

This means that any form of professional development that is designed must ensure that sufficient opportunities exist to allow teachers to practice and master new techniques before implementing in the classroom. Enactive mastery influences teacher professional development. When teachers engage in activities, the outcomes of their actions are interpreted, and beliefs are developed about their ability to carry out similar tasks. (Handtke & Bögeholz, 2019). Outcomes regarded as successful improve self-efficacy while those that are interpreted as unsuccessful decrease it.

Vicarious experience through the observation of other teachers performing tasks may help teachers develop positive self-efficacy beliefs (Hendricks, 2016). When teachers observe colleagues perform tasks, it may result in a judgement being made about their abilities to perform the same task. It is important to note that

> *vicarious experience is more effective when individuals recognize a common relationship between their abilities and the abilities of the model (Hendricks, 2016, p. 7) and*

> *the greater the assumed similarity, the more persuasive are the models' successes and failures(Bandura, 1997, p. 87)*

This means that a teacher's self-efficacy will be more likely to improve if he observes a colleague of similar ability rather than an outside expert. This will be possible if teachers can observe colleagues in authentic situations within the classroom. Using Lesson Study, this becomes possible since opportunities for these types of observations are a part of the process. The stages of each Lesson Study cycle involve planning, observing, and reviewing research lessons (Ogegbo et al., 2019). Since observation of colleagues is a vital aspect of the Lesson Study process, it will play a role in the development of teachers' self-efficacy.

While verbal or social persuasion may be a source of teacher self-efficacy, its contribution is less than enactive mastery or vicarious experience (Hendricks, 2016). It does, however, represent "a potentially valuable tool for cultivating the efficacy beliefs of teachers. The notion here is that the communication of verbal judgements from respected or influential others can affect an individual's self-efficacy beliefs" (Bray-Clark & Bates, 2003, p. 18).

This means that when sincere praise is received from a respected colleague, it may serve to strengthen self-efficacy beliefs. Bandura (1986) warns against using artificial praise, stating that it may weaken self-efficacy beliefs. In simple terms, being persuaded that teachers have the potential to master certain activities by a respected colleague means that they would be more likely to persevere provided the praise and support are sincere. This can be achieved in schools through

> *conversations, collaborative planning sessions, team meetings, peer observations, mentoring relationships, and a variety of other unplanned collegial encounters provide valuable avenues for learning and for receiving and providing the kind of verbal support and encouragement that can effectively build positive efficacy beliefs (Bray-Clark & Bates, 2003, p. 18).*

The developing of a collegial culture within the school and by setting high expectations could result in improved teacher self-efficacy. Lesson Study involves teachers working together for extended periods. The various stages of each Lesson Study cycle require teachers to collaborate extensively (Ogegbo et al., 2019). The type of collaboration experienced during the Lesson Study cycles is often seen as different from what teachers had previously experienced since teachers generally only meet to discuss routine matters.

The teachers' physical or emotional state may also influence self-efficacy. The emotional state teacher of a teacher will influence how he judges his self-efficacy. Stress or tension can be interpreted as signs of anticipated failure leading teachers to believe that they may not be capable of completing a task (Hendricks, 2016).

The implication for teacher professional development is that within schools there is a need for a safe, non-threatening learning environment where teachers may interact with colleagues in a supportive and collaborative manner (Bray-Clark & Bates, 2003). Bray-Clark and Bates (2003) mention that a safe, non-threatening environment "will enhance self-efficacy if teachers feel that mistakes they make in training will not reflect badly upon them or result in punitive actions and that the learning experience will improve their professional knowledge and skills" (2003, p. 18).

It is important to note that this is the type of environment that the Lesson Study model promotes. Teachers work collaboratively within subject departments and design research lessons. The environment that teachers find themselves in is supportive and collegial. This type of environment is ensured by the norms set out at the beginning of the programme.

2.6 FACILITATING TECHNOLOGY INTEGRATION

In the era of the 4th industrial revolution, technology is fast becoming a part of the everyday life of learners. It is used as part of almost every facet of their daily lives, but its use in schools remains limited (Barakabitze et al., 2019).

While ICTs have the potential to act as a catalyst for educational change its use is often merely that of a curriculum-supportive role (Barakabitze et al., 2019; Kerckaert, Vanderlinde, & van Braak, 2015). In order for effective technology integration to occur, facilitating conditions need to be in place. There are:

2.6.1 Training and support

Various forms of support are needed in order to ensure that ICTs can be effectively integrated into teaching (Ertmer et al., 2012). These include administrative, technological, professional, and peer support. Of these, technological support needed to deal with different technologies and technical difficulties is mentioned frequently (Barakabitze et al., 2019; Pelgrum, 2001; Prasad et al., 2015). The lack of technical support could result in technical problems which may discourage teachers from using ICT in their lessons due to fear of equipment failure (Jones, 2004). Apart from technical support, teacher professional development is needed to assist teachers in integrating ICTs into teaching.

2.6.2 Teacher Professional Development (TPD)

2.6.2.1 Clarity of Terminologies in TPD

Teacher professional development, often called staff development, has emerged as a valuable area of research over the past two decades. The reason for this is clear. As Guskey and Yoon (2009) state "in the history of education, no improvement effort has ever succeeded in the absence of thoughtfully-planned and well-implemented professional development." (p. 497)

While the value it adds to the profession cannot be questioned, there seems to be little consensus on a single definition for professional development (Evans, 2002; Kyndt et al., 2016). The Organisation for Economic Co-operation and Development (OECD) (2009) defines professional development as "activities that develop an individual's skills, knowledge, expertise and other characteristics as a teacher" (p. 49). This means that any activity an individual undertakes whether it be formal or informal in order to become better as a teacher would constitute professional development. Hargreaves and Fullan (1992) echo these sentiments by stating that professional development is a form of in-service development that assists in improving teacher confidence and skills. Darling-Hammond, Hyler, and Gardner (2017) describe professional development as “structured professional learning that results in changes to teacher knowledge and practices, and improvements in student learning outcomes” (p. 2). In contrast, the Business Dictionary describes it as a “process of improving and increasing capabilities of staff through access to education and training opportunities in the workplace, through outside organization, or through watching others perform the job” ("Business Dictionary," 2018). A significant element is that it is the result of multiple changes accumulated through learning over some time (Mitchell, 2013).

While the definitions above vary, the key elements remain consistent. The consensus is that professional development involves educational activities that are undertaken while employed in the profession, which in this case is education. The purpose as offered by the definitions is to improve teaching and learning, whether it be a result of changes in knowledge, skills or attitudes.

The accepted definition for professional development for this research will, therefore, be structured activities and processes that are undertaken by in-service teachers in order to improve their content knowledge, pedagogical and technological knowledge, and skills related to integrating ICTs into their teaching.

Professional development for in-service teachers is often undertaken to help improve teaching skills, implement policy changes or introduce new content (OECD, 2009). Regardless of its purpose, professional development is often criticised for being ineffective (Darling-Hammond et al., 2017; Whitworth & Chiu, 2015). Gable and Burns (2005) categorised current models of teacher professional development (TPD) into three broad categories. These are Standardised TPD, site-based TPD, and Self-directed TPD.

Standardised TPD is the most common approach employed when attempting to disseminate information and skills among large groups of teachers. This model includes the Cascade approach where information cascades down from an expert in the field to the teacher in the classroom (Bett, 2016; Ono & Ferreira, 2010). While this approach was useful in that information could be disseminated to a large number of teachers in a short space of time, this approach has been widely criticised since it may result in a dilution or misinterpretation of the content or the stressing of non-essential components of the training.

Other forms of Standardised TPD may involve conferences, workshops, seminars or courses (Shabani, 2016). These types of professional development involve having the teacher removed from class and being required to attend short training sessions. These are usually delivered by experts in the field but are often fragmented and offer little or no room for feedback or reflection. Further, they may be isolated or decontextualized to the classroom environment (Mokhele, 2017).

Self-directed TPD involves independent learning that occurs at the teacher’s discretion, where the teacher uses the resources that are available (Gaible & Burns, 2005). This could involve teachers designing and developing materials and resources that they could share, participating in online communities and helps teachers become models of life-long learners. Due to the nature of Self-directed TPD, teachers can choose their way of learning.

There is, however, an assumption that teachers will be self-motivated to pursue their professional development. This is usually not the case (Mat, Mohammad, & Samah, 2018). In a recent study, it was found that there is a direct relationship between self-directed learning and self-efficacy (Saeid & Eslaminejad, 2017). This means that this type of TPD will only be successful if the teacher is highly motivated and able to work independently. It is therefore recommended that this type of TPD be used in conjunction with other forms like the Standardised TPD or Site-based TPD (Gaible & Burns, 2005).

Site-based TPD takes place with local facilitators in the school environment. It involves intensive learning by a group of teachers who are involved in the gradual process of learning (Sheehy & Holliman, 2017).

Site-based TPD models generally:

Bring people together to address local issues and needs over a period of time.

Encourage individual initiative and collaborative approaches to problems

Allow more flexible, sustained and intensive TPD

Provide ongoing opportunities for professional learning among a single set of teachers (Gaible & Burns, 2005, p. 21).

The main problems encountered when engaging in site-based TPD is that it is labour and time-intensive.

The Guidelines for Teacher Training and Professional Development in ICT (Department of Education, 2007) was designed to address the need for professional development in the area of ICT integration. This document identifies ICT knowledge, skills, values and attitudes required by teachers to implement the national curriculum using ICTs.

2.6.2.2 Principles of Effective Professional Development Programmes

The Guidelines for Teacher Training and Professional Development in ICT (Department of Education, 2007) provides a list of key principles to be followed when designing professional development programmes for teachers. These are

- *Educational goals should be primary. The focus should not be on providing technical ICT skills only, but on the use of ICT to achieve learning outcomes.*

- *Teacher development programmes should provide teachers with situated/contextualised learning experiences. Programmes should be subject-specific and relevant to the learning areas.*

- *Teacher development programmes should be needs*-driven. *Programmes should respond to the requirements of subjects such as Computer Application Technology, Information Technology, Geography, Design, and Accounting.*

- *Ongoing support should be consistently available. This includes pedagogic support (particularly from subject advisers), technical support and creating communities of practice.*

- *Teacher development should be ongoing due to the changing nature of ICT. Programmes should reflect new technologies and applications (Department of Education, 2007, p. 4).*

This illustrates that the fundamental principles required to be followed when designing TPD programmes are that it should be needs-driven and provide opportunities for ongoing support.

Therefore, site-based TPD would be the most ideal since professional development is most effective when it is a continuous process that involves appropriate activities and follow-up in the form of constructive feedback and observation (Gulamhussein, 2013).

Effective professional development should be ongoing and provide opportunities for teachers to experience and reflect on activities (Cordingley et al., 2004). Further, social-constructivist theories focus on the social structure in which learning happens, how the individual interacts with the environment and the significance he ascribes to his experiences and reality (Trif, 2015). This highlights the importance of learning within a social context. Current approaches to learning show a shift from a passive, positivistic base to an active, constructive base.

Fullan (2011b) stated that effective professional development should involve active, collaborative learning experiences that provide teachers with the opportunity to adopt practices for their classrooms.

Darling-Hammond (2008) recognised the need for reform measures in teacher professional development and advocated a social constructivist approach as a basis for such reform and stated "teachers learn best by studying, doing and reflecting; by collaborating with other teachers; by looking closely at students and their work; and by sharing what they see" (p. 93)

However, this change is not evident in most professional development programs for teachers in South Africa (Akyeampong, 2017; Johnson et al., 2000). The current approach is anomalous since the document the "Guidelines for Teacher Training and Professional Development in ICT" (Department of Education, 2007) mentions that effective professional development for ICT integration should be holistic and include a pedagogical dimension, a technical dimension and collaboration, and networking dimension. The language used in the document implies a constructivist approach and further, an approach relying on teachers "participating in communities of practice" (Department of Education, 2007, p. 2). Wenger-Trayner and Wenger-Trayner (2015) describe a community of practice as "groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly".

Current models of professional development involve teachers working in isolation instead of within teaching communities (Wenger-Trayner & Wenger-Trayner, 2015). Research has shown that successful professional development programs occur within learning communities and provide ongoing support enabling immediate and usable solutions that teachers may face (Darling-Hammond et al., 2017; Hannover Research, 2014).

The type of TPD that will, therefore, have the greatest positive effect on teaching is one where teachers are active and have the following features:

> - *a considerable duration;*
>
> - *a clear theoretical rationale grounded in research, and a strong knowledge base;*
>
> - *is based on collaborative, active learning and teaching (not on a one-shot lecture or a 'drive-by' workshop), as well as on feedback;*
>
> - *is delivered to a team of teachers (same age group, subject, school)*
>
> - *is focused on specific content knowledge/strategies (not general), helping teachers develop the pedagogical skills to teach specific content, with strong positive effects on practice;*
>
> - *is coherent, practical, focused on students' learning of content and on the examination of students' work, in relation to standards for what students should know and be able to do.*
>
> *Active learning should include opportunities for reciprocal observation, co-planning, and co-teaching, as well as presenting, leading or writing activities. (Caena, 2011)*

2.7 PROFESSIONAL DEVELOPMENT FOR INTEGRATING ICTS INTO TEACHING

Meyer and Gent (2016) described the role of ICTs in education as follows:

> *ICT is relevant within education as a means of supporting a process of teaching and learning and is best employed in support of a value creation process. It is not a focus in itself. In addition, technology has a separate and distinct role in enabling the business and administration of education (p. 1).*

This means that when designing professional development programmes to integrate ICTs in teaching, the focus should not be on the technologies themselves but on how these technologies can provide a supportive role in teaching. This is supported by Voogt and McKenney (2017) since “even when the information and communications technology (ICT) applications have proven to be effective in isolation, this does not always imply that the same effects are also realised in natural educational settings” (Voogt & McKenney, 2017, p. 69)

They further describe that the best practice is to use ICTs as enablers of the teaching and learning process.

In order to ensure successful ICT integration, all aspects need to be considered, like the socio-economic status of the school and the availability of resources. Meyer and Gent (2016) state that for professional development, “a holistic view is essential, and must incorporate multiple dimensions in creating solutions, include multiple role players, and cater to multiple levels within the education system.” (2016, p. 1). While extensive literature exists on what constitutes effective professional development, evaluating professional development initiatives could prove challenging.

Guskey (2002) developed a framework consisting of five critical levels for evaluating professional development programmes. This framework provided questions and suggested how data could be collected in response to the questions. It also suggested what should be assessed and provided information on how the data could be used. This framework is used later in this chapter to evaluate the suitability of Lesson Study for professional development based on evidence from previous studies in the literature. The evaluation consisted of the five levels as described by Guskey (2002) These are “participants’ reactions; participants’ learning; organizational support and change; participants’ use of new knowledge and skills; and student learning outcomes” (Guskey, 2002, p. 48).

This framework provides a useful framework for evaluating professional development and has been used extensively. Guskey (2002) explained that while professional development is important, there are often problems with its implementation. This leads to teachers questioning the importance of professional development. Evaluations of professional development were reported to be inadequate or ineffective due to the emphasis on documentation and shallow results. This highlights the importance of evaluating a professional development model before implementation. Guskey’s (2002) framework is used in this research to theoretically evaluate if Lesson Study would be a suitable strategy to help teachers integrate ICTs in their teaching. It is also used in chapter six to guide the discussion around teachers’ experiences.

2.8 PROFESSIONAL DEVELOPMENT THROUGH COMMUNITIES OF PRACTICE

2.8.1 Communities of Practice

A growing number of organizations, including schools, have looked to professional learning communities to help develop their staff. A professional learning community, or as it is often called a community of practice, is not simply a group of people. Wenger-Trayner and Wenger-Trayner (2015) define communities of practice as "groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (p. 1).

A group of people who share an interest or have common concerns, who work together to fulfil both individual and community goals would be an example of a community of practice. This type of practice involves the sharing and creation of knowledge and best practices on an ongoing basis. Interaction can take many forms and may not necessarily be face to face collaboration. It could also involve virtual environments.

2.8.2 Characteristics of Communities of Practice

Wenger-Trayner and Wenger-Trayner (2015) describe the three key characteristics of communities of practice as follows:

The domain represents the identity of the group. Membership implies a shared competence that distinguishes members from other teachers. This common domain motivates members to participate, guides learning, and gives meaning to the actions of the group.

The community is described as a group of teachers pursuing a common interest and helping each other. This may involve participating in information sharing, discussions and activities within their domain. This idea of the community creates a bond that enables mutual learning to occur.

The practice involves the development and sharing of resources, stories, tools and experiences. The practice is thus the focus around which the community shares, maintains and develops its collective knowledge.

This type of collaboration designed for groups of teachers has developed a growing interest since "teachers who work together are more likely to have the opportunity to discuss concepts, skills, and problems that arise during their professional development experiences" (Seferoglu, 2010, p. 550).

Research of the literature available indicates that communities of practice would be a suitable way of helping teachers integrate ICTs into their teaching since it allows teachers time to collaborate with other colleagues (Seferoglu, 2010). It allows for learning to be integrated into the work. This results in a more sustainable form of professional development that can help teachers address the specific problems that they face (Lave, 1991; Wenger-Trayner & Wenger-Trayner, 2015). The characteristics of communities of practice described above indicate that Lesson Study is a specialized form of a community of practice. A critical aspect of communities of practice and Lesson Study is the collaboration that results.

2.8.3 Collaboration within a Community of Practice (CoP)

Collaboration is the fundamental principle that underpins the process of people working together. Collaboration is also a fundamental component of the Lesson Study process. Communities of practice increase collaboration between teachers within the school and beyond depending on the community (Sánchez-Cardona, Sánchez-Lugo, & VŽlez-González, 2012). This, in turn, helps to establish networks and fosters communication and may assist in transforming the social structure of the organisation.

Darling-Hammond et al. (2017) found that collaborative approaches were effective in promoting changes within the school that extended beyond what occurred in individual classrooms. Some of the advantages reported were that teachers were able to serve as support groups in order to help improve instruction and understanding. Also, "collective work in trusting environments provides a basis for inquiry and refection into teachers' own practices, allowing teachers to take risks, solve problems, and attend to dilemmas in their practice" (Darling-Hammond et al., 2017).

Improved communication and collaboration are of interest due to the impact on professional practise alliances among the community.

> *Through dialogue and productive inquiry, CoP members can identify new ideas or situations, share strategies, improve practice, and validate the information in order to generate knowledge that improves their work and the performance of the organization (Sánchez-Cardona et al., 2012, p. 1824).*

While the argument for collaboration in schools is strong, collaboration occurs minimally, and the teaching profession since "most schools embrace a culture of isolation" (Mitchell & Sackney, 2011, p. 71). This means that unless a conscious effort is made, by the school community, management of a school or people developing professional development courses, the collaboration will not occur.

While the evidence indicates that collaboration represents the best practice, some teachers continue to work in isolation (DuFour, 2004). Collaboration is often confused for comradery or team building, and while this can serve a useful purpose, it does not represent the kind of collaboration that can result in transformation.

The type of collaboration that characterizes a community of practice "is a systematic process in which teachers work together to analyse and improve their classroom practice. Teachers work in teams, engaging in an ongoing cycle of questions that promote deep team learning" (DuFour, 2004, p. 8).

Collaboration among members of the community, therefore, result in increased knowledge, access to resources and improved communication, which facilitates the sharing of concerns, ideas and best practices (Darling-Hammond et al., 2017). Some studies have indicated that it may result in participants developing a sense of mutual trust through their participation (Sánchez-Cardona et al., 2012).

These are important implications, especially in a school setting where changes like the introduction of ICTs require innovative approaches to teaching, teacher professional development and the management of resources.

2.9 CONSTRUCTIVISM

While Lesson Study is widely used in Japan, in order to attempt to implement a lesson study programme within the South African context, it first needs to be built on the strong theoretical foundations that support its use. The Lesson Study model is based on the principles of social constructivism and confirms the importance of each step of the process in order to bring about increased professional knowledge and skills in using ICTs in teaching. Teachers work collaboratively to plan research lessons. Through interactions with the content of the programme and each other develop themselves professionally. Constructivist conventions are also inherent in the concept of learning by reflecting on professional practice. A significant amount of time is spent reflecting on what was done during the processes to make improvements. Lesson Study, therefore, inclines to a constructivist approach.

Constructivism and in particular, social constructivism have had a significant impact on teaching and learning in recent years (Shabani, 2016). Constructivism is a theory that attempts to explain how people-learners and teachers learn (Churcher, 2014). It is a learning theory that describes how learning happens and suggests that people learn from their experiences and from reflecting on those experiences. Constructivism, therefore, provided a framework that reinforced the use of Lesson Study as the basis of a professional development programme for the integration of ICTs by teachers in their teaching. This theory is attributed to Jean Piaget, who suggested that individuals construct new knowledge from their experiences through the processes of assimilation and accommodation.

Assimilation occurs when teachers or learners integrate the new experience into an existing knowledge without changing it. The new information is retained and gets added to what already exists (Rothwell, 2008).

Accommodation, however, occurs when existing knowledge and the experiences of the individual contradict one another. Accommodation can be understood as the mechanism by which failure leads to learning: when we act on the expectation that the world operates in one way, and it violates our expectations, we often fail (Rothwell, 2008, p. 16)

Through the process of accommodation, individuals can modify their perceptions of how things operate. Therefore, they can learn from the experiences of others or their failures. During the Lesson Study process, teachers get exposed to the experiences of others while they plan and present lessons. Teachers have the opportunity to learn by observing others. During reflections, teachers can see what worked and what did not. Therefore, reflections form a vital part of the learning experience. A critical aspect of the Lesson Study process is the collaboration and social interactions that are involved. Therefore, Lesson Study exemplifies social constructivism.

2.9.1 Social Constructivism

Social-constructivist theories focus on the social structure in which learning happens, how the individual interacts with the environment and the significance which he ascribes to his experiences and reality (Trif, 2015). This highlights the importance of learning within a social context.

Rupp (2015) explains that social constructivism

> *is about how reality is constructed through human activity and how members of a society together invent the properties of the world. This, in turn, allows people to create meaning through their interactions with each other and the objects in the environment. In this view, learning is seen as a social process and occurs when people are engaged in social activities (p. 23).*

A social constructivist approach to teacher professional development recognises that teachers grow from interactions with others with whom they can develop understandings through dialogue and interactions. The lesson study principles support this. Social constructivism is based on certain assumptions about the nature of knowledge, the nature of reality and the nature of learning. Knowledge is regarded as being socially and culturally constructed through human activity in an active manner (Kim, 2001; Rupp, 2015). Knowledge is not limited to the external world or mind but results from the outcomes of interactions of the environment and the other teachers. It was anticipated that as a result of accumulating knowledge, sharing through collaboration and increasing teacher confidence, the use of a Lesson Study model would result in an improvement in teachers' ability to use ICTs in teaching.

Learning is viewed as a social process. Learning occurs when individuals are actively engaged in real-life problem solving that occurs socially through discussion and shared experience with other teachers (Kim, 2001). McMahon (1997) described learning as "a process of enculturation brought about through social interaction." (p. 1)

This means that emerges from interactions with colleagues and does not merely occur within the individual. This, therefore, supports the idea that teachers should be actively engaged in constant communication with experts and colleagues in their field. During the Lesson Study process, opportunities for this type of engagement and collaboration occur at various stages in the process.

Social constructivists believe that reality is not discovered; instead, it is constructed by society. This means that reality does not exist before social intervention. (Kim, 2001). During the Lesson Study process, teachers are encouraged to discuss, reflect, and evaluate their understanding and experiences and additionally, express it to others. While people can have similar understandings, it allows for the possibilities of multiple realities to exist since discussions between people will not be the same for all groups.

The Lesson Study model is based on the principles of social constructivism and confirms the importance of each step of the process in order to bring about increased professional knowledge and skills in using ICTs in teaching. Constructivist conventions are also inherent in the concept of learning by reflecting on professional practice.

2.10 LESSON STUDY

2.10.1 Japanese Lesson Study

Lesson Study is a form of teacher professional development that is collaborative and cyclical and aimed at improving teaching through reflection (Alshwaikh & Adler, 2017). The expression 'lesson study' is derived from the Japanese word *Jugyokenky* where *jugyo* means lesson and *kenkyu* refers to study or research and has its origins in a peer observation-based model (Ono & Ferreira, 2010).

While Lesson Study has been the primary form of teacher professional development in the past, it has come under increasing attention from educators from around the world from the year 2000 onwards (Cheung & Wong, 2014; Pedder & Xu, 2014; Wiburg & Brown, 2007). It is a collaborative teaching approach where teachers work together in order to examine, learn from and reflect on what happens in a classroom (Ono & Ferreira, 2010). Perry and Lewis (2009) describe Lesson Study as

> *a cycle of instruction improvement in which teachers work together to: formulate goals for students learning and long-term development; collaboratively plan a research lesson designed to bring to life these goals; conduct the lesson in a classroom, with one team member teaching and others gathering evidence on student learning and development; reflect on and discuss the evidence gathered during the lesson, using it to improve the lesson, the unit, and instruction more generally (p. 366).*

This approach usually comprises four to six teachers teaching the same grade or subject working through a cycle (see Figure 1.1).

One cycle consists of five parts. Part one is the research and goal setting stage which is followed by the planning of the lesson. The planning of the lesson is done as a group so that all participants are involved in the development process. The research lesson is then presented by one member of the group and observed by the other participants, first in one class. The penultimate part of the cycle involves reflecting on the lesson together. The reflection phase aims to improve on the lesson. Since lessons are developed by the group, no comment can be directed at individual teachers. When this is done, the lesson can then be revised and taught to other classes.

It has been used in the United States since 2001, in South East Asian countries, and there is a growing interest in it in the United Kingdom and Australia (Doig & Groves, 2011). Alshwaikh and Adler (2017) that the

> *extensive current interest in lesson study for mathematics professional learning and development was evident in the recent International Congress of Mathematics Education (ICME13) in Hamburg, Germany, in July 2016, where there were at least 22 papers from a wide range of countries and across primary and secondary mathematics within the topic study group strand of the conference, as well as a specifically focused discussion group (p. 2).*

The use of Lesson Study in South Africa has been limited, but there has been an increasing focus on its use in recent years (Bayaga, 2013; Letloenyane & Jita, 2015; Mokhele, 2017). Most of the research has, however, focused on mathematics education. Of the studies conducted in South Africa, the following two are the most well-known. The first involved a collaboration among the Japan International Cooperation Agency, the University of Pretoria and the Mpumalanga Department of Education to explore the use of Lesson Study as a professional development model in the South African context (Jita, Maree, & Ndlalane, 2008). The project known as the Mpumalanga Secondary Science Initiative was launched in 2000 and was envisaged to help provide opportunities for high school mathematics and science teachers to change classroom practices. The programme appeared promising at the onset up until 2001; however, soon after the Department of Education prohibited workshops during the school term (Ono & Ferreira, 2010). This resulted in Lesson Study not being used as a teacher professional development model until 2007. While attempts were made to revive it, the project officially ended in 2008.

The second study conducted in South Africa was completed in 2010 by Ono and Ferreira (2010) to assist with the implementation of Curriculum 2005. While some successes were reported, Lesson Study did not take off in the province. The reasons presented for this were, among others; that teachers were focused on curriculum coverage rather than dealing with misconceptions, teachers failed to take the initiative, and there was a perception that there was a strict division of responsibility at different post levels (Ono & Ferreira, 2010).

Van der Walt and de Beer (2016) reported on the use of a Lesson Study programme to develop pre-service teachers at two different universities in South Africa. The research questions of both projects were similar and were described as follows: How can adapted lesson study facilitate student teachers' professional development, pedagogical content knowledge and reflection? (Van der Walt & de Beer, 2016, p. 559)

The key finding of the study was that Lesson Study "provides affordances that could greatly assist student teachers in their professional development as teachers, especially in the process of enculturation" (Van der Walt & de Beer, 2016, p. 566)

The student teachers were seen to be more reflective in their practice, problem-based learning replaced the lectures, and more opportunities were provided for student teachers to develop the social skills involved in collaborative work.

While the use of Lesson Study is gaining recognition as a powerful form of professional development, its use within the South African context remains limited. Much of the research centres around Mathematics education (Adler & Alshwaikh, 2019; Mokhele, 2017) and, limited, if any exist related to the use of Lesson Study for the integration of ICTs into teaching.

2.10.2 Evaluating Lesson Study as a Form of Professional Development

There needs to be some evidence of the suitability of the new professional development programme for its purpose before it can be implemented. Guskey (2002) developed a framework consisting of five critical levels for evaluating professional development programmes. Guskey's (2002) framework provided questions and suggested how data could be collected in response to the questions. It also suggested what should be assessed and provided information on how the data could be used. This framework is used to evaluate the suitability of Lesson Study for professional development based on evidence from previous studies in the literature. The evaluation consisted of the five levels as described by Guskey (2002) These are "participants' reactions; participants' learning; organizational support and change; participants' use of new knowledge and skills; and student learning outcomes" (Guskey, 2002, p. 48).

A recent study by Murphy, Weinhardt, Wyness, and Rolfe (2017) was conducted in the South West, East Midlands and North West of England. The study aimed to evaluate the effectiveness of a Lesson Study programme that set out to help raise learner achievement through teacher professional development. It was one of the most extensive studies of its type conducted at 89 schools. Teachers who participated in this study reported that Lesson Study was a useful form of professional development and valued the opportunities for collaboration that were provided. The programme was therefore well-received, and "teachers valued the external training and the structured, timetabled peer collaboration that this programme offered; these were generally viewed as new and as supporting continued engagement with the content of teacher training. Teachers reported that their understanding of how to improve beneficial talk in the classroom was enriched through this programme" (Murphy et al., 2017, p. 5).

Teachers participating in the study reported benefits like "the experience of sharing a practice with teacher colleagues; shared planning; identifying complementary skills; reflecting on pupil learning with colleagues; and reaching a better understanding of pupil needs" (Murphy et al., 2017, p. 40).

In another large scale study by Taylor and Tyler (2012), it was found that while knowledge-based training was generally found to be ineffective, while on-site programmes that involving teacher collaboration and teacher observations have had positive effects.

In a further study (White & Southwell, 2003) involving 77 schools conducted in New South Wales to evaluate the use of Lesson Study, the following findings on the participants' reactions were reported.

> *Teachers continually highlighted and commented upon the use of collaborative work, working on common goals, sharing of ideas, team teaching and co-operation among staff as major benefits of the program. For some teachers, they reported that the program was their first real experience of collaborative planning and teaching (White & Southwell, 2003, p. 750).*

In addition to improved participants' reactions, several studies have reported an improvement in teacher learning as a result of participation in a Lesson Study programme. Cajkler and Wood (2016) reported that pre-service teachers who participate in a Lesson Study programme considered it to be an effective way to develop their teaching skills and knowledge. Students also reported that it represented a holistic approach to the study of teaching.

Widjaja, Vale, Groves, and Doig (2017) examined the learning experiences of teachers from a network of three schools who participated in a Lesson Study project. Their results reveal that through the participation in the programme, teachers reported increased collaboration skills and improvement of collaborative practices, and an improvement in focused questioning and whole-class discussions due to teachers being able to plan for learner responses.

While opportunities for non-threatening class observations were made possible, it also provided teachers with rich experiences of incidental learning (White & Southwell, 2003). Opportunities for observation and reflection may also help increase teacher confidence (Yalcin Arslan, 2019). Teachers also attested to " improved learning and different ways to teach a topic together with an increased depth of understanding of the content and structure of the lesson" (White & Southwell, 2003, p. 750).

Murphy et al. (2017) corroborated the findings of an improvement in classroom practice and learner understanding and further stated that the teachers involved in the programme were enabled to identify barriers to effective teaching and learning. Through the process of reflecting on their practice, teachers were able to gain an awareness of their learners and the context in which learning occurs (Yalcin Arslan, 2019). Reflective practices also resulted in a deepening of teacher knowledge.

Abdella, Reddy, and Arend (2018) in their study in Eritrea determined that "teachers claimed that they have conceptually developed, improved their skills in lesson planning and delivering science lessons, changed their attitudes, ultimately resulting in increased learning and changes teachers in classroom practice" (p. 23).

In the paper by Ono and Ferreira (2010) where the use of Lesson Study to implement Curriculum 2005 in South Africa was discussed, it was found that while the feedback teachers involved were positive, it was challenging to maintain long term teacher interest and involvement. The following were recommended in order for Lesson Study to be used as a successful strategy for professional development.

> *Endorse lesson study and make the effort to mobilise not only teachers but also circuit managers, principals, (Curriculum Implementers) CIs and staff at regional offices to become involved.*

Reserve time for school-based professional development during regular working hours.

Identify and empower teachers with a deeper understanding of Mathematics and Science as lesson study coordinators to share their expertise with other schools.

Encourage CIs to use more time to visit schools and clusters to facilitate lesson study.

Create opportunities for teachers to share best practices regionally and provincially (Ono & Ferreira, 2010, p. 71).

It was suggested that should these be in place; teachers would be able to develop their skills and confidence to teach effectively. In a small scale study of four Physical Sciences teachers in South Africa, Ogegbo et al. (2019) reported that lack of institutional support proved a challenge for teachers participating in the Lesson Study programme. They recommended that in order for teachers to reap the benefits of participation in the Lesson Study programme, strategic plans be developed at the institutional level to promote its use. Where intuitional support is available, Lesson Study has proven to be an effective form of professional development. Murphy et al. (2017) stated that when teachers received support from school leaders, they "valued the external training and the structured, timetabled peer collaboration that this programme offered; these were generally viewed as new and as supporting continued engagement" (p. 5)

Takahashi and McDougal (2016) support this in stating the in order for the impact of Lesson Study to maximised institutional practices and structure need to be in place.

While Guskey (2002) regards the impact of a professional development programme on learner outcomes as an essential evaluation, few cases have been documented on the impact of Lesson Study on learner outcomes. In a review initially consisting of 910 research studies, by Gersten, Taylor, Keys, Rolfhus, and Newman-Gonchar (2014) to evaluate the effectiveness of Maths professional development approaches, it was found that two studies met the scientific criteria set out and showed an impact on learner outcomes. Of the two, one was by Lewis and Perry (2014) based on the Lesson Study model. This study was conducted over five months and involved teachers observing and analysing lessons on "fractions" that were planned collaboratively. Extensive support in the form of training, follow-up and resources were provided. The result of the implementation was a significant increase in the not just the teacher but also learner knowledge of fractions in grades two, three and five.

Warwick, Vrikki, Vermunt, Mercer, and van Halem (2016) carried out a large scale study with primary and secondary school maths teachers in a London district. Apart from reporting a 21% increase in teacher confidence and expertise in the areas of mathematics studied, the study also reported a 3% increase in learner attainment compared to other schools in the district. Teachers also reported that involvement in the study assisted them in changing the lesson structure so that learners would be given more time for thinking and reasoning, thereby increasing the opportunity to improve learner outcomes.

Fadillah, Dewi, Ridho, Majid, and Prastiwi (2017) researched the effect of Lesson Study on the grade 11 learner outcomes in a school in Indonesia. Two classes were taught the same content. One was taught using the Lesson Study model and the other, the control, was using the conventional learning model. The data was collected from a test containing twenty questions. The results indicated that the average score for the class taught using the conventional learning model was 68,97% while the experiment, the Lesson Study, class attained an average of 72,88% concluding that learners taught using the Lesson Study model performed better than the control group.

Further evidence to support the positive effect on learner outcomes was provided by Ming Cheung and Yee Wong (2014) in a review of Lesson Study research between 2000 and 2010. Studies were evaluated and screened, which resulted in nine relevant papers being used in the research. The results of the findings showed that in all the studies, sufficient positive evidence was identified to indicate that Lesson Study was a powerful model to improve learner outcomes and help teachers examine their practices.

The large scale study by Murphy et al. (2017) did, however, indicate that while several other positives resulted from participating in a Lesson Study programme, the effect on learner attainment was not significant. Their study found that there was little evidence that the version of Lesson Study used resulted in improved maths and reading. A possible reason suggested for this unexpected result this was that there was “evidence that some control schools implemented similar approaches to Lesson Study, such as teacher observation. This trial might, therefore, underestimate the impact of Lesson Study when introduced in schools with no similar activity” (Murphy et al., 2017, p. 4).

This means the impact of Lesson Study on learner outcomes could have been underestimated.

While anomalies may exist, there is sufficient evidence to support Lesson Study as an effective form of professional development. It has the characteristics of a useful professional development model such as it is site-based and ongoing. Further evidence in the literature using Guskey's (2002) framework provide evidence to support this. This, therefore, means that Lesson Study can serve as a suitable model to help teachers integrate ICTs into their teaching.

2.11 MODELS OF ICT IN TEACHING

While several models like the SAMR (Substitution Augmentation Modification Redefinition) Model by Puentedura developed in 2010 adding to the work of Mishra and Koehler's TPACK model (Koehler et al., 2013; Mishra & Koehler, 2006), the TPACK framework (Mishra & Koehler, 2006), The Theory of Planned Behaviour (Ajzen, 1991), and Guskey's framework for the evaluation of professional development (Guskey, 2002), the focus of this study was on teachers' experiences on the use of lesson study for integrating ICTs into their teaching. This meant that an appropriate model for the study could not focus mainly on the technology but rather on a holistic approach. Therefore the TPACK framework (Mishra & Koehler, 2006), The Theory of Planned Behaviour (Ajzen, 1991), and Guskey's framework for the evaluation of professional development (Guskey, 2002) were selected as the frameworks guiding this study.

The SAMR model, while proving useful to help teachers plan their research lesson by guiding the levels of ICT integration, was rejected for this study. The reasons from literature for rejecting the SAMR model follows. Romrell, Kidder, and Wood (2014) said that "the SAMR model, while helpful, is still very subjective" (p. 12). The lack of consideration of context is evident in the model (Hamilton, Rosenberg, & Akcaoglu, 2016). Context such as teacher knowledge and infrastructure are not taken into account but can be a factor in teachers' use of ICTs in teaching. Hamilton et al. (2016) argue that the model has no theoretical explanation or peer-reviewed evidence that support the progression through the stages. They further state that this may result in misunderstandings or erroneous interpretations by educators. They go on to say that this limitation in research and evidence leaves the model with very little explanation and details on how to interpret and apply it; potentially resulting in erroneous interpretations, misunderstandings, and confusion by educators.

While the SAMR model may be useful to assess the level of technology integration, it is not suitable to determine teachers' experiences in integrating ICTs in their teaching and was therefore not used as the theoretical framework of this study. However, it was used by the participants to understand the levels of ICT integration, and it, therefore, guided their planning of the participants' research lessons during each cycle of the Lesson Study process.

Each model or framework chosen for this study is discussed below. The TPACK Framework is discussed first followed by The Theory of Planned Behaviour. Guskey's framework for the evaluation of professional development was discussed earlier in this chapter and therefore, will not be repeated here.

2.11.1 The TPACK Framework

When considering technology integration by teachers in the recent years, there has been a move away from focusing on the ICTs used to an approach where the connections among technology content and pedagogy are explored (Chai, Koh, & Tsai, 2013; Koehler et al., 2013). Many studies suggest that TPACK is an effective framework that can be used to help guide ICT integration in teaching. Voogt and McKenney (2017) stress that

> *TPACK is essential to enabling teachers to implement ICT in their teaching, as it enables teachers to select and use hardware and software, identify the affordances (or lack thereof) of specific features and use the tools in pedagogically appropriate and effective ways (p. 72).*

TPACK is seen as a useful framework to explain the types of knowledge that teachers need in order to integrate ICTs in their teaching. This does not imply that teachers need to know the framework instead that they understand how to incorporate the three knowledge areas into their instructional practice (Voogt & McKenney, 2017).

Rodríguez Moreno, Agreda Montoro, and Ortiz Colón (2019) indicated that the TPACK framework is regarded as "an efficient and reliable framework to guide the research about the integration of technology in the classroom"(p. 8) and "is established as a fundamental axis to give the possibility of experimenting with ICT, within specific content areas" (p. 8)

When choosing to use ICTs in their teaching, subject knowledge, pedagogical knowledge and content knowledge, as well as integrated knowledge, play a role in teachers' choice of ICTs used (Koehler et al., 2013).

The choice of ICT resources used requires teachers to have: knowledge of the resources, knowledge of relevant features and knowledge of the use of the resources in teaching. This is important since knowledge of the ICT resources allows teachers to select appropriate pedagogical approaches in order to achieve their learning goals. “Knowledge of how to use technology-rich curricular resources is necessary for teachers to be able to employ ICT in pedagogically meaningful ways to achieve learning in specific content areas” (Voogt & McKenney, 2017, p. 69)

The TPACK framework was built on Shulman’s Pedagogical Content Knowledge (PCK) model to include technological knowledge (Schmidt, Baran, Thompson, Koehler, et al., 2009). Pedagogical content knowledge (PCK) is based on the belief that teaching requires more than merely delivering content knowledge to learners (Loughran, Berry, & Mulhall, 2012). In addition to teachers' content knowledge and their pedagogical knowledge, pedagogical content knowledge was recommended as a third component of teaching expertise by Shulman (1986). Pedagogical content knowledge (PCK) provided a helpful foundation for understanding the importance of using the TPCK framework for the integration of technology (Harris, Mishra, & Koehler, 2009). Shulman (1986) suggested that the professional development of teachers should focus on content, pedagogy and a blend of both aspects. He further highlighted the following: What are the sources of teacher knowledge? What does a teacher know and when did he or she come to know it? How is knowledge retrieved and both combined to form a new knowledge base?” (Shulman, 1986, p. 8).

This resulted in increased expectations related to PCK requiring teachers to make their teaching more accessible to their learners. While many science teachers are considered to be subject specialists, they may not necessarily teach in ways that help learners learn (Kind, 2009). The importance of including PCK in teacher professional development is highlighted by the fact that teaching and learning do not occur in isolation and that the teacher and learner characteristics play a role in the learning environment (Shulman, 1986).

The TPACK model provides a suitable framework for evaluating the professional development experienced by teachers in integrating ICTs into their teaching. It was introduced to provide an understanding of the types of knowledge needed by teachers to integrate ICTs into their teaching (Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2013) and has become used extensively in understanding teachers’ integration of ICTs in the classroom (Rodríguez Moreno et al., 2019).

While it is based on Shulman's model, it is important for assessing teacher professional development experiences in using technology since

> *Understanding that introducing new educational technologies into the learning process changes more than the tools used—and that this has deep implications for the nature of content-area learning, as well as the pedagogical approaches among which teachers can select—is an important and often overlooked aspect of many technology integration approaches used to date. (Harris et al., 2009, p. 395)*

Technology, Pedagogy and Content Knowledge (TPACK), developed by Mishra and Koehler (2006), is described as a conceptual framework for the knowledge needed by teachers to effectively integrate ICTs in their teaching (Voogt et al., 2013). This framework is based on the belief that technology integration can occur successfully in teaching and learning if the technology is not considered in isolation but instead considered in conjunction with the two other core knowledge areas namely content and pedagogy. In order to integrate ICTs into teaching, competencies need to be developed. TPACK provides a structured way to guide this.

This framework (see Figure 1.1) consists of three main components of teachers' knowledge: content knowledge, pedagogical knowledge, and technological knowledge. In addition to the core knowledge components, the framework also emphasizes the connections and interplay among content, pedagogy, and technology (Mishra & Koehler, 2006).

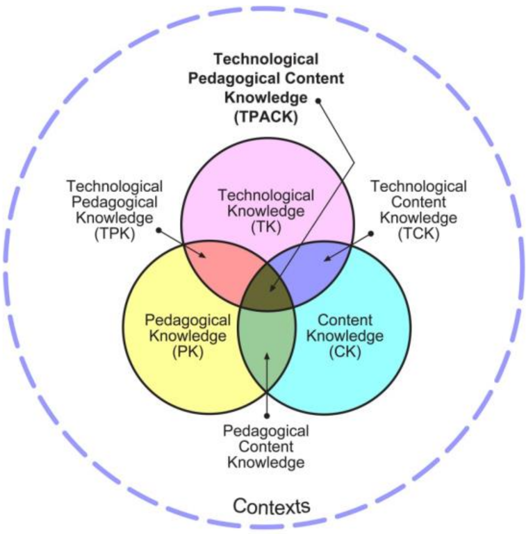

Figure 2.3: The TPACK framework and its knowledge components. (Koehler & Mishra, 2009, p. 63)

A brief description of each knowledge components in the TPACK framework from Mishra and Koehler (2006) is given below.

Pedagogical knowledge (PK) refers to the specialised knowledge of teachers for creating effective teaching and learning environments for all students. This includes principles and strategies of classroom management and organization, lesson plan development and implementation (Shulman, 1987). It also encompasses knowledge about the nature of the students and plans to assess student understanding (Mishra & Koehler, 2006). “Pedagogical knowledge is important because a teacher with strong pedagogical knowledge knows how students learn and construct knowledge and then he/she can organize his/her teaching according to students”(Kartal, Kartal, & Uluay, 2016, p. 4).

Content knowledge (CK) is knowledge about the subject matter that is to be learned or taught (Jimoyiannis, 2010). The term content knowledge refers to the body of knowledge and information that teachers teach and that students are expected to learn in a given subject or learning area including knowledge of central facts, concepts, theories, and procedures within a given field (Shulman, 1987). Koehler and Mishra (2009) stress the importance of teachers having a deep understanding of the facts, theories and other forms of content that needs to be delivered.

Technological Knowledge (TK) represents the technical skills and knowledge possessed by the teacher. It includes knowledge of software and tools (for example, email word processors and simulations) and hardware (Mishra & Koehler, 2006). The knowledge of technology can help teachers repurpose the ICTs for teaching.

Pedagogical Content Knowledge (PCK) represents the combination of content and pedagogy in order to organise and adapt subject matter for effective instruction. In simple terms, PCK is how subject matter is transformed for teaching. This occurs when the teacher interprets the subject matter, finding different ways to represent it and make it accessible to learners (Shulman, 1987). “PCK is an understanding in which teachers interpret the topics, present it in different ways, and adopt instructional materials to alternative conceptions and students’ pre-existing knowledge” (Kartal et al., 2016, p. 4).

PCK is a combination of content and pedagogy and is characterized as a blend of content and pedagogy in order to understand how aspects of content knowledge could be organised and adapted so that it could be presented effectively (Mishra & Koehler, 2006). It is the knowledge that is developed over time, and through experience (Loughran et al., 2012) and is about using instructional methods to deliver content that can enhance student learning. While PCK may not represent the same thing for all teachers, it is believed to be an integral part of teachers' knowledge and skills.

Technological Pedagogical Knowledge (TPK) is an extension of general pedagogical knowledge (PK). TPK is knowledge of various technologies and how they are used in teaching and learning (Mishra & Koehler, 2006). Teachers with this type of knowledge are aware of the impact that technology has on general pedagogical practices (Graham et al., 2009).

Technological Content Knowledge (TCK) is useful for describing teachers' knowledge of how subject matter is transformed by the use of technology (Jimoyiannis, 2010). It includes "the knowledge of how to represent specific concepts with technology, which means the way technology and discipline are reciprocally linked" (Rodríguez Moreno et al., 2019, p. 2).

TCK is knowledge about how technology and content are related. TCK in a specific subject refers to knowledge of the technologies that are relevant to working within that field (Graham et al., 2009).

(Technological pedagogical content knowledge) TPACK is an expansion of PCK and is achieved from a careful alignment of content, pedagogy and technology, and teachers wishing to integrate technology in their lessons need to be competent in all three knowledge areas (Graham et al., 2009). The TPACK framework incorporates the essential knowledge domains that are regarded as essential for integrating ICTs into teaching. A suitable definition was provided by Mishra and Koehler (2006).

> *Technological pedagogical content knowledge (TPCK) is an emergent form of knowledge that goes beyond all three components (content, pedagogy, and technology). This knowledge is different from knowledge of a disciplinary or technology expert and also from the general pedagogical knowledge shared by teachers across disciplines. TPCK is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and*

> *theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones. (Mishra & Koehler, 2006, p. 1028)*

While the TPACK framework was introduced to provide a greater understanding of how ICTs could be effectively integrated into teaching, it has been criticised for, among others the not being a new framework. Brantley-Dias and Ertmer (2013) argue that technological knowledge already existed in Shulman's (1986) model. Shulman described the content knowledge to include instructional materials that were useful for teaching. Brantley-Dias and Ertmer (2013) argue that had the paper been written later, ICTs would have been included as instructional resources.

A further criticism of the model is that the boundaries separating the knowledge areas is not clear. (Brantley-Dias & Ertmer, 2013; Parr, Bellis, & Bulfin, 2013). This lack of clear definition of the boundaries makes it difficult to measure improvements in knowledge areas through interventions (Parr et al., 2013).

While some researchers have expressed criticism of the TPACK model, the consensus is that it is consistently acknowledged as an important and relevant framework for setting the context and expectations for integrating technology into teaching. In a recent study of thirty-seven peer-reviewed articles by Rodríguez Moreno et al. (2019), the following were reported :

> *within the TPACK conceptual framework that the integration of ICT correlates positively with the analysed work on the TPACK model (p. 8)*
>
> *and*
>
> *This review reflects the current situation (from 2014 to 2017) of teachers' training regarding their technological, pedagogical, and content knowledge. It is considered that these basic dimensions, as well as the intersections they generate, confirm a solid model that allows obtaining a good diagnosis of teachers both in their initial and permanent training. (p. 8)*

While criticisms of the TPACK framework exist, it is a holistic approach to integrating ICTs in teaching. The TPACK framework thus represents an appropriate framework to guide the implementation of, and evaluate the effectiveness of, a form of professional development intending to help teachers integrate ICTs into their teaching.

2.11.2 The Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) (Ajzen, 1991) is often used to explain the behaviour of individuals at a given moment in time. Therefore, in this study, TPB was used as a framework to discuss the third research question: Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do?

The Theory of Planned Behaviour (TPB) began as the Theory of Reasoned Action and was developed to help predict a persons' behaviour at any given moment (Ajzen & Fishbein, 1980). These models state that people make logical, rational decisions based on the information that is available to them to engage in behaviours.

The theory was meant to explain behaviours over which people can exert self-control. A critical aspect of this model is behavioural intent. Behavioural intentions are affected by behavioural beliefs, normative beliefs and behavioural control (Ajzen, 2011; Ajzen & Fishbein, 1980). Therefore, according to the Theory of Planned Behaviour, the performance of a behaviour is affected by a person's intention to engage in that behaviour. The intention to engage in the behaviour is affected by the value placed on the behaviour by the individual, how others perceive the behaviour, and how easily the behaviour could be performed. An essential aspect of the Theory of Planned Behaviour is perceived behaviour control. The change from the Theory of Reasoned Action to the Theory of Planned Behaviour was due to the discovery that behaviour could not always be controlled (Ajzen, 2011; Teo, Zhou, & Noyes, 2016). As a result, perceived behavioural control was added.

The Theory of Planned Behaviour was used extensively in education to predict and explain the behaviour of teachers and pre-service teachers. For example, it was used to understand the adoption of WhatsApp university students in learning (Nyasulu & Dominic Chawinga, 2019), pre-service teachers perceived usefulness of social media (Ugorji, 2019), and to predict the chance of teachers taking a competency-based approach to teaching (Lenski, Richter, & Lüdtke, 2019).

The TPB states that three factors influence the behaviour of a person. These are the beliefs about: the consequences of an action; the expectations of significant others; and the factors that may enable or serve as a barrier to the action or performance of the behaviour. Behavioural beliefs affect the attitude toward the behaviour, while normative beliefs affect subjective norms and control beliefs affect perceived behavioural control (Ajzen, 1991, 2011). The greater these factors, the stronger a person's intention to perform the behaviour becomes.

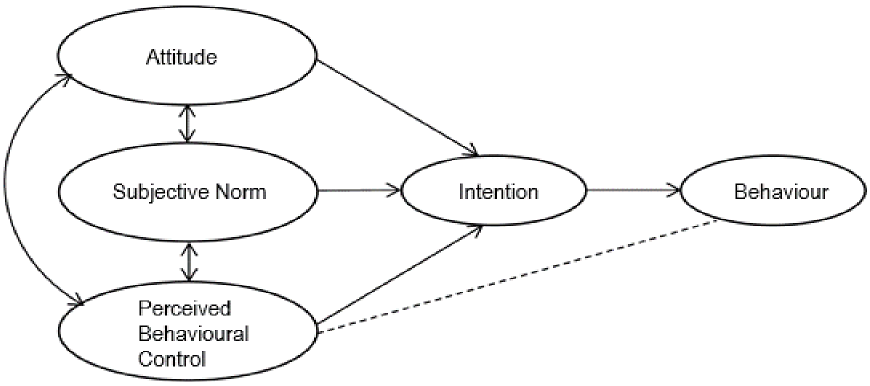

Figure 2.4: The Theory of Planned Behaviour (Ajzen, 1991)

The TPB states that motivation and ability are the key factors that determine behaviour achievement. The theory indicates three types of belief and six constructs that represent an individual's control over a behaviour. These are attitudes, behavioural intentions, subjective norms, social norms, perceived power, and perceived behavioural control (Ajzen, 1991). A brief description of each construct (Ajzen, 1991, 2011) is provided below.

Attitudes refer to the individual's evaluation of the behaviour. It involves considering the outcomes to evaluate the behaviour as either favourable or unfavourable.

Behavioural intention refers to the factors that influence behaviour. These are related explicitly to motivating factors, where there is a direct relationship between intention to perform behaviours and the performance of behaviours. The greater the intention, the more likely the behaviour will be executed.

Subjective norms refer to the beliefs about whether significant people approve or disapprove of the behaviour. It is related to whether colleagues or senior members of staff think that the individual should engage in the behaviour.

Social norms refer to the norms, standards or codes of behaviour expected within groups or cultures.

Perceived power refers to the factors that the individual may perceive as affecting the performance of a behaviour. These factors could facilitate or inhibit the performance of the behaviour. Perceived power is significant as it affects the individual's perceived behavioural control.

Perceived behavioural control refers to an individual’s perception of how easy or difficult performing the behaviour would be. This construct was added to the Theory of Reasoned Action, which resulted in the Theory of Planned Behaviour. It is essential to point out that perceived behavioural control can vary as it is dependent upon situations and actions.

While TPB has been used extensively in research, research suggests that there are limitations to the use of this model. The model assumes that the individual has available resources and has had opportunities to perform the behaviour (Jokonya, 2017). Further, other factors that may influence behaviour, like fear, experience, environmental or economic factors, are not considered. The model also assumes that the decision-making process that determines behaviour is linear and remains static(Jokonya, 2017; Sniehotta, Presseau, & Araújo-Soares, 2014).

While TPD has its limitations, it has proven to be a useful model for explaining behaviour and intentions (Conner, 2015). Attitudes and perceived behavioural control are successful predictors of behaviours. This indicates that TPB is a useful model that could be used to explain the behaviour of individuals in a given time and setting. Therefore, the TPB was used to discuss teachers’ use of Lesson Study for the integration of ICTs in their teaching. Since the model is effective at predicting and explaining behaviour, it was used to frame the discussion around the third research question: Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do?

In Chapter two, ICT integration within the South African context was presented. The discussion on ICT integration focussed on crucial definitions, guiding policies within South Africa, and barriers that teachers face while trying to integrate ICTs in their teaching. As a critical factor affecting ICT integration was reported to be the lack of teacher professional development, teacher professional development was discussed next. This was followed by a theoretical justification for the use of Lesson Study as a potential solution to the challenges teachers face when trying to integrate ICTs into their teaching. Finally, the guiding frameworks are presented, followed by a summary of the chapter. The following chapter presents the research design and methodology used to address the research questions.

Chapter 3: Methodology

3.1 INTRODUCTION

This research explored teachers' experiences of Lesson Study for the integration of ICTs in teaching. In this chapter, the research questions and the research paradigm are discussed. Deciding on a suitable research paradigm for this study proved problematic. Two possible options are discussed, the interpretive and the pragmatic paradigm. At first glance, the pragmatic paradigm appeared to be the most suitable due to the type of data collected; however, the research questions focus on the experiences of the teacher. This lead to interpretivism being chosen. The discussion of the paradigms and the justification for the choice is presented first. The design and the research instruments follow. The participants are described, including demographic information and teaching experience and the type of sampling used. A discussion about the participants, location, criteria for selection, the process and the types of data collected are discussed.

Next, the data collection tools and methods of data collection are discussed, followed by the procedure and type of data analysis employed.

Ethical considerations, trustworthiness, validity, reliability, and limitations follow. A summary of the sections concludes this chapter.

3.2 RESEARCH QUESTIONS

The purpose of this explorative case study was to explore teachers' experiences of Lesson Study for the integration of ICTs (Information and Communication Technologies) in teaching. To achieve this purpose, the research questions that framed this study were:

> How do teachers' confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study?
>
> What are teachers' experiences in using Lesson Study as a strategy to develop their competence in integrating ICTs (information and communication technologies) in their teaching?
>
> Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do?

Due to the complexities of exploring teachers' experiences, the research design was based on the aim of developing the most comprehensive picture possible. A mixed-methods approach was employed so that the data from different sources were used and could be triangulated.

3.3 RESEARCH PARADIGM

The term paradigm was first used in research by Kuhn (1970) and was explained to be "universally recognised scientific achievements that, for a time, provide model problems and solutions to a community of practitioners" (Kuhn, 1970, p. viii).

Kuhn (1970) described a paradigm as the way a researcher makes sense of their world. It is used to represent ways of thinking that are shared by researchers in a particular field and encompasses beliefs, values and methods, among others.

The SAGE encyclopaedia of qualitative research methods describes paradigm as

> *a set of assumptions and perceptual orientations shared by members of a research community. Paradigms determine how members of research communities view both the phenomena their particular community studies and the research methods that should be employed to study those phenomena (Given, 2008, p. 591).*

The purpose of a research paradigm is that it helps the determine the underlying beliefs and assumptions around the researcher's view of the problem under investigation and how it is investigated (Chilisa & Kawulich, 2012). While several paradigms do exist, Denzin and Lincoln (2011) identified the following six: constructivism, critical theory, feminism, interpretivism, positivism and post-positivism while Creswell (2017) acknowledged the existence of four: advocacy, interpretivism or social constructivism, pragmatism and post-positivism. For this research, two were considered based on the relevance to this research, pragmatism and interpretivism. Each is discussed below, followed by a justification for the choice of paradigm.

The pragmatic paradigm was developed in response to the discussions surrounding the criticism of a singular approach to research to one where the use of both qualitative and quantitative within a single study was acceptable (Kelly et al., 2018). Pragmatism is a philosophy that states that only things experienced or observed are real. Pragmatists focus on the outcomes of the research, "the actions, situations and consequences of enquiry" (Creswell, 1998, p. 23). Goldkuhl (2012) described the core of pragmatic ontology as "actions and change; humans acting in a world that is in a constant state of becoming" (p. 141)

John Dewey, one of the founders of pragmatism, emphasised the importance of focusing on the reality of experience. Experience is considered to be active and ongoing, where there is a fundamental interactive unity between what is being experienced and by whom it is being experienced (Carlsen & Mantere, 2007). There is also the view that actions and beliefs that have resulted from those experiences cannot be separated. Actions are taken based on the possible consequences of actions (Goldkuhl, 2012).

Morgan (2017) expanded on the three main elements of pragmatism. These are listed below.

The first is that "actions cannot be separated from the situations and contexts in which they occur" (Morgan, 2017, p. 26).

This element considers the world as one of human experience where beliefs take shape as actions are taken in similar situations meaning that learning is dependent on the place, context and time. Therefore teachers' knowledge and beliefs cannot be separated from contexts of use and opportunities for action (Carlsen & Mantere, 2007).

Secondly, "actions are linked to consequences in ways that are open to change" (Morgan, 2017, p. 26).

Pragmatists are of the view that it is impossible to experience the same thing twice since if the situation of action changes, the consequence will be different. This means that beliefs are continually changing as a result of experiences, and therefore the beliefs are provisional.

Pragmatists believe that different people have different worldviews since people do not have identical experiences. However, people can have similar experiences, and this may lead to a degree of shared beliefs. Morgan (2017) lists the final element as "actions depend on worldviews that are socially shared sets of beliefs" (p. 27).

The goal of this paradigm is, therefore, to provide a social function and real-world experiences (Sharma, Devi, & Kumari, 2018). Pragmatism, as a paradigm, is oriented toward solving practical problems within the context of the real world. Researchers using this worldview focus on the practical implications of the research and use multiple approaches to collect and analyse data hence the use of a qualitative and a quantitative approach (Creswell, 1998).

Pragmatists argue that the divided view of a qualitative and quantitative approach should be reframed so that the strengths of both could be acknowledged (Tashakkori & Teddlie, 2010). The overall research approach implied is one of mixed data collection and analysis (Creswell, 2017) hence the consideration for this study.

The interpretative research paradigm is based on the convention that reality is a result of human experiences and social contexts and is, therefore, best studied within that context and through the experiences of the participants (Ponelis, 2015). Interpretative studies, therefore "access the world through the interpretations of individuals" (Slootman, 2018, p. 43).

Since social reality is believed to be entrenched within social settings, reality is interpreted by making sense of the world rather than through hypothesis testing. Further, the knowledge that results from interpretative research "is integrally linked to the participants and the context of the research, meaning that the products of interpretivist research are not universally applicable theories or laws but, rather, rich and contextually situated understandings" (McChesney & Aldridge, 2019, p. 227).

Interpretive research is, therefore, subjective rather than objective, and researchers do not follow rigid methods in answering questions (Thanh & Thanh, 2015). The research is viewed instead of the views of the participants. Ponelis (2015) elaborates as follows: "The interpretive research paradigm is characterised by a need to understand the world as it is from a subjective point of view and seeks an explanation within the frame of reference of the participant rather than the objective observer of the action" (Ponelis, 2015, p. 538).

Several vital principles characterise all interpretative research. Of these, the one regarded as foundational for interpretative work is that

> *In an interpretive study, it is essential to create a holistic understanding of the studied area; not only an understanding of its different parts. The understanding should emerge through dialectical movements between the holistic understanding and the understandings of singular parts (Goldkuhl, 2012, p. 140).*

Interpretative research is guided by naturalistic enquiry. Therefore, phenomena cannot be separated from the social context and must be explored within the natural setting. This means that contextual variables may also play a role in the data generated (Goldkuhl, 2012; Kivunja & Kuyini, 2017). The purpose is to interpret and explore meanings rather than to generalise.

Interpretive researchers presume that people create meaning of the world around them as they interact with it. Therefore, the job of the researcher is to develop an understanding of phenomena by looking at the meanings that participants give to them. This means that the interpretative researcher makes sense through their cognitive processes and thinking resulting in the assumption of a subjectivist epistemology (Kivunja & Kuyini, 2017). The researcher and the participants are also assumed to be engaged in an interactive process, therefore, meaning "that the researched subjects ("the participants") are interpreters and co-producers of meaningful data" (Goldkuhl, 2012, p. 140).

Interpretive research is therefore based on the belief that reality is socially constructed and knowledge is negotiated within social setting and cultures (Kelly et al., 2018). This means that truth is not associated with an objective reality rather a subjective one. Since this is the case, the result is that multiple valid truths can exist.

What follows is a table of comparisons between pragmatism and interpretivism and a justification for the choice of paradigm for this research.

Table 1: A comparison of the pragmatic and interpretive paradigms

	Pragmatism	**Interpretivism**
Reason for doing the research	To solve real-world problems and improve human and ecological conditions.	To understand and describe human nature
Philosophical underpinnings	reality and knowledge are based on beliefs and habits that are socially constructed	Informed by hermeneutics and phenomenology
Associated terminology	Action Consequences Problem-focused Real-world application Mixed methods	Naturalistic Phenomenological Hermeneutic Social and historical Theory creation
Research methods	Qualitative or Quantitative or a combination of methods	Qualitative methods dominate although quantitative methods can be used

	Conformed to concrete research questions or aim	
Data collection Examples (but not limited to)	positivist and interpretivist paradigm, interviews, experimentation, testing, observations	Interviews Observations Document analysis
Ontology	Reality is ambiguous, but based on the language, history, and culture respect	Multiple socially constructed realties researcher and reality are Inseparable
Epistemology	Knowledge is derived from experience. The researcher bring back subjectively assigned and objective meaning of actions	Knowledge is based on thick descriptions of meanings, forming through human experiences

Adapted from (Chilisa & Kawulich, 2012; Kivunja & Kuyini, 2017; Žukauskas, Vveinhardt, & Andriukaitienė, 2018)

While some researchers avoid the paradigm discussion by selecting an a-paradigmatic approach (McChesney & Aldridge, 2019), paradigms are essential. Paradigms are important because

> *they provide beliefs and dictates, which, for scholars in a particular discipline, influence what should be studied, how it should be studied, and how the results of the study should be interpreted. The paradigm defines a researcher's philosophical orientation (Kivunja & Kuyini, 2017, p. 26).*

This, therefore, affects decisions made throughout the research, including methodology.

The purpose of the study was to explore teachers' experiences of Lesson Study for integrating information and communication technologies in teaching and not to provide an objective assessment of the use of Lesson Study (as may have been the focus of pragmatic or post-positivistic research). This focus represents the interpretative paradigm as understanding rather than critiquing or generalising was the aim (Goldkuhl, 2012). Within this topic, the key objectives of this research were

To explore how teachers' confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study

To gain an insight on teachers' experiences in using Lesson Study as a strategy to develop their competence in integrating information and communication technology (ICT) in their teaching

To determine why teachers, experience the use of Lesson Study to integrate information and communication technologies (ICTs), in the way they do.

It is clear from the objectives of the study that the focus is on understanding and describing the behaviour of teachers (interpretivist) rather than the practical implications of the research or to solve real-world problems (pragmatist) (Kivunja & Kuyini, 2017). The purpose of this research was not to study the impact of Lesson Study in a general context. It was instead explicitly focussed on the teachers from the school chosen for the research, their experiences, and the factors that played a role in their context. The aim was, therefore, not generalisation but understanding teachers' experiences in their natural setting.

> *The purpose of interpretative research is to understand people's experiences. The research takes place in a natural setting where the participants make their living. The purpose of the study expresses the assumptions of the interpretivist researcher in attempting to understand human experiences (Chilisa & Kawulich, 2012, p. 56).*

The need was not to only collect data on technical aspects, but consideration was also given to social issues. Since Lesson Study was an innovation at the school, the collection of subjective data was required since objective data only may not have been available when needed (Ponelis, 2015).

One of the critical considerations in deciding upon a research paradigm was the point that this research consisted of both quantitative and qualitative data collection methods. While the pragmatic paradigm is commonly used for mixed-method research, the interpretative paradigm is used less frequently for this type of research (Kivunja & Kuyini, 2017). In most cases, the interpretative paradigm is used for qualitative research however Willis, Jost, and Nilakanta (2007) mention that interpretivists

> *don't always abandon standards such as the rules of the scientific method; they simply accept that whatever standards are used are subjective, and therefore potentially fallible, rather than objective and universal. Interpretivists accept almost all of the types of quantitative methods that positivists use, but they differ in how they interpret the results of quantitative research (p. 110)*

Although using mixed methods are appealing, it is vital to understand the nature of the knowledge that is being researched (Mirhosseini, 2018). Mirhosseini (2018) argues that it is difficult to claim that the type of knowledge sought is both objective and subjective. This is a key criticism of the pragmatic paradigm. Within the interpretative paradigm, while data may be collected using mixed methods, the knowledge generated is usually subjective.

Interpretative research is usually based on the beliefs that multiple socially constructed realities exist and that knowledge is context dependant (Kivunja & Kuyini, 2017). These background factors need to be taken into account when attempting to develop an understanding. Finally, there is the belief and acceptance that there will be an interaction between the researcher and the participants (Kivunja & Kuyini, 2017). Based on the above information, the interpretative paradigm framed this research.

3.4 RESEARCH DESIGN

This research took the form of a mixed-method, multiple case study approach to explore teachers' experiences of Lesson Study for integrating ICTs in teaching. The case study design was used since the research represented an observed inquiry that "investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2009, p. 18). A single case study was initially considered for the research since all 12 teachers were involved in the programme. However, it became evident during the pilot phase that differing interactions were occurring within subject departments due to the varying levels of experience, the social interactions, the subject content and the preferred teaching methods. Multiple case studies were then conducted. Participants were separated into subject departments and worked through the Lesson Study cycles as separate units.

A case study approach was employed since case studies explore and investigate existing real-life phenomenon through the analysis of a few events or conditions (Cohen et al., 2013). In this case, it is Lesson Study for the integration of ICTs in teaching, and their relationships in a particular context – teachers' experiences (Zainal, 2007). This study involved using a limited number of participants. Four per subject area resulted in a total of only twelve participants. While this small number indicated that generalisations of the results were not possible, the small number of participants meant that in-depth exploration of the teachers' experiences would be possible. By employing the case study research design open-ended questions like "how" and "why" could be considered, and additionally, the rationale behind teachers' decisions could be explored (Yin, 2009). The research focuses on contextually rich current events or phenomena rather than historical phenomena. At the same time, the behaviour and experiences of the teachers could only be observed within the context in which the study occurred (Yin, 2009).

Although case studies have various advantages like providing insights into the comprehensive behaviours of the subjects, they are also criticised for their inability to generalise their results (Cohen et al., 2013). The data collected is also open to different interpretations due to the richness and complexity. However, Denzin and Lincoln (2011) argue that looking at multiple teachers in various environments enhances the generalisability of case studies. Case studies may also be used where the aim is to generalise a set of results to a broader theory (Yin, 2009). The purpose was to gain an understanding of teachers' experiences of Lesson Study for integrating ICTs in their teaching. Therefore, due to the interpretive stance used to gain an in-depth understanding of teachers' experiences, a case study method was used.

3.4.1 Research Strategy

This study was an interpretative, mixed-method case study that was analysed through qualitative and quantitative methods. The qualitative component formed the bulk of the research while the quantitative formed a much smaller part taking the form of a QUALquan study.

Qualitative research is described by Denzin and Lincoln (2011) as a method used in different academic fields where the goal of the researcher is to collect and develop an understanding of human behaviour and the reasons for that behaviour within a specific context. Quantitative research is, therefore, an approach that makes it possible to study a phenomenon within its context using a variety of sources allowing for a multifaceted exploration of a phenomenon, understanding of teachers, and their experiences and perspective. Qualitative research allows the researcher a glimpse into the world of the participant to see the dynamic nature of events and to look for patterns and trend (Cohen et al., 2013). While qualitative research presents data as detailed descriptions of phenomena within the natural context to understand the meaning teachers associate with it, quantitative research deals with statistical or numeric data.

Quantitative research focuses on the process of collecting and analysing numerical data. Since samples generally are extensive data, it can be used to find patterns and averages, make predictions, and generalise results to broader populations. The focus is on objectivity and is used when collecting quantifiable data systematically from society is a possibility (Queirós, Faria, & Almeida, 2017).

Quantitative research methods stem from the positivistic convention. It is concerned with collecting and analysing data that is structured and can be represented numerically allowing for statistical analysis through accurate and reliable measurements (Cohen et al., 2013).

Measurements like averages, comparisons, proportions, and relationships allow for the quantification and provision of evidence for variables in a study resulting in revealing trends and behaviours. Quantitative research involves measuring variables on a sample of subjects, and the focus is mostly theory testing.

However, it is essential to note that they do not provide an understanding of why people behave in specific ways. In other words, quantitative research highlights tendencies across data or groups, but not the reasoning behind observed behaviours.

While there are merits in both research methods, Creswell (2017) notes that by including either qualitative or quantitative methods only, research fails to fulfil the expectations of significant approaches used in humanities and social sciences. To obtain a more holistic view of teachers' experiences of Lesson Study for the integration of ICTs in teaching a mixed-method approach was used. For this research mixed methods are defined as "research in which the investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or a program of inquiry" (Tashakkori & Creswell, 2007, p. 4).

While quantitative and qualitative methods deal with different perspectives of research, combining them is still possible. This study combines data from the TPACK questionnaire (quantitative) with the qualitative data from the semi-structured interviews, lesson observations, documentary analysis and teacher workgroup observations. The semi-structured interviews were the primary source of data while the data from the TPACK questionnaire supplemented the qualitative data. The quantitative data was, therefore, used concurrently with the qualitative data to interpret teachers' experiences.

A concurrent triangulation strategy was employed in this study (Creswell, 2017). Qualitative and quantitative data were collected concurrently and then compared to determine if there were any similarities or differences. This method was chosen to strengthen any weaknesses present in the primary sources of data. Creswell (2017) mentions that while the data should ideally be weighted equally, one form of data may be given priority. The quantitative data in this study was used to support the findings from the qualitative data, and therefore the qualitative data was given priority.

The merging and comparison of the data occurred in the discussion section. The quantitative data was crucial in addressing the second research question namely "How do teachers' confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study?" as the TPACK questionnaire represented the primary source of data. Qualitative data was used to support or disprove the results of quantitative data to gain a better understanding of teachers' experiences. In contrast, qualitative data served as the primary source to address the other research questions namely "What are teachers' experiences in using Lesson Study as a strategy to develop their competence in integrating ICTs (information and communication technologies) in their teaching?" and "Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do?"

The concurrent triangulation strategy was useful since it could result in findings that are well-validated and substantiated (Creswell, 2017). This method, however, can produce data that is difficult to analyse and may result in discrepancies that are difficult to resolve. While limitations of this mixed-method research exist, the concurrent design strategy was deemed best for this study since the limitations of one method (either qualitative or quantitative) could be overcome by the other. Mixing data from different sources also assisted in the triangulation of results.

3.4.2 The research site

The research site for this study was a school in a middle-income suburb on the outskirts of Pinetown, in the Kwa-Zulu Natal province of South Africa. The school was a high school and consisted of approximately 1108 learners from Grade 8 to Grade 12. It was a well-resourced school and had a well-developed ICT infrastructure. Wi-Fi, internet and intranet access was available to learners and teachers. Grade 8 and 9 learners were required to have an electronic device available for accessing educational resources that teachers distributed through the Google Classroom-based learning management system. Nearly all classrooms had digital projectors installed. The governing body of the school had employed an IT manager to oversee the running of the school's ICT infrastructure and to provide technical support when needed. The school had encouraged teachers to use a blended approach when using ICTs. According to the school's ICT policy, blended learning is defined as the type of learning that combined digital and online media with traditional teaching. Traditional teaching is not described in the plan, but it eludes to it being the use of paper, chalkboards and hardcopy resources like textbooks. While all these resources were available ICT usage remained limited. The Head of Digital Learning at the school conducted an anonymous survey with the teachers, and one of the critical reasons reported by teachers for the limited use of ICTs was the lack of professional development on the use of these resources in teaching.

3.4.3 The Participants

Purposive sampling (Cohen et al., 2013) was used to identify and select participants so that rich data can be gathered from limited resources (Etikan et al., 2016; Palinkas et al., 2015). A school working on integrating ICTs into teaching, and learning was used. The teacher-participants were required to have access to Information and Communication Technologies (ICTs) that could be used in teaching. Four teachers in each of the three learning areas, Life Sciences, Mathematics, and Economic and Management Sciences – giving a total of twelve teachers, were asked to participate in the study. A presentation was done at the school explaining the research, and Heads of Learning Areas were invited to include their departments in the study. Many Subject Heads were hesitant to be part of the study citing time as a major barrier.

The school senior management team, however, was keen on getting teachers involved. The principal at the school requested that a presentation be held for all teaching staff. After the presentation, 38 teachers volunteered to be part of the study. The selection criteria used for teachers in the main study consisted of two principal criteria. At least four teachers from the same learning area had to be available to participate in a Lesson Study group, and the teachers from that learning area were using or attempting to use ICTs in their teaching. As a result of applying these criteria, four groups of four teachers from Life Sciences, Economic and Management Sciences, Mathematics and English resulted. The remaining teachers were grouped according to the GET (General Education and Training) subjects, for example, History and Geography teachers formed a social sciences Lesson Study group. These teachers engaged in the Lesson Study process first and formed part of the pilot study. Once a cycle of the pilot study was complete, the research group participated in the process. During the first cycle, the subject head of the English department resigned to take up a position at another school. The remaining English teachers requested to withdraw from the study due to increased workload and changes to the leadership structure within the department. Their withdrawal was accepted since teachers were entitled to withdraw at any time during the study. This condition was stipulated in the ethics approval document

The teachers participating in the study consisted of four Life Sciences teachers, four Mathematics teachers, and four Economic and Management Sciences teachers. The Life Sciences group was made up of two senior teachers Tina and Coraline, who had 45 and 32 years of teaching experience, respectively. Selena and Bruce, the younger members of the department, had taught life sciences for six years. Tina, Bruce and Selena had a Bachelor of Science degree with a post-graduate professional qualification in Education.

The Mathematics department was relatively young. Wendy, with 37 years of experience teaching Mathematics, was the most senior member. Dustin, the subject head, had eleven years of teaching and possessed a Bachelor of Education Honours degree. Shikaar and Marike had the least teaching experience of the group with Marike at ten years and Shikaar at five.

The Economic and Management Sciences group was made up of Thiro, Johno, Lisa and Vashnie. Thiro and Lisa, the most senior members of the department with 30 and 33 years' experience respectively, were the subject heads of the department. Thiro ran Business Studies while Lisa headed the Accounting department. Vashnie had a Bachelor of Commerce degree while Johno had a Bachelor of Arts degree and a Post Graduate Certificate in Education. Vashnie and Johno had 10 and 4 years of experience teaching Economic and Management Sciences, respectively.

The teachers participating in the study believed that professional development was essential for ICTs to be effectively integrated into teaching. Teachers had previously accessed a limited number of professional development activities. It had become compulsory that every member of the teaching staff was required to attend three professional development courses held by and external company each year. This was part of an initiative that the school had undertaken to ensure that teachers collected externally initiated SACE (South African Council of Educators) points. The most common type of professional development involved one-day workshops presented at the school. An external service provider would offer a two-hour course, and teachers would listen and take notes. The senior management of the school determined the content. Apart from these compulsory courses, teachers had limited access to other professional development activities. Teachers who participated in the study were willing to try alternative forms of professional development due to the lack of availability of activities they were able to access. Due to the significant number of teachers who responded (32), 20 were used in a pilot study, while 12 others were used for the research. Teachers did express scepticism and a bit of trepidation. Scepticism since all the work involved in the study seemed to be familiar since, to many, it merely involved developing, presenting and reviewing a lesson. Trepidation because when teachers began engaging in the process, they realised the detail and amount of time required was substantial.

3.4.4 Data Collection Tools

3.4.4.1 The TPACK Questionnaire

Creswell (2017) describes user-friendly questionnaires as a practical and efficient method of data collection. Since most questionnaires are answered anonymously, openness and trustworthy responses are encouraged (Creswell, 2017). Questionnaires do, however, require lots of time to collect and analyse data, and there is that danger that responses from participants may lack clarity however it does help to eliminate bias since all participants answer the same questions in the same order. The TPACK questionnaire validated by Schmidt, Baran, Thompson, Mishra, et al. (2009) was administered at the start and the end of the study. The questionnaire was administered at the beginning of the study to gauge teachers' confidence in each of the seven areas of the TPACK framework namely: content knowledge, technological knowledge, pedagogical knowledge, technological pedagogical knowledge, technological content knowledge, pedagogical content knowledge, and technological pedagogical content knowledge. Permission was sought from the author, Dr Denise Schmidt (dschmidt@iastate.edu), as per requirement on the questionnaire. An email was sent to the author explaining the intended use, the research questions, the location for the research and the population being surveyed (see Appendix B1).

Quantitative data were collected using the questionnaire (Appendix D1) by Schmidt, Baran, Thompson, Koehler, et al. (2009). The questionnaire consisted of 28 questions based on the TPACK framework with no negative questions. A five-point Likert scale was used for all the items ranging from "strongly disagree" (1) to "strongly agree" (5). For example, teachers were asked to indicate using the five-point scale, whether they could choose technologies that enhanced the teaching approaches for a lesson. The content areas contained in the original questionnaire consisted of mathematics, social studies, science, and literacy and was designed for primary school teachers. The content areas were adapted to suit the current research. Some questions were grouped while others were removed. For example, the following items: I have sufficient knowledge about science; I have sufficient knowledge about literacy; I have sufficient knowledge about mathematics, and I have sufficient knowledge about social studies were replaced with "I have sufficient knowledge about the subject I teach".

The modified questionnaire was then piloted with 22 teachers for reliability. These teachers did not participate in the main study and but were from the same school as the participants. The questionnaire was handed out to the teachers involved in the pilot study, and of the 22 handed out, 20 were returned. The returns represented a response rate of 91%.

The reliability of the TPACK questionnaire was also confirmed in studies by Schmidt, Baran, Thompson, Koehler, et al. (2009), and Albion et al. (2010), among others. Cronbach Alpha reliability coefficients in the original questionnaire are between 0.78 and 0.93.

The results obtained from the questionnaire were analysed at the beginning to determine teachers' confidence in using ICTs in teaching and learning. The results of the questionnaire were then entered into SPSS Statistics software version 26 and analysed.

Over approximately seven months, two lesson study cycles per learning area (a total of six complete cycles) were then conducted.

The validated TPACK questionnaire was then administered again. A comparison of the teachers' scores at the beginning and end of the study was made to determine if Lesson Study affected teachers' use of ICTs in teaching and learning.

3.4.4.2 Interviews

Qualitative research is concerned with people's perspectives and their insights into the world (Cohen et al., 2013). Seidman (1998) points out that interviewing is one of the best instruments for qualitative data generation. Therefore, semi-structured interviews were used as one of the methods of data generation. The interview, lesson observations and documentary analysis were conducted from a qualitative analysis of teachers' perceptions of lesson study for integrating ICTs in teaching.

The interview was initially piloted to ensure that the actual interviews were conducted smoothly. Running the pilot allowed for the checking of the appropriateness of the questions, to estimate the time needed and assess whether the items would be useful in fulfilling the purpose of the study (Van Teijlingen & Hundley, 2002). Based on the responses from the pilot group, it was ascertained that the responses needed to be probed for more clarity and a clearer understanding. Some questions had to be reworded to achieve a dialogue style and to be non-leading. For example, “Please describe your experience with this phenomenon?” was changed to “Please describe your experiences working with your team?” Questions were included to cross-check teachers’ responses such as “Did you experience any obstacles working with your team?”; “What were some of the disadvantages?” and “What are the obstacles that cannot be overcome?”

On completion of the study, arrangements were made with the interviewees and a suitable time and venue were arranged. Due to the interpretivist stance, descriptions of the experiences of the teachers were collected and analysed. While the semi-structured interview schedule did consist of some common questions, the unstructured conversation was encouraged to allow teachers the opportunity to elaborate or raise questions of their own. The analysis of the interviews was conducted individually and also as part of the lesson study group. In this way, commonalities and differences in teachers’ experiences could be identified.

An interview guide was developed before the individual interviews. This interview guide was a list of questions and topics that needed to be covered. Some discretion was used in terms of the order of the questions asked. Allowances were made for the following of topical trajectories if and when the respondents strayed from the guide. The advantage was that it allowed for the collection of detailed information in a conversational style and enabled the researcher to delve deeply into the topic to understand the answers provided (Harrell & Bradley, 2009). Teachers were interviewed in a venue of their choice to ensure that they were comfortable. Teachers were thanked for agreeing to the interview, and the interview proceeded at a pace that was suitable to the teachers. Time was allocated for teachers to clarify questions, ask questions and justify their responses.

Each interview was digitally recorded with the permission of the interviewee. Permission had been obtained in writing when the interview was scheduled, and verbal permission was obtained before the interview began. The interviews were recorded to reduce interviewer bias and to ensure that the entire interview was captured (Mathers, Fox, & Hunn, 1998). Recording the interview allowed for the discussion to flow, and the interviewee was not distracted by the researcher trying to make notes while speaking. Digital audio recordings have advantages over field notes only in that they can be replayed, and transcribed verbatim and preserve the sequence of the discussion

Semi-structured interviews were used since they allowed for focused discussions and follow up questions, including picking up cues from the interviewee and allowing for clarification (Kajornboon, 2005). It also represented a good source of stories and provided context. Additionally, non–verbal behaviours could be observed easily (Opdenakker, 2006).

Interviewing does, however, have some disadvantages or limitations. The first is the amount of time required. It took approximately two weeks to conduct all twelve interviews. Arrangements had to be made for the interviews to be undertaken when teachers were available. In some cases, this had to take place after school hours since teachers had full teaching loads. Interviews are often time-consuming for both the interviewer and teacher being interviewed (Akbayraka, 2000). Interviews have been criticised for being difficult to analyse and considered to have low reliability since reliability denotes the extent to which a research instrument produces the same result on repeated trials (Alshenqeeti, 2014). The following, as suggested by Alshenqeeti (2014) to help maintain the validity and reliability of the interviews were done. These included conducting a pilot interview, the avoidance of leading questions, making notes in addition to recording the interview, and allowing teachers to sum up and clarify.

The recorded interviews were listened to and transcribed using transcription software. The transcriptions were compared to the recordings for accuracy, and corrections were made. Where necessary, interviewed teachers were asked to clarify incomprehensible words or phrases from the recordings. These transcriptions were then analysed so that themes from the data could be used to develop an in-depth understanding of teachers experiences in using Lesson Study for integrating ICTs in teaching and assist in answer the principle research questions.

3.4.4.3 Lesson Observations

The lesson observations formed an essential part of the lesson study process as it served to verify what the participants believe and do (Mack, Woodsong, MacQueen, Guest, & Namey, 2005). It also helped provide an understanding of the context in which the teacher works.

The school where the research was conducted had an advantage in that all classrooms had cameras that could be used for recording lessons or for lesson observations. Also, electronic hardware, such as webcams and laptops were available.

Due to the teachers being unable to leave their classes during regular school hours, it was agreed that lessons would be recorded. Non-participant observation (Cohen et al., 2013) was conducted as the observers were not involved in the teaching and merely behaving as an outsider. In discussions with teachers, several advantages were posited. Disruptions within the school would be minimised; learners would be more likely to act as they usually would if the lesson was recorded, and the presenter would also be able to view and participate in the discussion and review of the experience. By actively involving the teacher-presenter in the discussion session, additional details were obtained like the justification for deviation from topics at a point in the lesson. Rules were discussed and clarified at the beginning of the review process to ensure that the presenter-teachers would not feel as if any criticism was directed at them. A set of rules was agreed upon at the start, including that feedback needed to be constructive. Also, any weaknesses in the lesson were not the fault of the teacher instead of the responsibility of the team. While these rules were in place, it was often the presenter-teacher who was found to be the most critical of the lesson.

The Information Technology Manager was contacted, and arrangements were made for an additional webcam to be installed in the classroom before the research lessons were conducted.

The lessons were observed, and the lesson observation sheet (Appendix C3) was completed by teachers from each case study group. The teachers observing the class took on the role of a complete observer (Baker, 2006) for the duration of the lesson. Teachers were able to listen and observe without participating since the experience had already taken place. While teachers were unable to ask for clarification or qualifications of observations during the lesson, these were possible during the discussion sessions. While teacher experience was the primary concern, learner responses did add to the discussion and helped provide insight into pedagogy, content and the effectiveness of technology used.

It was discovered that a more detailed lesson observation sheet was needed during the pilot phase of the study. The first observation form produced vague and oversimplified comments on the lesson reflecting a very superficial analysis. For example, when teachers were asked to note any evidence of confusion, teachers wrote “none”. When teachers were asked to report on the matching of the ICTs to the instructions strategy, some stated “good” without justifying their responses. A more detailed lesson observation instrument was then drawn up in consultation with the pilot group. The new observation instrument was later used in another pilot lesson and proved more useful.

The observations made were annotated and were varied in nature. Annotations of observations included notes on the delivery of the lesson, the teacher's confidence, as indicated by speech patterns and body language, learner engagement, and learner responses. The lesson observations formed a critical part of the feedback and the lesson review process. This, in turn, aided in revising or improving the lesson.

Observation as a data collection method is criticised for being open to observer bias, and it is assumed that people perform better when they know that they are being observed (Iacono, Brown, & Holtham, 2009). However, the collection of data took place in the venue where the activity occurred and therefore allowed for direct observation of what people did. Since the lessons were recorded and observed by multiple participants, observer bias was limited.

3.4.4.4 Document analysis

Document analysis is used in qualitative research to provide meaning to a topic through the interpretation of documents (Bowen, 2009). Bowen states that there are three main types of documents, namely: public records, personal documents and physical evidence. The primary kind of document used in this study could be categorised into physical evidence or artefacts as it is sometimes referred to as. The physical evidence used included the lesson planning, lesson observation and the lesson review documents. The analysis of the documents served as an essential research tool. It was particularly crucial for triangulation. Analysing documents incorporates coding content into themes similar to the analysis of interview transcripts. Qualitative researchers often use two or more data collection methods to corroborate and converge findings (Bowen, 2009).

Document analysis provides many advantages. Document analysis represents an efficient and effective way of collecting data due to the nature of documents. Documents are cost-effective, reliable, practical resources that are easy to manage. A key benefit of documents id that they can be reviewed multiple times yet remain unchanged in the process (Bowen, 2009).

Document analysis used in this study served to compliment the other research methods. It assisted in providing supplementary data and helped with the triangulation of findings. Document analysis helps ensure that the research is comprehensive since it may contain data that participants have forgotten or aspects of the research that cannot be observed again (Bowen, 2009).

There are limitations to using documents as a data source. Documents are usually designed to answer research questions specifically and may, therefore, not provide all the answers required by the research questions (Bowen, 2009). Some documents may be incomplete or produce data that may be inaccurate or inconsistent. It is, therefore, crucial to examine the quality of the documents used. A pilot study may be necessary as was done in the case of this research. The documents used in the study had to be revised during the pilot phase since the data generated proved to be vague and insubstantial. A revised lesson planning template was drawn up (Appendix C2). The planning template included the formalised team norms, detailed information on the planning, the preparations to teach the research lesson and a reflective exercise on the planning process.

There needs to be an awareness of the potential for bias from the researcher and in the document. O'Leary (2017) states that it is vital that the subjectivity of the document is evaluated to preserve the credibility of the study. While O'Leary (2017) says that the advantages outweigh the disadvantages, it is cautioned that there needs to be an exact, planned process so that the researcher knows what the method entails.

Document analysis used in this study helped supplement the data gathered from other sources. The lesson planning sheet, lesson observation template and the review of the lessons were used to add to and assist in the triangulation of data.

3.5 PROCEDURES

An application was made to the principal of the research school after receiving the ethical clearance from the University of Kwa-Zulu Natal (Appendix A). A meeting was set up to discuss the logistics of the study. Permission to conduct research had previously been granted since it was a requirement for obtaining the ethical clearance certificate.

The principal and the director of academics agreed to the meeting, and a time and date were set. A short presentation was prepared, detailing the study. The director of academics and the principal agreed that the study would be valuable for the teachers of the school but included some conditions. The first is that the study was not to affect teachers' ability or availability to carry out their duties during regular school hours. The second was that teachers would not be compelled to continue participating should they feel that it interferes with their duties.

A meeting was then set up to meet with Heads of Subjects. A presentation was done for the heads of subjects at that meeting detailing the study and explaining the lesson study process. People who were interested in participating were asked to remain behind to make further arrangements. At this initial meeting, only three Heads of subjects indicated an interest in participating. However, based on the criteria for the selection of participants - At least four teachers from the same learning area had to be available to participate in a Lesson Study group, and the teachers from that learning area were using or attempting to use ICTs in their teaching- only two subjects were able to participate. The reasons given ranged from lack of time to subject departments being under pressure with their workload. This meant that the study was in danger of being cancelled.

A follow-up meeting was arranged with the principal and the director of academics to report back. The situation was explained, and they were informed of the possibility of the study being conducted at another school.

The Director of Academics then suggested that a presentation be made to the general members of staff. Time and date were allocated for the introduction of the study.

A presentation was made to the staff on a date allocated by the Director of Academics. A PowerPoint presentation providing contextual information, justifying the type of the study, and detailing the procedure was made. The staff were more receptive than previously, and 38 indicated an interest in participating. By applying the selection criteria, four subject departments were initially able to participate in the main study – giving 16 participants from Life Sciences, Economic and Management Sciences, Mathematics and English.

The remaining teachers were grouped according to the GET (General Education and Training) subjects, for example, History and Geography teachers formed a Social Sciences Lesson Study group. These teachers engaged in the Lesson Study process first and formed part of the pilot study.

3.5.1 The pilot study

At the first meeting, the teachers were welcomed and thanked for their willingness to participate in the study. The roles of all involved were discussed, including the teachers, the researcher and the information technology team. The principal had decided that since the study involved the integration of ICTs in teaching, the IT team would assist. They were required to be available to provide technical assistance or to assist teachers with training where needed.

The TPACK questionnaire was administered to the pilot group consisting of 22 teachers. At this stage, two teachers withdrew, stating that they were unaware of the amount of time required at the beginning of the programme. The withdrawal of the two teachers resulted in 20 teachers in the pilot group. All 20 questionnaires were completed and returned. The raw data were examined and entered into SPSS Statistics software.

During the first meeting, a schedule of meetings was drawn up based on the availability of the teachers.

3.5.1.1 The pilot study– Stage 1

Stage 1 included a general information session. The twenty teachers who formed the pilot study group met together for the first presentation. An outline of the programme was discussed, and an exemplar cycle of the Lesson Study process was presented. Teachers were allowed to ask questions throughout the presentation. A set of literature containing articles on Lesson Study was given to teachers to use as a reference. The norms for the programme were discussed, and verbally agreed upon.

A diagrammatic representation of the programme was shown to teachers explaining what the process would resemble.

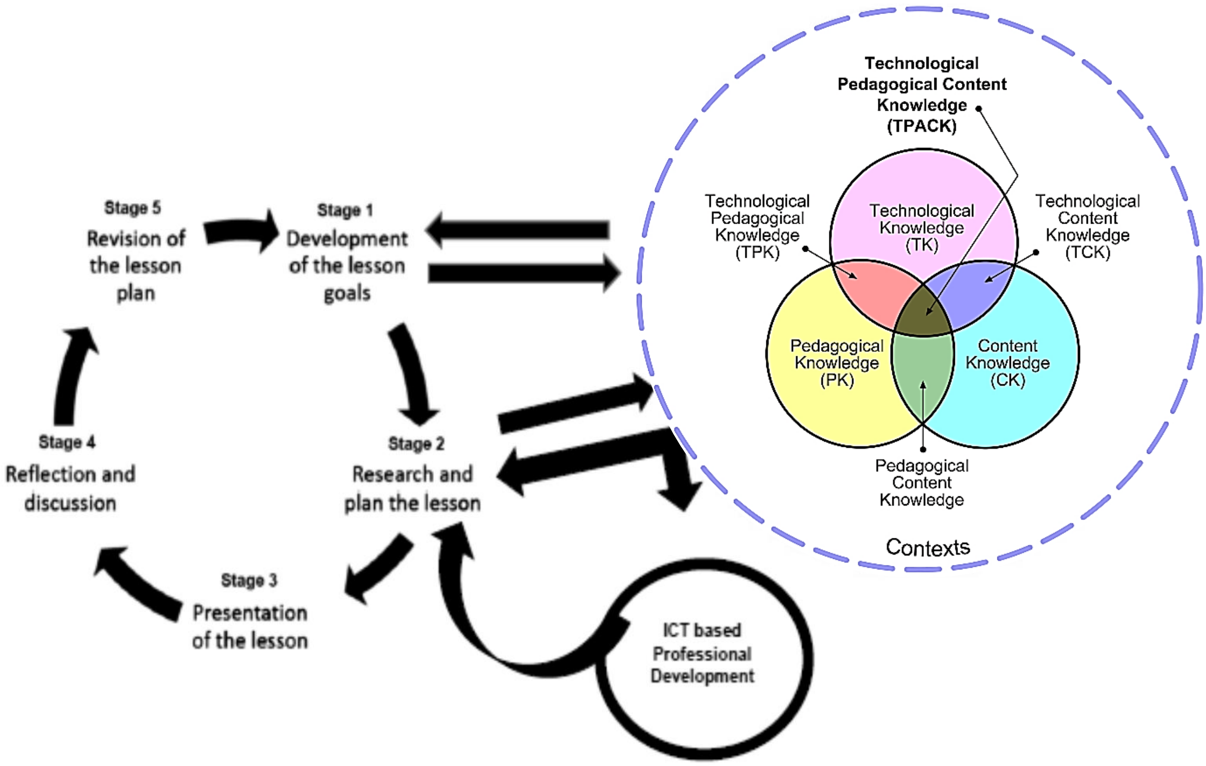

Figure 3.1: Diagrammatic representation of the pilot Lesson Study process for integrating ICTs

It was thought that to integrate ICTs in teaching teachers would need to consider the TPACK framework during the goal-setting stage and the research and planning stage only. During the pilot phase, it was found that this would not suffice and teachers needed to consider the TPACK framework throughout the process. A revised model was then drawn up for the study.

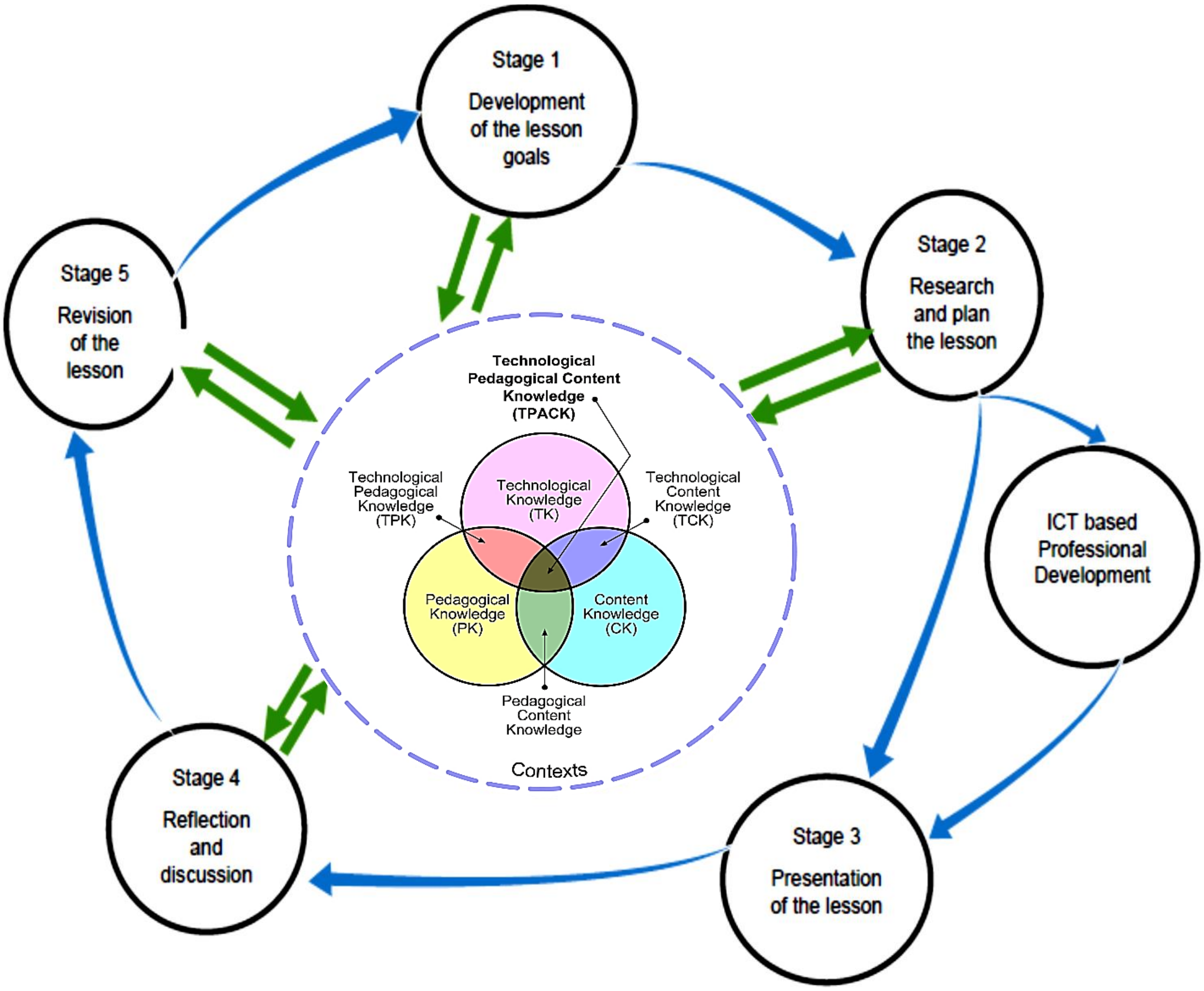

Figure 3.2: Diagram of the modified Lesson Study process

The Lesson Study cycle was discussed, and questions were taken from the group. It was deemed necessary by the group to formalise the norms or rules for the groups since there were concerns that some team members may dominate discussions. A set of rules was agreed upon, and groups were organised based on learning areas that teachers were currently teaching.

The procedure for stage 1 and 2 was discussed in detail, and teachers were asked to begin the process. The original lesson planning template was given to the groups and groups were asked to decide on the lesson goals and to start researching planning the lesson. Teachers spent a further two hours at the session planning. During this time, the facilitator and the IT team moved among the groups answering questions or making recommendations. A week was allotted for the planning to be done.

Teachers then met a week later as Lesson Study groups to discuss the plans to teach the lesson. The teacher and the classroom for the research lesson were identified. The classroom had to have the required ICTs and working cameras. The IT manager was contacted and asked to check and confirm that this was the case. The date, time and location for the research lesson were confirmed. Copies of the lesson observation form were made available and discussed.

The research lessons were discussed, and it was found that the lesson planning template given to teachers were not completed with adequate detail. Details of the plan were vague, and although teachers were confident in what was to be presented, the lack of detail meant that the task would be difficult to replicate. An example of this is given below.

RESOURCES and TYPE OF SUPPORT REQUIRED (EG TRAINING TO USE SPECIFIC ICT TOOL ETC.)	Projector Interet and W/sheets

	CONTENT	TEACHING METHOD	RESOURCES INCL. ICTS
INTRODUCTION DURATION:	GIS	Video Clip	Projector
BODY 1 DURATION:	What is GIS reasoning	Notes	
BODY 2 DURATION:	Remote Sensing Satellite images	Video clips and Images	Internet and Projector
CONCLUSION DURATION:	Review of lesson	Leaners answer questions	W/sheet

Figure 3.3 Sample of a lesson plan from the pilot study

The lack of detail in the planning template meant that it had to be revised for the main study. A revised lesson planning template was drawn up (Appendix C2). The planning template included the formalised team norms, detailed information on the planning, the preparations to teach the research lesson and a reflective exercise on the planning process.

The lessons were taught and recorded using the permanent camera from the classrooms. Arrangements were made with the IT manager to have an additional web camera mounted at the back of each room during the research lesson. The use of the cameras proved useful in that teachers were not required to leave their classes to observe, and learners did not feel intimidated since only one teacher was present at the lesson.

A meeting was arranged for teachers to view the research lesson. Teachers were provided with the lesson observation template (Appendix C3) and were asked to observe and complete the form individually. When individual forms were completed, teachers discussed their answers as a group. Since the research lesson was recorded, teachers were able to begin reflecting and discussing.

The reflective phase was guided by the review of the lesson document (Appendix C4). The questions required detailed reflections on the ICTs used, how the ICTs were used, the links with the content, and suggestions for improvement, among others. A separate section was included for the reflections from the teacher-presenter. Teachers completed the review and were asked to schedule a meeting to revise their lesson plan if necessary.

The final meeting of the first cycle involved revising the original lesson plan to incorporate the changes decided upon during the process. Teachers then agreed to meet to engage in a second Lesson Study cycle. A group of three teachers were then invited to pilot interview schedule. Arrangements were made for this to take place when the teachers were available. These interviews were conducted in a venue and a time that teachers had decided. The transcripts of the interviews were analysed to check if it would be useful in answering the research questions.

3.5.2 Lessons from the pilot study

The documents used by the teachers needed to be revised. Teachers required more guidance in terms of the details and descriptions necessary for the planning process. The new planning document formalised the norms for the programme while provision was made for teachers to adjust these for their groups. The descriptions of the content, pedagogy, and technology used required more detailed information, so questions were posed to teachers in this regard. The planning document included reflective questions on various aspects. For example, teachers were asked to report why they chose the topic. A separate section was developed to help teachers reflect on the actual planning process. Questions like: "How did the team discuss the topic?" and "In what way was the lesson linked to the broader goals" were included.

The recording of lessons, instead of teachers observing lessons, resulted in several advantages. It was possible to view and review specific parts of the lessons so that teachers' views could be discussed. The amount of time needed for reviewing was reduced since the review followed the observation. A further advantage was that the teachers did not need to rely solely on notes or observations during the teaching, meaning that more data could be gathered.

The Lesson Study group were able to observe the lesson as a team together with the teacher presenter, helping reduce the feeling of isolation. This meant that the teacher-presenter felt like part of the group rather than the one being assessed.

Revisions to the questionnaire were made based on the pilot interview. The initial interview schedule began abruptly with a question on teachers' views of the advantages and disadvantages of the Lesson Study process. This question was moved later in the interview. The first question was changed to one where teachers were asked to give their opinion on the process. The result of this change led to the interview taking on a more conversational tone rather than a formal one. Several words used in the pilot interview required clarification. For example, asking teachers to describe their experiences with the "phenomenon" was clarified. This interview question was reworded to make the question less formal and more apparent to the participant. The question asking teachers if they would like to continue using Lesson Study to develop themselves professionally was rewritten to relate specifically to Lesson Study for the integration of ICTs. During the pilot interview, teachers' responses were varied and very little related to the integration of ICTs in teaching so this change was considered necessary.

The revised interview schedule was trialled with a group of three teachers from the Physical Sciences department.

3.5.3 The Study

The participants of the study were chosen based on the criteria identified in the sampling subsection. They were asked to participate based on the availability of a minimum of four teachers from the department. The four departments initially selected were English, Mathematics, Life Sciences, and Economic and Management Sciences, resulting in 16 teachers in the original study and later it changed to 12 teachers, with the English department exiting.

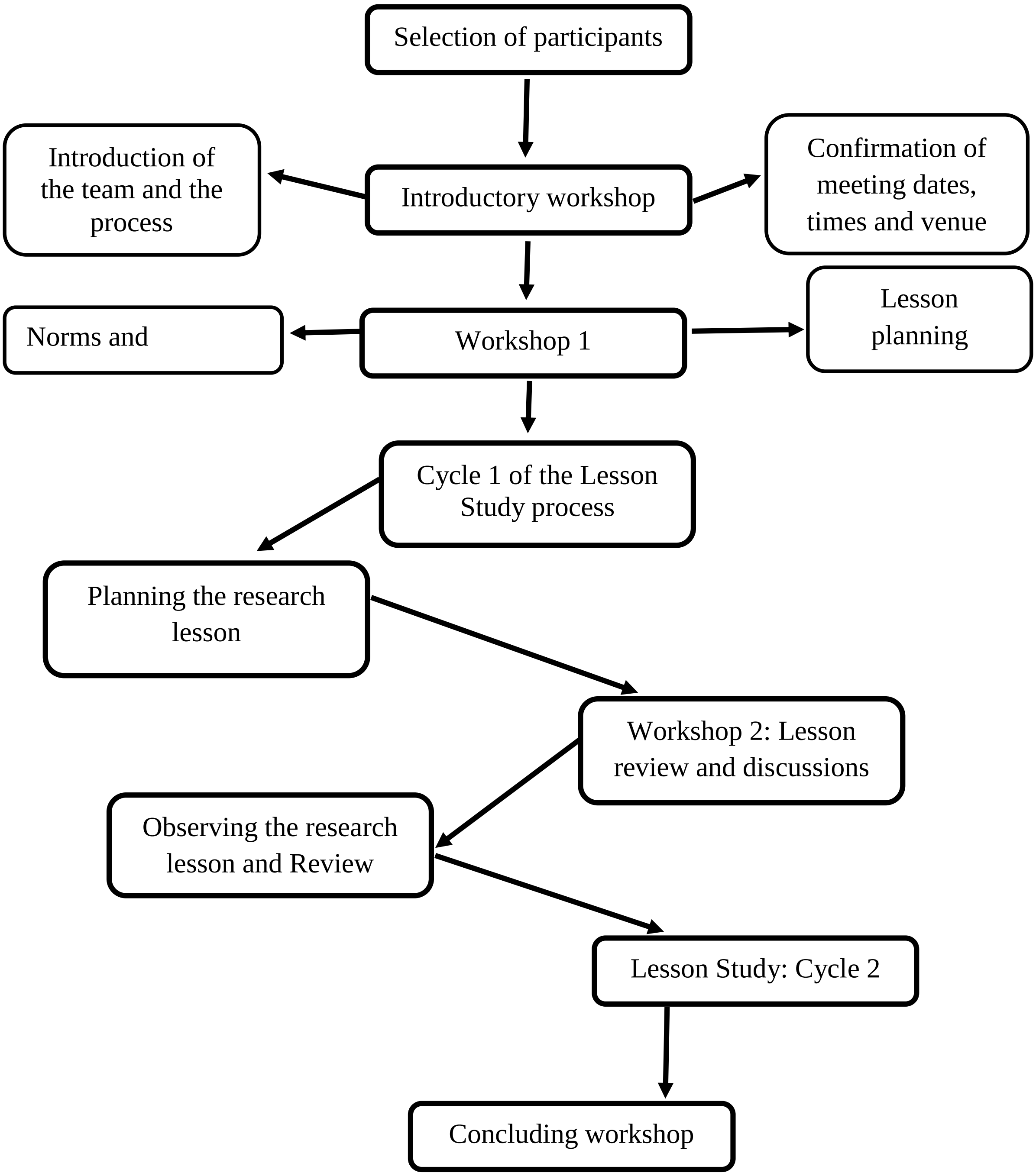

Figure 3.4: Flow diagram indicating teachers' Lesson Study process

A meeting was set up to discuss the logistics of the programme. The nature of the lesson study programme was discussed, and a PowerPoint presentation on lesson study was given to the group. The presentation included the theory of lesson study and a demonstration of a lesson study cycle using video clips obtained from YouTube. Additional reading material was also provided to the participants.

The theoretical presentation was followed by short video clips obtained from YouTube demonstrating the stages of the lesson study cycle. The video clips were intended to show participants what each step would look like when used in the classroom. Questions were fielded when the presentation ended. The questions focused on the logistics of the study. Many teachers, including the Director of Academics, expressed concerned about the duration and the amount of time required by teachers to participate. There were concerns that the study would encroach on contact time with learners. It was explained that the planning and workshops would be held after regular school hours and that the lessons would be recorded so no teaching time would be lost. Teachers were satisfied with the responses, and the meeting continued.

The dates for three workshops were negotiated in consultation with the participants, the Director of Academics and the IT Manager.

The workshop was held in the science laboratory at a time decided upon in the previous session. The laboratory was large and consisted of two adjoining classrooms which allowed for groups to work separately, and had the required ICTs like projectors and computers.

It was at this workshop that the English department announced that they would not be able to participate in the study. The Head of English had resigned before the first workshop to take up a position at another school. As the school was unable to employ another teacher at short notice, the other teachers from the department absorbed the workload of the Subject Head. The number of teaching lessons and the administrative duties of the teachers had increased, meaning that they had less time to be involved in other activities. The teachers did indicate a willingness to participate in further lesson study programmes that were to be held. Due to the large number of teachers used in the pilot study and the criteria for selection of participants, no other departments were available to replace the English Department in the research. The number of teachers participating in the study dropped from sixteen to twelve.

The people present at this workshop comprised of the participants, the IT Manager and the Director of Academics. The IT Manager and the Director of Academics attended as observers. The role of the researcher was discussed with all present. Participants were informed that in addition to presenting the workshops, the researcher would be available to guide teachers through the lesson study process. Also, the necessary technical support would be provided or sourced. The IT manager indicated a willingness to provide any technical assistance needed.

The participants were provided with the revised Lesson Planning template (Appendix C2). The norms were discussed, and participants were asked to make changes that they thought would be more suitable for their groups. The concept of lesson study, the planning template and planning procedure was discussed. Teachers were required to have a copy of their CAPS (Curriculum and Assessments Policy Statements) documents available. During this workshop, teachers identified suitable topics that could be completed within the required timeframe and committed to at least two lesson study cycles.

It was stressed that the emphasis needed to be put on the use of ICTs in their teaching. A plenary discussion was then held, with the support of the Director of Academics, to identify challenges that teachers anticipated during the programme. The IT Manager addressed ICT related queries like the availability of Wi-Fi in classrooms and the use of cameras to record lessons.

A discussion on the use of ICTs in teaching was held. It was agreed that a blended approach would be employed as this was what the school required. Teachers expressed concern over the detail needed in the planning process. It was explained that the lesson would serve as a model lesson for integrating ICTs in their subject. Therefore, the planning would need to be comprehensive. Teachers agreed that the lessons would be prepared with the emphasis on learner understanding, learner engagement, and the integration of ICTs in teaching. The remainder of this session was used to plan the lesson.

Teachers separated into subject groups and chose a part of the laboratory where they were able to work comfortably. Since only three groups were present, sufficient space was available, and teachers were able to communicate with each other without excessive noise from other groups. The IT Manager and the researcher moved among the groups assisting and providing suggestions where needed. Field notes were made while the groups worked.

Each group had chosen a topic that they could use for a lesson. The topic chosen had to be done within the following three weeks and needed to be in line with CAPS requirements. The group members worked on completing the lesson planning template. They considered the content, pedagogy and the technology to be used and discussed how these could be effectively integrated into the lesson. The teacher who would deliver the research lesson, the venue, the date and time of the research lesson was discussed and confirmed. Teachers continued to work until 5 pm and agreed on a follow-up meeting to finish planning, and the workshop concluded shortly after that.

The follow-up workshop was conducted a week later. Teachers from the three subjects and the IT Manager were present. Of the twelve, eleven teachers were at this follow-up workshop. One was unavailable due to after-school duties. A colleague agreed to meet with her to discuss the contents of the workshop the next day. This workshop also took place in the science laboratory. The venue was large, and the teachers were familiar with the environment.

Interestingly, teachers sat in the same area that they chose during the previous workshop. Teachers were allowed to complete the planning process, and the lesson observation template (Appendix C3) was discussed. A PowerPoint presentation was given. Different aspects of the observation template were discussed. This session provided teachers with the opportunity to reflect on the planning phase. Final arrangements were made for the logistics of the research lesson. A copy of the research lesson plan was given to each teacher from each subject. The IT Manager was contacted, and arrangements were made to check the cameras in the research classroom. Arrangements were also made to have the recordings available through the school. Meetings were scheduled with each of the three departments to observe their recorded lesson. The workshop ended when the planning and the preparations were done.

The lesson observations for each subject were conducted separately. Research lessons for each subject were completed at different times, and it was decided that lesson observations would occur as soon as possible after that. Arrangements were made by the Subject Heads to meet. A suitable time and venue were chosen, and recordings of the research lesson were obtained from the IT Manager.

The IT Manager had offered to be available during each lesson observation session, should technical assistance or other queries arise. Therefore, during each session, six people were present. Copies of the lesson observation template were available for teachers did not have their own. Teachers were asked first to observe the lesson individually without discussion. The research lesson was projected onto a screen, so all teachers were able to view it at the same time. During this time, teachers completed their lesson observation template individually. This process lasted about fifty minutes. When this was complete, teachers were asked to discuss the observations with their colleagues. Attention was drawn to the rules for discussing the observation lesson. Teachers were reminded that the discussion needed to be of the research lesson and not the teacher. Data were collected in the form of notes during this stage.

It was decided that the presenter-teachers should begin the discussion by reflecting on their notes. After the presenter-teacher spoke, others reflected on the lesson based on their notes. These reflections lasted between thirty and forty-five minutes. When all teachers had the opportunity to talk, teachers began the review of the lesson by referring to the lesson review template (Appendix C4), so it could be taught in another class. Since the critical objectives of the study were about the use of lesson study to integrate ICTs in teaching, five questions focused on the ICTs used. Teachers referred to their responses to the review of the lesson and revised the lesson for another class. Another teacher then taught this revised lesson.

Arrangements were then made for a second lesson study cycle. Since teachers were aware of the process, there was no need for an introductory workshop. Teachers from each department made arrangements to meet for the planning, observation and review of lessons. During this cycle, teachers were encouraged to use ICTs that they did not usually use in their teaching. The Life Sciences department chose Kahoots and mind-mapping software. The Mathematics department decided upon graphing software while the Economic and Management Sciences department planned a lesson using Google sheets that allowed learners to work collaboratively on a project.

Teachers were provided with all the documents needed to complete a cycle. Since each department worked independently of each other, teachers from each department chose dates and times that were suitable for them. A schedule of meetings was drawn up and made available. A new teacher-presenter was selected for this cycle.

The teacher participants were asked to complete the relevant documents for each stage of the lesson study cycle. These were used to generate data for the study. On completion of the second lesson study cycle, arrangements were made to conduct semi-structured interviews with each participant. The data generated and the analysis of the data are presented in the subsequent chapters.

A concluding workshop was held at the end of the programme. The purpose of the final workshop was to formally thank the participants and the school management for their support and participation in the research. Participants were allowed the opportunity to voice their views on the process. During this meeting, the Director of Academics requested a new cycle in the following year. An arrangement was made to meet at the end of February 2020; however, due to the Covid-19 pandemic, this was postponed.

In summary, each subject department participated in at least two lesson study cycles. Teachers chose topics from the CAPS documents that required completion and planned lessons that helped them integrate ICTs in their teaching. They worked collaboratively and were able to incorporate content, technology and pedagogy into their teaching

3.6 DATA ANALYSIS

Both qualitative and quantitative data were used to answer that research questions in this study. However, the analyses were conducted separately so that data from both methods could be studied independently at first. These separate analyses were then examined together to allow for holistic conclusions to be drawn.

A concurrent triangulation strategy was employed in this study (Creswell, 2017). Qualitative and quantitative data were collected concurrently and then compared to determine if there were any similarities or differences. This method was chosen to strengthen any weaknesses present in the primary sources of data. Creswell (2017) mentions that while the data should ideally be weighted equally, one form of data may be given priority. The quantitative data in this study was used to support the findings from the qualitative data, and therefore the qualitative data was given priority.

The merging and comparison of the data occurred in the discussion section. The quantitative data was crucial in addressing the second research question namely "How do teachers' confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study?" as the TPACK questionnaire represented the primary source of data. Qualitative data was used to support or disprove the results of quantitative data to gain a better understanding of teachers' experiences. In contrast, qualitative data served as the primary source to address the other research questions namely: "What are teachers' experiences in using Lesson Study as a strategy to develop their competence in integrating ICTs (information and communication technologies) in their teaching?"; and "Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do?"

The concurrent triangulation strategy was useful since it could result in findings that are well-validated and substantiated (Creswell, 2017). This method, however, can produce data that is difficult to analyse and may result in discrepancies that are difficult to resolve. While limitations of this mixed-method research exist, the concurrent design strategy was deemed best for this study since the limitations of one method (either qualitative or quantitative) could be mitigated by the other. Mixing data from different sources also assisted in the triangulation of results.

3.6.1 Quantitative data analysis

The TPACK questionnaire (Schmidt, Baran, Thompson, Koehler, et al., 2009) was given to teachers participating in the study at the start and the end of the Lesson Study programme. The quantitative data analysis was conducted in line with the instructions provided on the validated TPACK questionnaire. Each item response was scored with a value of 1 assigned to "strongly disagree", to 5 for "strongly agree". For each construct, the participant's responses were averaged. For example, the six questions under TK (Technology Knowledge) were averaged to produce one TK (Technology Knowledge) score. A 2-Tailed Paired T-Test was conducted to assess the improvement of knowledge before and after an intervention.

The following pairs denoted the areas that were assessed:

Pair 1 - Technological knowledge only

Pair 2 - Content knowledge only

Pair 3 - Technological, Pedagogical and Content knowledge

Pair 4 - Pedagogical and Content knowledge

Pair 5 - Technological and Content knowledge

Pair 6 - Technological and Pedagogical knowledge

Pair 7 - Pedagogical knowledge only

The data were entered into SPSS Statistics package version 26 and analysed.

The random variable of interest was the difference in knowledge before and after an intervention. The T-Distribution was used as the underlying distribution of this variable. This distribution was used since the sample size N of each pair was very small. The underlying variance was unknown, leading to a distribution similar to a Normal distribution but with fatter tails implying significant variation in the results, which made an accurate analysis difficult. However, using statistical inference, a reasonable conclusion was possible given the sample data.

The difference in knowledge was defined as the value before intervention minus the value after the intervention (implying that a negative mean difference indicates improved knowledge, and a positive difference indicates a deterioration in knowledge).

The null hypothesis (H_0) for this experiment was that there was no difference in knowledge before and after intervention for each pair (i.e., Mean difference = 0). The alternative hypothesis (H_1) was that there was a positive or negative difference in knowledge for each pair (i.e., Mean difference $\neq 0$). A 95% confidence level was used to determine which pairs have a statistically significant mean difference.

The results of the intervention on these seven pairs over a composition of all subjects were examined. The results of the intervention on these seven pairs over the subjects of EMS, Life Sciences, Mathematics and combination of all subjects were analysed.

3.6.2 Qualitative data analysis

Qualitative research generally produces large amounts of data. Qualitative data analysis involves organising, accounting for and making sense of data in terms of the participants' definitions of the situation, noting patterns, themes, categories and regularities (Cohen, Manion, & Morrison, 2017). Thematic analysis (Braun et al., 2016) was used to analyse that qualitative data. The thematic analysis describes a set of techniques used to analyse documented data and develop themes (Vaismoradi et al., 2016). The key feature is the process of methodical coding, probing for meaning and the provision of an explanation of reality through the themes (Vaismoradi et al., 2016). It involved taking the data that was collected and organising it so that some form of understanding or explanation could be developed.

Seidel (1998) developed a model to explain the basics of qualitative data analysis. The model consists of 3 parts: Noticing, Collecting, and Thinking about things. These parts are interlinked, and cyclical meaning that the data analysis process is not a static, linear process; instead, it is dynamic. Qualitative data analysis in qualitative research consists of three simultaneous flows of action, namely: data reduction, data display, and conclusions (Miles & Huberman, 1994). These actions are present both during and after data collection.

Data reduction is the process of organising, simplifying, extracting, and transforming the data to make it more accessible (Miles & Huberman, 1994). It is reduced to help understand the data. The qualitative data were collated and organised in preparation for data analysis. Data from the documents used by the teachers in the Lesson Study process and the lesson observations were analysed. The interviews were transcribed fully to ensure that critical information was not lost. While this process was very time consuming, it allowed for multiple opportunities to listen to the data before beginning the actual analysis. Each participant was allocated a code for identification later. This code was kept confidential. The code was available to only two other people, the research supervisor and the participant. Once the recordings were transcribed, they were listened to again and compared with the transcriptions and notes. Summaries of the data, which included the demographic data of each participant, were then made. During this process, preliminary themes were identified.

The purpose of data displays is to organise the data in a way that the data can be easily analysed so that conclusions can be drawn (Miles & Huberman, 1994). The final component of the analysis process involves concluding. Miles and Huberman (1994) stress that definitive findings should not be made during the data collection process. Any preliminary results would have to be verified during the process.

Yin (2009) describes various means of linking data to a proposition such as pattern-matching or coding, time series analysis or logic models. Pattern matching is the process where different parts of the same study could be linked to a theoretical proposition (Yin, 2009). The strategy employed for this study was coding, and the data were examined for recurring ideas, patterns of beliefs and words or phrases. The transcripts were divided into smaller segments to identify patterns in the data. When all the data was available in a word-based format, the data could be analysed systematically and methodically (Miles & Huberman, 1994).

Miles and Huberman (1994) describe four advantages of coding data. Coding helped reduce a large amount of data into smaller, more manageable units. It allows for more focused fieldwork since the researcher can begin analysis during data collection. It helps promote cross-case research and finally, helps develop an understanding of the interactions of the participants.

A thematic analysis was used to determine the common issues and central themes that arose. When the data were coded, data was taken out of the original context and put together under each code. Examples of data on the same topic were put together to search for patterns.

These patterns were then sorted into themes. The transcript was then studied again to see if any overlapping pieces could be combined, resulting in the final list of codes that were used to code the rest of the data. The analysis of the data collected from the interviews, documentary analysis, and observations was essential to the reporting of the results since it provided detailed information on teachers' experiences of Lesson Study for integrating ICTs in teaching. The coding reflected patterns related to Lesson Study for integrating ICTs in education, the teachers, the events they experienced, and issues that emerged.

The codes that emerged from the data were organised into themes. A sample of a transcript was given to a colleague to code. The codes were compared, and inconsistencies were discussed. When consensus was reached, the coding of the data continued, and themes were developed. The themes were interpreted in light of the relevant literature available. The interpretation of themes was followed by the writing of the research finding and the drawing of conclusions

While the qualitative and quantitative results were reported differently, these results were integrated wherever possible. In doing so, a broader, cross-study integration of the findings among the three subject areas was made possible allowing for discussion on the research questions and the relationship with the themes and conclusions across all data collected.

All the data, documentation and results of the questionnaire were carefully and systematically analysed since it was necessary for exploring teachers' experiences of lesson study for integrating ICTs in teaching.

3.7 ETHICAL CONSIDERATIONS

Before the research could begin, an application was made with the University of KwaZulu-Natal to conduct research. The study was granted ethical clearance and an ethical clearance certificate was issued.

Letters were sent to the Head of the institution and possible subject teachers where the research would be conducted. Written informed consent was sought from all the participants.

The aim of the study was discussed, and participants were informed about what would be required should they chose to participate in the research. Participants were informed about the risks and benefits of participating in the study, confidentiality and anonymity issues. Assurances were given that the information provided by participants would not reveal their identity (Cohen et al., 2007). Pseudonyms were used for the school and the participants to ensure anonymity. They were also informed that they could withdraw from the study at any time without fear of penalty.

During the duration of the study, all data were considered confidential. Participants were informed about the storage and disposal of data. The data will be stored in a password-protected file. After the required five-year period, the data will be disposed of. All hard copies will be shredded in the presence of the supervisor, and data from electronic media will be deleted.

Interviews and lesson observations were conducted in venues chosen by the participants and during times that were convenient to them to ensure that the discussions and observations were conducted in a non-threatening manner and to limit the stress experienced by the participants.

In most case studies, there is an emphasis on the relationship between the researcher and participants. Ethical issues were vital in maintaining good relationships, and two key concerns dominated these. These were informed consent and protecting the participants from harm. Actions, as outlined above, were taken to ensure that this was done.

3.8 TRUSTWORTHINESS/ VALIDITY AND RELIABILITY

3.8.1 Validity and reliability of the questionnaire

Quantitative data were collected using the questionnaire by Schmidt, Baran, Thompson, Koehler, et al. (2009). The questionnaire consisted of 28 questions based on the TPACK framework

The modified questionnaire was piloted with 22 teachers from the same school for reliability. The questionnaire was handed out to the teachers involved in the pilot study and of the 22 handed out 20 were returned. The returns for the pilot represented a response rate of 91%.

The reliability of the TPACK questionnaire was also confirmed in studies by Schmidt, Baran, Thompson, Koehler, et al. (2009), and Albion et al. (2010), among others. Cronbach Alpha reliability coefficients in the original questionnaire are between 0.78 and 0.93.

Table 2: Reliability of the TPACK questionnaire (Schmidt, Baran, Thompson, Koehler, et al., 2009)

TPACK Domain	Cronbach's alpha α
Technological Knowledge (TK)	0.86
Content Knowledge (CK)	0.78
Pedagogical Knowledge (PK)	0.82
Technological Pedagogical Knowledge (TPK)	0.93
Technological Content Knowledge (TCK)	0.86
Pedagogical Content Knowledge (PCK)	0.87
Technological Pedagogical Content Knowledge (TPCK)	0.89

The analysis of the Cronbach alpha for the questionnaire indicated values between 0.78 and 0.89. Acceptable Cronbach alpha values above 0.7 are considered acceptable (Taber, 2018). Therefore, the Cronbach alpha for the questionnaire is highly acceptable.

3.8.2 Trustworthiness

Quantitative research talks of validity and reliability while Qualitative researchers speak of trustworthiness, which is merely answering the question 'Can the findings be trusted? (Korstjens & Moser, 2018). The trustworthiness or rigour of a study refers to the confidence that can be placed on the data collected, interpreted, and generally ensuring the quality of research (Lincoln & Guba, 1985). Lincoln and Guba (1985) developed a set of criteria to ensure the trustworthiness of a study. These are credibility, transferability, dependability, and confirmability.

Credibility refers to checking if the findings represent participants' original data and is a correct interpretation of the participants' unique views and were achieved by prolonged engagement and persistent observation. Since the duration of the study was seven months long, prolonged engagement at the research school was maintained. The participants of each Lesson Study groups also served as additional observers to help triangulate the findings. They were given copies of their transcripts and group discussions, to confirm that the data represented the participants' views, and to help ensure credibility. Triangulation helps to provide a convergence of data that improves credibility (Bowen, 2009). Supporting results across different types of data can help reduce the impact of bias through the use of other methods for examining data.

The lesson observations and the transcripts of interviews were given to the respective participants for comment. Participants were asked to verify that the transcripts were accurate and reflected what happened during the interview and the lesson. All participants were involved and participated in the Lesson Study process, including the lesson observation that was made possible through the recording of lessons.

Transferability relates to the degree to which the results of qualitative research can be transferred to other settings or contexts with other participants (Korstjens & Moser, 2018). Transferability was facilitated through a highly detailed description of the research situation and methods. However, due to the nature of the study, transferability could only be demonstrated in a school with similar resources. Since the school was well-resourced, the effect of the availability of resources was not considered, and therefore different results could be obtained from an under-resourced school.

Dependability was ensured through the participants' involvement in the whole process, such as confirming that the reported findings represent the data as received from them. Copies of transcripts were given to participants to verify. Field notes were made available to participants so that they could confirm the data and findings. The data collected from each participant were stored in separate files in a locked cupboard. Each participant's file contained their data and copies of the Lesson Study group data. Participants had access to their personal file only and were able to view and comment on their data whenever they requested. Participants were, however, not allowed to view files of other participants. Dependability was established using an audit trail (proper documentation and storage of raw data and field notes), and a colleague and another researcher analysed the data to compare results.

Confirmability: This is concerned with ensuring that data and interpretations of the findings are not figments of the researcher's imagination, but authentic (Tobin & Begley, 2004). Another researcher cross-checked the data and analyses to achieve conformability. A comparison was made with a colleague in terms of the coding process. The list of codes and a part of the transcript was given to the colleague. The colleague was then asked to code the transcript. The identity of the participant whose transcript was coded was not revealed. A comparison was drawn between the codes. Where inconsistencies were found, a discussion took place to understand the rationale behind these inconsistencies. Once a consensus was reached, the revised codes were used to continue with the data analysis. Also, confirmability was facilitated through engagement with a fellow researcher. Opportunities were provided for reflections on personal biases and the research process. This was achieved by inviting the fellow researcher to question and challenge aspects of this study.

Reflexivity is described as the process of critical self-reflection as a researcher (biases, preferences, preconceptions), and the research relationship (relationship to the respondent, and how the relationship affects participant's answers to questions) (Korstjens & Moser, 2018). In addition to allowing the participants the opportunity to comment on the data, triangulation was used to limit the effect of researcher bias (Shenton, 2004). Triangulation involved using two or more methods to collect data on the same topic and using multiple participants. In this study, data from the interviews served as the primary source of qualitative data, while data from the planning process, lesson observations and the reflections helped in triangulation. Triangulation helped corroborate findings and, equally as necessary, help identify inconsistencies which could lead to more complex discoveries (O'Connor & Gibson, 2003). Various methods were used to collect data in this study: the use of a questionnaire; semi-structured interviews, lesson observations and document analysis. Detailed reflexive notes were taken while participants worked through the stages of the Lesson Study process, and a conscious effort was made not to impose meanings on the findings.

3.9 ROLE OF THE RESEARCHER

The role of the researcher in this study was multi-fold. The roles included designing and trialling the documents used by the teachers in the lesson study cycle. Trialling was followed by the redesigning of these documents based on the results of the pilot study.

The questionnaire and the interviews were also piloted. The interview questions were then adjusted based on the objectives of the study. The interviews were conducted, transcribed and analysed. The questionnaire was scored, analysed and interpreted in light of the qualitative data generated through other sources.

The researcher served as the facilitator for the lesson study programme, preparing and presenting content on the various aspects of the lesson study process. The role of the researcher was critical in the first cycle, but as teachers became more familiar with what was required, the researcher-as-facilitator role decreased. This role was then limited to providing support where necessary.

3.10 LIMITATIONS

While limitations were identified in this study, it does not imply that the research was a failure. It does mean, however, that the study needs to be viewed within the context of these limitations.

A case study methodology was employed in this study for several reasons, as discussed earlier in the chapter. A case study approach was used since case studies explore and investigate existing real-life phenomenon through the analysis of a few events or conditions (Zainal, 2007). In this case, the research involved Lesson Study for the integration of ICTs in teaching, and their relationships in a particular context – teachers' experiences. Although case studies have various advantages like providing insights into the comprehensive behaviours of the subjects, they are also criticised for their inability to generalise their results (Cohen et al., 2017). The data collected is also open to different interpretations due to the richness and complexity. The case study approach was selected since the intention was not to generalise the results but to gain an in-depth understanding (Yin, 2009) of teachers' experiences of Lesson Study for integrating ICTs in teaching. The data collected were, therefore, unique to the three cases and the school where that research was conducted.

The quantitative data obtained during the study was from a small sample of only twelve teachers. Researchers generally agree that small sample sizes generally have limited statistical power for identifying differences between groups or variables (Anderson, Kelley, & Maxwell, 2017; Leppink, Winston, & O'Sullivan, 2016). This means that even when a significant difference in means was present, as seen in some of the TPACK knowledge areas, a statistically significant difference was difficult to obtain. Therefore, the null hypothesis could not be rejected. Larger sample sizes would have produced more statistically significant results. However, the quantitative results were not interpreted in isolation. It was used primarily to support or dispute the data from the qualitative findings.

The study was conducted in one well-resourced school. As the objective of the study was to explore teachers' experiences in using Lesson Study to integrate ICTs in teaching, the research school needed to have ICTs available for teachers to use in their teaching. Teachers' experiences in under-resourced school were not explored. The results of this study are, therefore, only applicable to schools with similar resources. The findings of this study would have been more generalizable had more schools from different socio-economics backgrounds participated.

The coding and classification of the data were conducted using different methods to confirm the resulting codes and themes. Samples of the data were also given to colleagues to code so that comparisons could be made, and the codes and themes confirmed. However, the issue of subjectivity of the coding process could be a limitation. It may be possible that other researchers may obtain different codes from the data. This is also a limitation of qualitative research.

3.11 SUMMARY

This study explored teachers' experiences of lesson study for integrating ICTs in teaching. The research paradigm, purpose, research design and research methods were discussed.

A mixed-method approach, combining qualitative and quantitative data collection methods, was used. While a mixed-method approach was used, the research paradigm chosen was interpretive due to the nature of the research questions. The key objective was to explore teachers' experiences of Lesson Study for integrating ICTs in teaching, and therefore the interpretive paradigm was used. The interpretive paradigm provided a useful framework to describe, interpret and understand teachers' experiences. A multiple case study approach was employed, and the justification for this was provided in this chapter. A case study approach was chosen since this approach allowed for the generation of in-depth information on teachers' experience in this study.

This research was conducted in a high school in the Pinetown area of KwaZulu-Natal, South Africa. Four teachers in each of the three learning areas (subjects) were purposefully selected to participate in the study. This study was conducted over seven months, involving teachers participating in Lesson Study cycles and reflecting on these. The study was piloted. This pilot study represented the first stage of the research process.

Multiple data collection methods were used to maximise reliability and validity. The use of various forms of data collection also helped with the triangulation of data, thereby enhancing the credibility of the findings. Qualitative data collection methods comprised of the interview, observations, and document analysis while quantitative data was collected using the validate TPACK questionnaire. Statistical analysis of the quantitative data was conducted using the SPSS Statistics software package version 26. This data was analysed together with the quantitative data. The qualitative data generated through this research was coded and categorised into themes. The quantitative and qualitative data were analysed together to answer the research questions.

The results of the study are presented in the ensuing chapter.

Chapter 4

The Qualitative findings

4.1 INTRODUCTION

The previous chapter, Chapter Three, focused on a discussion of the paradigm, followed by the research design and methodology used to answer the research questions. Sampling procedures and data generation and data analysis methods were described.

Chapter four and five contain the findings and the results of the research, respectively. Chapter four contains the qualitative data that were generated primarily through the semi-structured interviews but included other forms of qualitative data generated through observations and document analysis. The findings of the data are presented. Chapter Five contains the results of the quantitative data obtained from the TPACK questionnaire.

This study employed mixed methods to explore teachers’ experiences of Lesson Study for integrating ICTs in teaching using multiple case studies. This section presents the findings obtained from the qualitative data.

The case study design was used since the research represented an observed inquiry that “investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not evident” (Yin, 2009, p. 18). In these cases, teachers’ experiences of Lesson Study to integrate ICTs in their teaching, within the context of a high school in South Africa, were explored. Multiple case studies were used due to differing interactions occurring within subject departments as a result of the varying levels of experience, the social interactions, the subject content and the preferred teaching methods. Participants were separated into subject departments and worked through the Lesson Study cycles as separate units. The findings are presented separately for each department since each department represents a unique case. A cross-case summary is then presented. The analysis and discussion in chapter six will discuss the findings of both the individual cases and all cases taken together.

The presentation of the findings is done based primarily on the research questions of the study:

> How do teachers’ confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study?

What are teachers' experiences in using Lesson Study as a strategy to develop their competence in integrating ICTs (information and communication technologies) in their teaching?

Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do?

The findings are presented as cases and major themes listed as sub-categories within each case.

A description of the participants and school is given at the start to provide context for each case study. The following three items guided the presentation of data: the effect on teachers' confidence; Teachers' experiences of Lesson Study for ICT integration; and the explanations behind teachers' experiences. The qualitative findings are obtained from the interviews, document analysis and lesson observations. The bulk of the qualitative data was obtained from the interviews. Data obtained through document analysis and lesson observations were used to support the interview findings and assist with triangulation.

Pseudonyms were used for all participants to ensure anonymity. The pseudonyms used were chosen so that the gender and ethnicity of the participants were preserved.

4.2 FINDINGS OF CASE STUDY ONE- LIFE SCIENCES

Case study one was conducted with the Life Sciences department of Current High School. The participants of this study were two senior female teachers, Coraline and Tina, and two junior teachers, Selena and Bruce. Bruce was the only male teacher in the Life Sciences department. Their demographic information is presented in Table 3 below.

Table 3: Demographic information of the participants of Case Study 1- Life Sciences

NAME	SUBJECT	EXPERIENCE	EDUCATION
Selena	Natural Sciences Life Sciences	6 years at Current High School. 2 years tutoring.	BSc Microbiology and Biochemistry. PGCE: GET and FET: Natural and Life Sciences
Bruce	Life Sciences Physical Sciences	6 years at Current High School	BSc Honours in Biological Science Cum Laude PGCE in GET and FET

Tina	Life Sciences Physical Sciences	45 years at: ABC Girls High GHI Girls High JKL High Current High	BSc U.ED
Coraline	Life Sciences	VWX High School: 1988-1989 MNO High School (Afrikaans Medium) 1990-1998 Current High School: 1999 to present	HDE Botany and Zoology

The Life Sciences department claimed to be a closely-knit department who were involved in high levels of collaboration before the study.

> *So we all effectively are in communication, sharing ideas, sharing resources the whole time. (Selena)*

> *if we do something in one of our lessons that works really well, we found a cool program or a good video it's shared like with you straight away. (Selena)*

> *When we have a job to do we get together. We get it done. (Tina)*

The two junior teachers first joined the department as learnerships. They were mentored by the two senior teachers, Coraline and Tina, before being appointed as teachers. Resources were shared among all teachers. Weekly meetings were a requirement at the school, and teachers used that time to discuss progress with the syllabus, assessment planning and the teaching programme for the week ahead.

All Life Sciences teachers were involved in the co-curricular programme at the school. Teachers were required to provide extra lessons after school or be involved with coaching or managing sport. Senior teachers had a maximum of two non-teaching lessons per day while junior teachers had one per day. Due to the limited amount of time available, previous professional development programmes were held on Friday afternoons.

The findings of the qualitative data are presented in the following subsection. The findings are presented according to the themes that emerged from the data. A thematic analysis was used to determine the common issues and central themes that arose. When the data were coded, data was taken out of the original context and put together under each code. Examples of data on the same topic were put together to search for patterns.

These patterns were then sorted into themes. The transcript was then studied again to see if any overlapping pieces could be combined, resulting in the final list of codes. Another researcher cross-checked the data and the codes that emerged. A comparison was made with a colleague in terms of the coding process. The list of codes and a part of the transcript was given to the colleague. The colleague was then asked to code the transcript. The identity of the participant whose transcript was coded was not revealed. A comparison was drawn between the codes. Where inconsistencies were found, a discussion took place to understand the rationale behind these inconsistencies. Once a consensus was reached, the researcher used the revised codes to continue with the data analysis.

The analysis of the data collected from the interviews, documentary analysis, and observations was essential to the reporting of the results since it provided detailed information on teachers' experiences of Lesson Study for integrating ICTs in teaching. The coding reflected patterns related to Lesson Study for integrating ICTs in education, the teachers, the events they experienced, and issues that emerged.

While themes are organised according to the research questions, some overlap of data does exist. The discussion of the findings is presented in chapter six.

4.2.1 Intra-departmental Collaboration

Teachers reported that the collaboration that resulted from participating in the Lesson Study programme was a critical benefit of the process.

> *I think yes that the process actually opens up that conversation between colleagues and allows for a teacher who does know how to do something to*

> *come alongside another in a kind of almost unnatural way because it's often the older teacher helping, the younger. In this case, the youngest often like trying to teach a skill to the older teachers and which I got exceptionally excited about. (Bruce)*

Bruce mentioned that the way the Life Sciences department worked collaboratively was almost unnatural to him. During the development of the lessons, he assumed a leadership role. To him, this was unnatural since the senior teachers had mentored him and were usually the ones leading. Due to his experience with ICTs, these roles were reversed, providing him with a leadership opportunity. The working relationships that had been established within the department ensured that collaboration occurred seamlessly. During lesson observations, it was evident that the teachers respected each other's opinions, giving everyone a chance to express their views. Bruce also refers to the teachers in his department as colleagues, even though two are senior members of the staff.

Coraline reported that due to the collaboration, teachers were able to view situations from different perspectives. This helped them develop new and innovative ways to approach planning, leading to increased enthusiasm and involvement.

> *As colleagues, everyone had to bring something else to the lesson. So you think of it so maybe from a very narrow perspective, and then they would jump in and say oh but we can also come from this angle or maybe let's start, you know, the conclusion of the lesson. Let's start with that and work our way through so just different ways of, you know, dealing with the subject matter instead of the normal usual 'here's a picture; now we study it'.*

The collaborative sharing of ideas was reported to have helped teachers plan and develop a lesson. Coraline said that it helped to get different viewpoints which could result in variations of the usual lesson plans.

> *A lot came out in terms of how would plan your lesson in the end, because it's a variety of ideas coming together. So I think it's actually better to do it together because you do get different points of view.*

The level of experience in using ICTs in the Life Sciences department varied greatly, with the two younger teachers with different levels of experience was useful, in that those with more experience in technology, pedagogy or content could assist others being more comfortable using ICTs than the older teachers. Selena reported her collaboration among other statements as:

> *If you have a cross-generational department to help teachers who aren't naturally inclined to use ICT's, then it's helpful because you (are) working in collaboration with each other. (Selena)*

4.2.2 Collaboration and division of responsibility

A challenge experienced by senior members of the department was the technological knowledge required to integrate ICTs in the lessons. While Tina reported that she did use ICTs, it was not one of her strengths. The ICT resources used in lessons were developed together with the other teachers and shared.

> *I try as hard as I can to use the IT which is relevant to me in every single lesson. I don't do the go home and send me an answer sheet thing. I haven't done that yet, but I could see that later on I would once I have become au fait with it, I would use it excessively.*

All teachers said that the collaboration that they engaged in did result in some benefits. A critical advantage was the division of responsibility for the tasks that teachers had to complete as part of the process.

> *In our department, we have two very experienced teachers brilliant, brilliant, brilliant in terms of how to get content across - what's important? What's focused on? Even in terms of the assessment by the government. What are the things that are very common and then we have two very young teachers, who actually is able to, who we are lot more up to date with technology and how to use it and even is more willing to try it and so that combination of experience and sort of enthusiasm and new ideas. (Bruce)*

The more experienced teachers were responsible for the content, while Bruce and Selena focused on the use of ICTs. While the work was divided among the teachers, they did not focus solely on their area of expertise. Instead, they led these areas while the others participated.

> *So Bruce (pseudonym) had used a Kahoot before, so he set up the Kahoot and then he kind of trained everyone how to use it. And then I needed, it was my job to find mind mapping. So it, kind of, worked like that. (Selena)*

The process initially was, actually, quite easy for us or for myself because I was really being guided by the two younger teachers in my department. (Coraline)

Coraline confirmed that the younger teachers helped by guiding in terms of the usage of ICTs. Through their guidance, she gained confidence in the process and even suggested that the process was relatively easy.

4.2.3 Collaboration – Previous Experiences Vs During Lesson Study

The teachers in the Life Sciences department claimed to have previously worked collaboratively.

We already are very collaborative with how we work, but you could see the benefits because I know that other departments are not like that. (Selena)

While they had worked collaboratively with each other in the past, teachers' interactions were limited to discussions about the completion of syllabus and other routine tasks.

The normal working together would be run-of-the-mill, talking about those syllabus content and marking and who sets what test. That's your normal mundane. This took us away from all that, you know, this was completely away. It was a different mind-set. It was fresh. I would say, you know, we've all ran with fresh ideas that we haven't really put into practice before so I think you know definitely. It took us out of our comfort zone a bit. (Coraline)

The Lesson Study programme was said to help teachers experience a different type of collaboration. While the process did result in a level of uneasiness, teachers displayed renewed motivation and enthusiasm. Teachers also reported a positive change to the working relationship stating that through involvement in the programme, they had achieved higher levels and enhanced quality of collaboration.

It added another dimension to our professional relation to one another, which is quite good. So we enjoy rather than sitting around saying where are we in the syllabus everybody. (Bruce)

It was fun sitting there with two older teachers and then the younger ones or like trying to figure out software together, figure out apps and things like that *and then kind of coming back after doing a lesson and then having much to talk about in terms of how it would work. What were in the things we would struggle with? Some of the frustrations around things like the internet or children who left their stuff at home, etc. etc. It just added a new layer. (Bruce)*

The process emphasised collaborative work rather than a hierarchical system where the Subject Head is responsible for the dissemination of all knowledge. Teachers worked collaboratively and assumed leadership roles based on the skills and knowledge they possessed rather than the position they held. In this case, junior teachers who had the technological skills led in the area of ICT integration.

4.2.4 Lesson Study and teacher isolation

Tina was the most senior teacher in the Life Sciences department. She also indicated that she was not very confident in using new ICTs. However, through engagement in the process, she said that she felt involved and part of a team.

They were very willing to share with me even though I didn't do it. They would say these are the answers to the questions and whatever. You know, this is what we said, and I think this is very good. (Tina)

They were very helpful, and they try to keep me in the loop. Although I wasn't in grade eight, but they did try, and they sent me all the stuff, and we work together on that Kahoots thing and we you know as he was doing it as he was although he was working the machine. We were all watching and integrating with him. So it was a very worthwhile experience. (Tina)

All members of the department echoed this message. The lesson study process assisted in getting teachers together when they usually would not have. By meeting more often, sharing of resources and more significant personal interactions were facilitated.

You definitely do feel less isolated when you are receiving, like, an e-mail with a really cool video that somebody found on your departments sort of e-mail or if you are busy working and someone's made a template for marks that needs to be put in and made available to everybody, or there's excitement on the life science WhatsApp group because someone's found a website with *past papers that the students can use, and we can make those available to them. (Bruce)*

we sat together, and we were all focused on one topic, and everyone brought their ideas to the table. So in our case, definitely because it is true. You sit by yourself, you do your own planning, and you don't really talk to others because there's never time, but you find that if you do this and it's now planned you're actually saving time in the long run, so definitely helped. (Coraline)

By working as a team and dividing up the work, everyone was involved. In this way, each member of the group reported that they felt valued. Teachers said that the collaboration that they experienced helped reduce the feeling of isolation that is usually associated with the teaching profession. Through collaboration, teachers were able to hold leadership responsibilities that they would otherwise not have. While the collaboration experienced was different, teachers said that it added another positive dimension to their working relationship.

4.2.5 Teachers' experiences of the Lesson Study process

Teachers experiences of the Lesson Study process for the integration of ICTs were generally positive. Bruce found the structure useful.

I think like that for me that was a like a really helpful formative thing for me and it just like even well prepares you for your own lesson, because you are sitting thinking through the structure, the things that you will include in various times of your lesson. You have a much better idea what you're going in to do, which is very helpful. (Bruce)

By engaging in the Lesson Study process, teachers reported being better prepared to teach lessons. The structure that teachers were required to follow also assisted in helping teachers reflect on the teaching, therefore improving the quality of the instruction.

Selena enjoyed the process since and stated that

this one was really nice because it gave you kind of like the theory, and then it made you make it practical, which was helpful, and that's supposed the design behind professional development.

Teachers reported being forced out of their comfort zones and made to be innovative and creative. This, they said, helped reduce the monotony of teaching.

> *I thought it was very innovative and really helpful. (Tina)*

> *What this has done is it's forced us to be innovative and creative, and that's what you need when you're a teacher. Sometimes the week in, week out, of teaching can be very monotonous. (Bruce)*

Bruce was of the view that the process followed during the study should form the basis of good teaching.

> *It sounds I think like this idea of preparing something, thinking it through, executing it, reflecting on it and proving it, executing again. I think that's the foundation of what should be a good teaching preparation and execution.*

The result was lessons that were structured ICTs integrated effectively.

> *And so I think what was lovely, well as you look forward to these lessons because the kids came to life, they so enjoyed it when we were sitting right? I think I was going to do this game on photosynthesis and you saw them getting all competitive and then it was a race between me and them and that brings in a new aspect to every lesson. You feel secure because there's a structure and you are so excited.*

Bruce regarded Lesson Study as a very useful tool to develop teachers professionally. The process, he states, has clarity in terms of goals and structure. Teachers were aware of what was required and had to be actively involved to benefit from the programme.

> *There's clear goals. There's a clear application, ... you have to be engaged with it.*

4.2.6 Teachers' experiences of Lesson Study compared to previous programmes

Previous professional development programmes were held in large groups in the school staff room. A company specialising in teacher development would be hired to provide a two-hour presentation on a topic chosen by the senior management of the school. Courses were held once each term on a Friday afternoon. The course usually took the form of a PowerPoint presentation followed by a discussion. In some cases, the course facilitator planned for group discussions. Teachers in the study were asked to compare their experiences with Lesson Study and previous professional development courses that they had attended.

> *One of the issues I suppose with the professional development that we receive when you get a three-hour lecture is often it's hard to decide how to translate that into a practical component. To hear all these things, to me like what does this have to do with teaching? Or how would I implement this in the classroom? And this one was really nice because it gave you kind of like the theory and then it made you make it practical which was helpful and that's supposed the design behind professional development is that they would be an increase in your ability to educate within the classroom and find some of the other ones, like the translation from the workshop to the classroom doesn't ever happen. (Selena)*

When Selena compared previous professional development course to the Lesson Study programme, she identified a critical difference. The Lesson Study programme could be applied in a real-world teaching environment, while previous courses were theoretical and difficult to translate into practice. Coraline echoed these sentiments.

> *This (Lesson Study) is content that we actually use in the class. Sometimes we have professional development, we have speakers, and it doesn't quite relate to what we're doing in the classroom. The talk is really nice, and you know enjoyable, but you don't really come out of it.: Oh, I can use this aspect or that aspect. Whereas this was completely focused on what we do in our lesson, in Life Sciences. So I quite like that because you know, it's useful, usable stuff. So definitely very effective. (Coraline)*

While previous professional development courses were valuable, teachers found it challenging to integrate the lessons learned into classroom practice. Lesson Study, however, resulted in the development of work that was meant to be used in the classroom.

Bruce regarded the simplicity of the programme to be an essential factor. The practicality and the emphasis on classroom integration, rather than theory were considered significant.

> *I think like a lot of the beauty is like a lot of the jargon that you kind of learn and sort of academic teaching like has very little bearing on the sort of on*

the ground. It means something to the academics, but it doesn't have a great deal of meaning to those who are actually doing it. But sometimes this is very practical. It's very doable and so to actually make it possible for ordinary laypeople, so to speak, to do I think makes all the difference.

The timing and duration of the Lesson Study programme were regarded as better than previous teacher development. The stages of the Lesson Study programme were scheduled when teachers were available as a group. Each phase involved active participation by the teachers and was held over a long period.

It wasn't on Friday afternoon when everybody was half asleep, and just someone talking. You're actually hands-on, and you really got down to creating a lesson, and there was a lot of input. So it was a very joyful experience. (Tina)

It's kind of spaced out over a period of time. There's clear goals. There's clear application. There's you have to be engaged with it; otherwise, it's not going to work for you. (Bruce)

Bruce appreciated that teachers were actively involved in their learning rather than observing. He also regarded it as vital that he was able to learn from colleagues within the same department

Just the learning together I think is quite invigorating actually because you're sitting there with people and you're not perfect. You're not bored out of your mind. Sometimes you could be at another training. Actually, I was sitting there trying to figure it out, trying to make it better and there's always something that you can learn. (Bruce)

Bruce and Tina both remarked on the importance of the collaborative learning that they experienced and the benefits of the smaller groups.

It was one-on-one. You helped each group deal with whatever the issues were and then luckily we had Bruce (pseudonym) who was very into this, so he led the band. But everybody came with so everybody learned something. (Tina)

I do think for busy professionals who, to plunk them in front of a speaker for a very long period of time. It's only moderately effective. (Bruce)

While other professional development programmes are considered time-consuming and an inconvenience, Bruce mentioned that the Lesson Study process felt very different.

> *It's quite funny we've spent hours on this way of learning, but it hasn't felt like a burden because these hours weren't all in one space at one time. If you tell people you're going to spend five to six hours at a training, they will probably riot. If you have done it like this where there are these hours, these little pockets and things along the way with a very clear improvement and evidence of a kind of effective process at the end of it that I think, I was a lot more willing to buy in, and it could potentially work for a number of different teachers.*

The critical factors that differentiated Lesson Study from previous professional development programmes were: the time frame; the duration; the teacher involvement; the inter-departmental collaboration and the content. Teachers considered these factors as significant when determining the success of a professional development programme.

4.2.7 Reflective practices

Reflection on the various stages of the Lesson Study programme is an integral part of the process (see Figure 1.1). Bruce and Coraline explained how, through engagement in the process, they were able to reflect on what they were doing in the classroom.

> *With this process you're almost forced to stop, to reflect on actually how you can get that idea or explanation of a system, or something like that across in a way that's different, new and possibly even more effectively for a generation that is very technologically saturated that everything they do is technology. (Bruce)*

> *I always thought that I was quite good at this IT thing, you know, I thought I was on top of it, but I didn't realise they were so much more out there since the last time I looked. (Coraline)*

Bruce and Coraline were able to reflect on their teaching and make changes that they thought would help them be better at it. Changes to pedagogy were made where necessary.

> *I think the one that forced me to look for innovative ways to actually teach a topic because it's very easy, especially if you're charismatic or you know the*

material, and you know, kind of what you need to go, to just do the old traditional style of teaching, where you are standing up in front holding their attention. (Bruce)

My own teaching style is very much like, there is a preparedness but often is a very much seat-of-the-pants kind of teaching, but even in this period of having to make sure that I had Kahoots loaded, various PowerPoints, videos, things. Like it's actually affected even my senior classes and things with everything before the lesson is now set up really so that there's a more seamless transition between human engagement and technology, which is great. (Bruce)

Teachers reported that during the Lesson Study programme, they were forced to reflect on their teaching practices. By reflecting on how they taught, teachers were able to make changes where necessary. Bruce mentioned that the discussions held during and after the reflection phase had helped teachers take cognisance of their delivery of the lesson. The reflection as a group provided further insight.

The reflection process afterwards was quite cool with our department because the guys were having those conversations naturally already of this. Actually, that way that you thought that was a little bit lacking in certain ways or you didn't give the full picture there—things like that.

4.2.8 Barriers experienced by teachers

4.2.8.1 Teacher workload and lack of time

The barrier identified by all teachers that prevented them from being fully involved in the Lesson Study programme was time.

Time always seems to be the one, and I think that that's a common shared time that we can guilt-free use would be both our biggest obstacle because otherwise there is stuff to do. There's marking this, Grade Head duties, especially when the teachers in our department are stretched out across various responsibilities around the school. And so I would say that yeah that probably was like one of the biggest challenges for us is just finding that time to make sure that we were together. (Bruce)

That would really only be time, but it's like with anything, you know, what obviously now has to sit down because you already have your lesson plan in mind. Now you have to sit down and think of a differently you have to create and time is an issue. (Coraline)

Within our department, they were two or three meetings/trainings, and one of us wasn't able to be at because of something like detention duty or extramural activity or batting. So that was probably the only thing in terms of all four of us being available at the same time without some other commitment getting in the way.

We battled to find the time when we were all free to get together, and we were only doing one lesson at a time. So if you think that the idea is that this is used for every lesson that is taught, there just wouldn't be enough time. (Selena)

Teachers were all involved in the co-curricular programme at the school, and two had held leadership positions. Finding a meeting time when all teachers were available was difficult since many teachers had other school commitments.

Selena suggested that teachers should have a lesson built into the timetable when they could meet to discuss new developments or engage in professional development.

If the teachers got timetabled in a half an hour or whatever a week. Let's look at a new ICT or a more effective ICT. But yeah, without that time it's hard for the department to get together. (Selena)

4.2.8.2 Resources and infrastructure

Power cuts due to load shedding were reported to be a problem. Teachers said that they had difficulty preparing for ICT use in lessons when there was the possibility of an interruption in the electricity supply to the school. Resources like projectors, desktop computers and Wi-Fi could not be used. Any lesson planned around these resources would have to be abandoned.

I think load shedding in the beginning part of the year is a bit tricky and so to conduct a lot of the technologically, exciting lessons because you never know if your lessons are going to be interrupted or not. (Selena)

Teachers stated that learners often did not have their electronic devices available for use in the classroom. The electronic devices were often used for social activities and would require charging before lessons. Since limited charging stations were available, learners were left with inoperative devices.

> *Students whose devices had very poor battery life by the stage in the year because of overuse, abuse, they're charging things like that. Students who just had lost their devices or broken them. I think that was the one difficulty because you want everyone to be involved. Everyone to be able to take out their own device. (Bruce)*

> *If we are wanting to use ICT's then we need to have the correct equipment for that ICT's, and so that the kids are supposed to have, learners are supposed to have their own tablets, but our biggest issue was the use of their tablets. So a lot of them by the time we use them are lost or stolen or broken, not charged, not connected to the internet. So we're wasted like 20 minutes of the lesson trying to get them connected. (Selena)*

Coraline also mentioned that learners would sometimes not have access to the Wi-Fi. Free Wi-Fi was provided to learners at the school. It was their responsibility to ensure that their devices were registered on the school's network. The IT manager was available during lessons to fix connectivity issues; however, this resulted in a loss of instruction time.

> *We sometimes battle to get their tablets connected to the school Wi-Fi. So we found that that took up a lot of time at the start of the lesson to get everybody connected and we actually had to have Mr. IT Manager in there to help with that. (Coraline)*

The availability of relevant resources was a problem for Life Sciences. Much of the resources available to teachers were not related to the South African curriculum. Teachers had to spend additional time modifying these for use in their classrooms.

> *It's hard to find something that is related directly to the South African context or their grade context. So I mean like in Science you do electricity in grade 8, grade 9 and matric and so a lot of this online stuff that's available, it's never quite tailored. (Selena)*

4.2.9 Teachers' justification of their experiences

Teachers within the life sciences department responded positively to the Lesson Study programme. They were able to list several benefits of participation in the programme and indicated an interest in using the Lesson Study model for intra-departmental professional development.

> *I think we're very possibly will start including in some elements of this which we did already but not as intentional as we have over this time. So I think like what we could do is possibly like we're wanting to revamp a number of sections of our syllabus technology wise and power points and all sorts of things. And so I think that probably will make a good avenue for this to be applied. (Bruce)*

Bruce considered the Lesson Study programme to be valuable and therefore considered using it to improve on the future planning and use of ICTs within the department.

Teachers valued the collegiality and collaboration that resulted from their participation.

> *I like the idea of like sharing your content knowledge and your application of it to others. I think we do run a risk of being what like selfish with our intellectual properties or whatever and I think that this is a nice way to break that down. (Selena)*

> *You weren't having to come up with the ideas by yourself. You could, like there was a plethora of, like, ideas and things that people had used and both were effective that other people had never used before. (Selena)*

The duration of the project required teachers to expend a large amount of time working through the various stages. While it would have been easy for teachers to leave the study, they demonstrate high levels of self-efficacy and motivation.

> *So it was a lot of fun actually to sit down for some of the lessons. We had a free lesson together sitting and thinking let me try it software. Then we tried various types—the mind mapping software. We tried different types. Like no, this would never work. And then we got out our own personal tablets, and we were trying it on our tablets and things like that. (Bruce)*

4.2.10 Teachers perceptions of the effect of Lesson Study on their teaching

Bruce said his involvement in the process had resulted in him being more prepared for and innovative in the way he delivered his lessons. He regarded this as a positive experience indicating that it helped give him a greater sense of professionalism.

> *I think it's been a good improvement me and the preparedness even if to think through the syllabus instead of just saying what's on the next page? Where are we going really? It feels like you're being a much more authentic professional teacher actually to be prepared for a lesson in that way*

Coraline stated that the programme had helped her use ICTs more effectively in the classroom. She justified the increased use of ICTs by saying that learners would acquire more knowledge through its use since they were exposed to it daily.

> *I think it is very effective because the Young Generation obviously learn better with IT and screens and they interact better, that's what they are used to do in life out there. So I think if you bring it into the classroom, you can certainly make it a very effective method.*
>
> *I'm an old teacher, and I do see that if you don't change your way of teaching, you are going to lose these children. Not every lesson has to be a multiple, fun, good or but you certainly have to bring it in at times just to keep their interest. (Coraline)*

The collegiality and support within the department were evident in the way the teachers interacted with each other. This played an essential role in the development of teachers' confidence in using ICTs in the classroom.

> *I think like what we saw in our department particularly when we had all the teachers who are less au-fait, is that the right term, with technology and kind of their baseline was PowerPoints and videos. And then to start exploring new things with them and then seeing a teacher who's being a teaching for 30 years doing a Kahoot in her classroom or a mind mapping software and coming out successfully was very, very cool. (Bruce)*

While teachers were motivated and willing to participate in the programme, the primary factor that hampered their involvement, was the amount of time needed to work through each Lesson Study cycle.

> *I think the only disadvantage would be the time for the initial setup which we identified in a lot of our things. (Bruce)*

> *The intentional collaboration was nice to find specific things but on the other hand the time factor is tight so it would be like if there was like a streamlined process. (Selena)*

> *I mean a lesson in a week to just sit and focus on the subject because people don't really have time to go home and create all of this. We found that we created everything at school together and it actually happened quite fast because all three of us, so yes an extra lesson somewhere would help. (Coraline)*

Teachers did suggest that by having a particular lesson built into the school timetable for teacher development and preparation, the barrier associated with time could be overcome. Teachers could use this time to work and develop materials collaboratively.

4.2.11 Teachers perceptions of the Lesson Study process

Teachers viewed the Lesson Study process for integrating ICTs in their teaching as an effective one. The benefits over previous professional development programmes included that it was relevant to what was being done in the classroom.

> *This one (Lesson Study for the integration of ICTs in teaching) was really nice because it gave you kind of like the theory, and then it made you make it practical which was helpful, and that's supposed the design behind professional development is that they would be an increase in your ability to educate within the classroom (Selena)*

Selena and Coraline shared similar views on the Lesson Study process.

> *This was completely focused on what we do in our lesson, in life sciences. So I quite like that because you know, it's useful, usable stuff. So definitely very effective. (Coraline)*

Tina said that she felt strongly that the process was effective at achieving the outcome set out at the onset of the programme. She believed that any form of professional development that helped teachers integrate ICTs in their teaching was useful. On reflection on the process, she considered Lesson Study to be valuable and enjoyable. She was impressed by the structure of the programme and the active involvement of the teachers.

> *I think anything to do with IT and dragging teachers out of their old ways is a good thing.*
>
> *I saw people working that would never have got off their butt and done it. We would never. I strongly feel that it was a unit of work that we had to get done. It was advantageous to those teachers. It was a very, and you gave such excellent guidelines, and yes, I thought it was very worthwhile. Very worthwhile. I think we learned something and we would not have learned anything this whole year if you hadn't done it.*
>
> *I just thought it was extremely advantageous to us. I thought it was; we were so lucky to have someone giving us this opportunity to learn in school in our own time. You know what I mean? I thought that was if anybody didn't participate, there were crazy. They were crazy. (Tina)*

Bruce perceived the Lesson Study process to be valuable since it helped teachers formalise the lesson planning process. By following a formal procedure, opportunities for reflection were made possible, thereby assisting teachers in producing more effective lessons.

> *I think it's a very effective process and it's thorough you actually sit, and you think through what you're doing in the lesson, and you're able to structure it a lot more than sort of seat-of- your-pants-teaching which I think often takes place.*

Bruce stated that the process had helped with collaborative work within the department and also assisted in improving the motivation and enthusiasm of teachers.

> *I think that was the only thing otherwise I think our team loved the process, we loved what we got to do and, everyone was very keen and very on board. So it like it made it very easy to sit down, exchange ideas, show someone something with being very elated.*

We had to apply our minds and was a cool challenge. I think that the nice thing about our department is that they enjoy a challenge to try and overcome. So this was a cool challenge to try and make sure that we did well in.

Bruce also indicated that there was an improvement in the way he delivered his lesson. He reported improvements in planning, reflection and integration of ICTs in his teaching.

And so I think what was lovely, well as you look forward to these lessons because the kids came to life, they so enjoyed it when we were sitting right? I think I was going to do this game on photosynthesis and you saw them getting all competitive and then it was a race between me and them and that brings in a new aspect to every lesson. You feel secure because there's a structure and you are so excited because it's for the kids

4.2.12 Summary

The qualitative data for Case Study one was presented in this subsection. Data from the interviews with the Life Sciences teachers, documents and lesson observations were presented.

The data indicated that the Life Sciences teachers experienced Lesson Study for the integration of ICTs in their teaching as an effective form of teacher development. The responses from teachers were generally positive. A key barrier identified by all teachers was the amount of time required for participation in the programme.

Overall, teachers responded favourably to the programme citing many benefits such as improved collaboration and new and innovative approaches to the use of ICTs in teaching. The data from the three case studies are discussed together with the quantitative results in chapter six.

4.3 THE FINDINGS OF CASE STUDY TWO – ECONOMIC AND MANAGEMENT SCIENCES

Case study two was conducted with the Economic and Management Sciences (EMS) department at Current High School. The EMS department was made up of Thiro and Lisa, who were the most senior teachers in the department. Thiro was the Subject Head of Business Studies, and Lisa was the Subject Head of Accounting. Vashnie had ten years of experience teaching Accounting and EMS, while Johno was the youngest member of the department in both age and experience. Their demographic information is presented in the table below.

Table 4: Demographic information of the participants of Case Study 2 - EMS

NAME	SUBJECT	EXPERIENCE	EDUCATION
Thiro	Accounting Business Studies EMS	30 years. 1989 – XYZ Secondary 1989-1992 UVW Secondary 1993 EP Primary 1994 – 2013 AB Secondary 2013 – to present: Current High School	Matric. B. Paed (Commerce) B. Ed (Management)
Johno	EMS Business Studies	Lodge: Outdoor facilitator. Academy: Outdoor facilitator. Current High School: Teacher	Degree: B.A. (Psychology) Postgraduate certificate in education: intermediate and senior phase
Lisa	EMS Accounting	BMX High: 1987-2007 EP High: 2008 – March 2013 Current High School: April 2013-present	B. Comm HDE

Vashnie	EMS Accounting	10 years Current High School	B.Comm PGCE

All Economic and Management Sciences teachers were involved in the co-curricular programme at the school. Teachers were required to provide extra lessons after school or be involved with coaching or managing sport. Senior teachers had a maximum of two non-teaching lessons per day while junior teachers had one per day. Due to the limited amount of time available, previous professional development programmes were held on Friday afternoons.

The findings of the qualitative data are presented in the following subsection. The findings are presented according to the themes that emerged from the data. While themes are organised according to the research questions, some overlap of data does exist. This is discussed in the following chapter.

4.3.1 Collaboration

4.3.1.1 Structured Collaboration

One of the key benefits identified by the EMS teachers was the changes in the way they worked collaboratively with each other. While teachers stated that they did work collaboratively in the past, the type of collaboration they experienced while involved in the Lesson Study programme was different.

> *I felt a lot of the stuff I had been doing beforehand was kind of left to me to do my own thing, which isn't necessarily a bad thing. I don't mind it. But, you know, I think having collaborative work, you do get ideas that you wouldn't necessarily think of. So your argument, additional value. So I do think that this lesson study has in a way forced us to collaborate, which is a good thing, because we did spend more time planning lessons, getting new ideas. (Johno)*

> *In the past, if we find a resource, or whatever. We just simply share the resource, and then what they do with it is basically up to them, how they use it or whatever. I suppose it's the making and sharing of resources and teaching methods in it that's different. (Lisa)*

This type of collaboration allowed the teachers to work together in planning and developing new and innovative ideas for lessons. Previously, teachers simply shared resources and considered this collaborative work.

> *I mean collaboration in the past was based on older methodologies, and you know what the Department of Education requires, and it was more rigid in terms of how we adapt to things. Yeah. I mean, it was, I mean, the lesson could be, you know, varied. I mean, there's different ideas of how a lesson can unfold. I mean, new ideas always bring about new sort of experiences and fears as well. So I think that role would help in many ways to collaborate and to discuss things. (Thiro)*

Vashnie mentioned communication among members of the department had improved due to the structures that were in place. One of the norms established at the beginning of each Lesson Study cycle was that every teacher had the right to be heard.

> *It also forces you to listen to what somebody else says because you're actually working together. You're put in the situation where you've got to come up with these ideas together. You're filling out those forms together and believe it or not. There are things that you actually pick up from each other.*

Thiro mentioned that teachers were able to gain multiple perspectives on their planning and teaching when they worked together. This resulted in changes to the way lessons were delivered.

> *I mean, obviously, collaboration is important. I mean, there's no one way in which you can deliver a lesson or one methodology in which kids, if you're looking at it from different angles, you see a little bit more, you know, in terms of how you can improve things. (Thiro)*

Johno remarked that when the department worked together on the Lesson Study programme, they were able to gain new insight into their teaching, which resulted in added value to the process.

> *I think it just, you know, adds different views. You know, I tend to get my head down and have my idea and run with it and then you kind of rock-hard everything else. But working with other people, they can have a completely*

different view on something that you haven't realised. It just adds extra value. (Johno)

Johno also added that by working together, teachers' workload was reduced.

It's different from what I experienced here in terms of, you know, most of the workload is done individually.

4.3.1.2 Collegial support

The support that teachers received from each other helped them cope with the challenges they faced while participating in the Lesson Study programme. Lisa mentioned that without the aid of her team, she would not have been able to succeed in integrating ICTs in her teaching.

I think we all managed together. If it was just thrown at me. I certainly wouldn't have been able to do it.

We all just worked together, and everybody was sort of committed to helping each other, so teamwork was good. (Lisa)

The support provided by members of the department extended beyond content coverage. Instead, teachers focused on doing what was best for their learners. The discussions dealt with helping children develop a better understanding while at the same time allowing teachers the opportunity to express their opinions on the challenges they faced. The fact that teachers were able to share their feelings indicates a level of trust and support among them.

So we bring it together because we then identify, but that child might not understand it. Oh, I've got this learner and this learner will do this and will do that. So when we all sitting together all our ideas come together, all our challenges come together. So we kind of just feed off that. (Vashnie)

Vashnie noted that while she was a junior member of the department, the team had trusted her and Johno to lead them. While she did find it challenging, she appreciated the confidence the team had on her abilities.

There are a lot of challenges in terms of getting them (the teachers) to also understand the use of it (ICTs). So when it came to explaining, I would have to explain exactly how I was doing each thing.

It's very different because we each of us are learning something new. It's a whole; it's a whole different scenario as compared to here's a textbook. This is the exercise you're doing with your learner's. (Vashnie)

4.3.1.3 Improved teamwork through reduced teacher isolation

Teachers reported that through engagement in the Lesson Study programme, commonly prevalent feelings of isolation were reduced. Working as part of a team helped the teachers cope with the challenges they encountered during the programme.

We're thrown in a new dimension here. I mean, I could understand, and others could understand in the group, my difficulties that I felt in terms of adapting to new methodologies and adapting to modern technology.

So it sort of helped in a way, that I'm not alone, that there are others that are still battling and grappling. (Thiro)

Sharing of resources and supporting colleagues were emphasised in the process.

Lots of people tend to work alone. Keep information to themselves. This forced us if you want to use the word forced; it forces you to work together. It forces you to impart knowledge. (Vashnie)

we all just worked together, and everybody was sort of committed to helping each other, so teamwork was good. (Lisa)

Vashnie mentioned that the collaborative work that the team did help teachers gain an insight into their teaching. It provided the groundwork for reflecting on their practices.

When you work in isolation, you think you are better than everybody else. You fail to realise that experience whether younger or older comes both ways. So this kind of made us see exactly what each of us have, our strengths and our weaknesses.

4.3.2 Teachers' perceptions of the format of the Lesson Study programme

Teachers valued the structured approach of the Lesson Study programme. Johno claimed that the linear structure was easy to follow and helped teachers plan effectively.

I do think it's effective because it gives you a very like a nice breakdown in our structure in which to organise your activities. It's very like linear in a sense from A to B, which is nice to follow. So it does help the process being meaningful going into integrating something new.

Since the process was easy to follow, teachers could focus on the vital task of planning for the integration of ICTs in their teaching.

Lisa, who admitted to being "technologically challenged", stated that the process was structured and easy to follow.

It's pretty step by step by step. So yeah, I suppose, with experience, you could maybe miss out a few, you know a few steps, but it's structured.

You know it kind of guides you into accessing more information, which allows you to then use it. (Lisa)

Vashnie mentioned that by having to follow a structured approach when planning and participating in the various stages of the Lesson Study process, it helped teachers anticipate problems that may have arisen.

We had to write things down, kind of made it a lot more make more sense. You knew which order things had to be done and it kind of also helped to plan the entire lesson properly. You could see shortfalls before the actual lesson took place.

Thiro mentioned that the "step-by-step approach" was a refreshing change from previous forms of professional development.

4.3.3 Comparing previous forms of professional development to Lesson Study

Thiro pointed out that there were significant differences between other forms of professional development they experienced and Lesson Study.

I think the other sort of workshops and things like that is just the mundane stuff, you know, day to day stuff that we need. Obviously, we need that, but this is the ultimate. It is taking to a different level, different dimensions and different century.

While other professional development courses focused on routine activities, Lesson Study represented an extra-ordinary change in teacher development.

Previous programmes were said to have been held by people with limited experience in the classroom. Teachers felt that these were not relevant to their situations.

> *In the past, professional development was not professional for teachers. They are from people who are not teachers. People who don't know a classroom. People who don't know learners. (Vashnie)*

> *The others if you asked me what I was sat and did there I can't answer you because I felt it was just a waste of time and done by people who don't understand the teaching profession. So it's more of a corporate than for us. (Vashnie)*

The nature of the courses and the content covered in previous professional development programmes were said not to be suitable. Teachers had difficulty translating what was discussed into practical application for the classroom.

The content of the Lesson Study programme was thought to be relevant and current. Thiro found the fact that it was not laden with theory a positive aspect.

> *It's relevant to the time, very relevant to the time that we are in at the moment. Whereas, other educational programs that we did was old mundane stuff that we learned through university. (Thiro)*

One of the critical advantages mentioned was that participation in the programme resulted in gains that could be practically applied to the classroom. Previous programmes focused on the theoretical aspects of education. While this was considered useful, teachers preferred practical applications of theory rather than the theory alone.

> *You know, it's actually involved in the classroom. I mean, the majority of our job is to stand in front of the board teaching. And this does add value to that. Whereas I understand the XYZ* (pseudonym for a name of the company hired to conduct professional development workshops at the school) *things, but it's not, I would say it's not practical as this lesson study has been, which I prefer as someone who likes to do things, I'd rather be doing the practical side of things. (Johno)*

Vashnie pointed out that since the programme involved working with colleagues and developing material that was relevant to the classroom situation, it proved more valuable than those experienced before Lesson Study.

> *It's very important to understand what we need. And what kind of training we require because every school is different. So apart from calling somebody from the outside who can't really help us as much, I would prefer other development workshops being formulated along the same process, but get us to learn different things. (Vashnie)*

> *We've had people say to us stop and breathe for 10 seconds. We're teachers we don't have time to stop and breathe for 10 minutes, you know, so don't tell me to do things that's not going to work in my classroom. Whereas with this, we learned things that I can use in my classroom on a daily basis, so that's a big difference. (Vashnie)*

4.3.4 Opportunities for self-reflection

Thiro, Lisa and Vashnie stated that the process had helped them reflect on their teaching. It helped them discover what worked when they reviewed the lessons. By doing so enabled them to plan better.

> *I think in my first couple of years how they hang did the kids actually understand what I was doing and that probably was because in those days we didn't have to actually go through the whole. You know if I'd had to review my lesson, I probably would have realised that. (Lisa)*

> *Very often we forget about, you know, the pupil and how the pupil thinks. In this modern world, in the modern age of thinking and I think, you know, using lesson study in ICT's, integrating ICT's into that, actually opened our minds to the way learners learn nowadays. (Thiro)*

> *I never really put it into practice until I was doing the actual program, and I needed to put it into practice. Then it kind of opened up a whole new world for me because come coming from that, and I realise how the kids were actually reacting to it. (Vashnie)*

4.3.5 Teacher confidence

Johno reported an increase in his knowledge of the subject content and his ability to access information. By planning and using ICTs well, the lesson became a lot easier to present.

> *I think definitely my subject content knowledge improved accessing new information. Also, another way to react with the kids and makes it a lot easier and sort of, you know, instead of trying to open up documents. You can have it up on the screen and you're working with it up front, which is nice. (Johno)*

Lisa, who stated in a discussion that she had found using ICTs difficult, mentioned that through engagement in the Lesson Study programme was able to use some ICT resources that she had not used previously.

> *I have used the projector, a DVD, thanks to Vashnie (pseudonym), or YouTube clip and the kids enjoyed it. It was quite; I was actually quite taken.*

Vashnie stated that while she was not able to perform some tasks involving ICTs earlier, her confidence improved as she progressed through the Lesson Study programme.

> *I did battle with at the beginning was the downloading of the video because that's something that I honestly didn't know how to do. (Vashnie)*

Thiro stated that he was not confident in using technology in his teaching. One of the reasons stated was that he was an experienced teacher and had used methods that worked for him. As a subject leader, he believed that he needed to develop his knowledge and skills to enhance his lessons.

> *I think the knowledge itself, the insight, the, I'm not used to technology as such. You know, I haven't been involved as much as I should've. So maybe the education in that aspect should be improved on. Well, me personally, I mean, it should be getting involved more in exploring new technologies a little bit more. (Thiro)*

Thiro mentioned that the support received from members of his department helped increase motivation and confidence. He also mentioned that the structure of the Lesson Study process allowed teachers the opportunity to engage and reflect on what they were doing.

I think especially the older teachers, teaching more than, what, 15, 20 years or so. I'm not so keyed up with issues, you know, with regard to modern technology that has been used in the classroom and things like that. And therefore, you know, the lesson study process was effective and that, you know, you basically engage them, open their minds, and It got them to think about things (Thiro)

They were very cooperative. I must say, in coming to meetings and doing the lessons, in preparing, some of them just volunteered to do such a thing. (Thiro)

Johno mentioned that the planning phase had helped him become more confident in the choice and use of ICTs. By planning better, he was able to choose more relevant and new resources.

I think it does add an additional planning element to a lesson. So you're actually planning more, and you end up using new stuff, especially in the technology research and actually forces, not forces you, but it enables you to pick up more relevant content, for want of a better word. (Johno)

4.3.6 Barriers experienced during the lesson study programme

The one barrier identified by all the participants of the EMS (Economics and Management Sciences) group was time. All participants indicated that due to their teaching load and co-curricular involvement, finding time to work together was a problem.

Johno mentioned that

In terms of just having a heavy schedule does add extra workload initially because it's a new system.

It's hard to get everything else done, especially if you're a teacher involved in sport and other things. It's an extra workload.

I would have liked to, actually, be a lot more proactive about it. But it did come at a rather busy time for me because I wasn't able to give it as much attention as I would've liked, ideally.

Lisa, who admitted to having trouble adjusting to new situations said

Because it's new, the ICT, the change and the newness. It takes time for me.

She also mentioned that the lesson study process takes time to engage effectively.

I don't know because that's also it (The Lesson Study process) takes a lot of time.

Thiro, who also had many school commitments apart from teaching, like sport, Grade Head responsibilities and subject leadership, stated that time was a major factor that affected his involvement in the programme.

There must be some space as well to involve ourselves a little bit more extensively with this. I do find that there are time problems in terms of completion of syllabus versus utilising different technologies that we have. It is sometimes time constraining.

It was time-consuming. (Thiro)

Apart from time, Johno reported problems with the ICTs used. This affected his planning and use of ICTs in teaching.

I had to try to plan a lesson but the projector, in my classroom wasn't working. The PowerPoint wasn't working once they fixed the projector. So it does. I think in order for it to be very successful, we need to have the right tools in place to do it. (Johno)

Lisa also stated that it was difficult to change the way teachers taught when they used similar methods for a long time. She called this a "reluctance for change".

Well to try and actually integrate it when you're so used to your own your teaching methods. It's, the change is difficult. (Lisa)

4.3.7 Teachers' justifications for their experiences

4.3.7.1 Teachers' perceptions of their abilities

Teachers perceived self-knowledge of their technological, pedagogical or content knowledge played a role in the way they approached the Lesson Study programme. For example, Thiro stated that he was afraid of trying new methods in his teaching, which may have hampered his progress.

> *I think there's a lack of knowledge, basically, in terms of my part itself. And I think it's, it reflects on the older teachers itself, you know, in that entire issue of being scared, of getting into involved in new methods and methodology and things like that. (Thiro)*

Lisa mentioned that her challenge was the use of ICTs.

I'm, it's more the use of technology because as you know, I'm a little bit limited. I just think I'm very set in my ways. And it's not probably that I can't do it, but at this stage, why invent the wheel? (Lisa)

4.3.7.2 The perceived value of the Lesson Study process

Teachers stated that the Lesson Study process was a valuable way to help them integrate ICTs in their teaching. The advantages mentioned were the importance of collaboration, the development of new teaching methods, and the logical but easy to follow, structured approach of the process.

> *Anything in education that is obviously going to enhance a lesson or enhance education itself would be definitely beneficial in the long run. And definitely, I would like to see this program actually develop and you know, more sort of meetings and more sort of collaboration takes place along these lines. (Thiro)*

Thiro believed that the process would ultimately be beneficial. He stated that it helped him develop innovative approaches to his teaching and allowed him to gain an awareness of how he taught his subject.

> *It opened my eyes to new and different ways of actually doing things. It gave me; it empowered me to a large extent. If we, haven't been to the program itself, then we will probably be in wrapped in our own way of thinking. So it brings, as I said, a different view, a different dimension, a different methodology. It opens our eyes to new ways of actually exposing information as well or assimilating information as well. (Thiro)*

Johno mentioned that he had had the benefit of being able to reflect on his previous approach to teaching. By being able to reflect on his teaching, he said that he was able to make changes. Also, he claimed that it helped increase his content knowledge by researching and accessing new information.

> *You're more engaged in contemporary issues as opposed to maybe stuff you've been doing for the last five, ten years and just out of habit. Now you research new information, and you're accessing it, so it increases your content. (Johno)*

> *Like I said, I think it does add value. So anything that's going to be an improvement should be something that we should consider. (Johno)*

Lisa appreciated the logical and sequential process. She said that the format of the process helped her follow and complete tasks without becoming overwhelmed.

> *A step-by-step (guidance) through the process, was a bit of help. (Lisa)*

Vashnie said that the programme involved real content. Teachers were able to use this in an authentic classroom situation. There was no fixed method that teachers had to use to integrate ICTs in their lesson. They had to work together to find what would work for their situation.

> *It works with real content, and nobody is trying to tell you (to) do it in a certain way. You're saying here's your ICT, here's your content. Marry them both the way you feel is fit. (Vashnie)*

4.3.7.3 The effect of engaging in Lesson Study on teaching

Vashnie noted that through involvement in the process, she was able to develop new skill and knowledge that could help her in teaching.

> *So from everything that stemmed from that particular lesson kind of opened up a whole new teaching aspect for me. (Vashnie)*

She also claimed that her knowledge of technology and her technological skills improved. She was able to use a variety of technical resources that she previously thought was not suitable for her subject.

I didn't for one second think I could use the very same thing for accounting apart from putting up a memo on the board, or you know, whatever but then what I started doing was I started using the board for my ledgers. I started using… so it kind of made me realise that I can use the same ICT's in another subject which opens up now the ability for me to use it across my classroom. (Vashnie)

Thiro did admit to being apprehensive and a bit afraid of the process. He, however, believed that this form of professional development was a meaningful way to help teachers develop their knowledge.

I am an older teacher. I'm teaching for more than 30 years now, and I think I'm a bit scared of the process itself. We still hang on to a bit of the older methods, but I think this is the way forward… I think this is taking a new dimension and very relevant to the times that we are in at the moment and I think it's gonna be the future. (Thiro)

Thiro noted that by being exposed to new technologies, he realised what was available. Exposure to new technologies helped him develop a new way of presenting content.

And now with the new technologies that we have and the new availability of new ways of actually exposing information, I think, you know, we as educators need to actually, you know, step up the game with regard to that. (Thiro)

By engaging in the Lesson Study process, Thiro reported several gains and improvements in his teaching.

I'm using ICT's and using new technology. I mean, I could share information so much more easily through e-mail, through Google classrooms and through various other methods. You know, in the past that wasn't so, so, so, so easy to do. And you're not so isolated as a teacher. I mean, I can communicate with my pupils, my colleagues on various platforms. (Thiro)

4.3.7.4 Learner factors

While Thiro found that learners often abused the privilege of using a device in the classroom, by using it for social activities rather than educational ones, he believed that it is vital that learners are exposed to technology in teaching.

> *I also find that sometimes students use this to their advantage. You know, sometimes beneficial and sometimes not. You know, they take advantage of technology to do other things as well. So we've got to be a little bit more guarded in that respect.*
>
> *If you look at today's world, well, information technology is vital. Pupils are actually highly engaged with technology and things like that. (Thiro)*

He stated that teachers needed to adapt their teaching so that it is more relevant to the way learners learn.

> *You know, we need to change our learning techniques and learning styles and teaching techniques and adapt it to the learning styles of the pupils in modern-day. (Thiro)*

Vashnie mentioned that pedagogical approaches needed to be changed. She believed that learners needed visual or auditory stimulation to help them learn, and ICTs would be a suitable means to provide this.

> *They need something visual. They need something that's audible. So when we try to integrate this, it kind of makes them realise we kind of trying to do things that make them excited and makes their learning far more interesting (Vashnie)*

Johno stated that technology integration is an essential aspect of teaching since learners are exposed to technology recurrently daily. Since learners are exposed to technology often, he believed that it would be a natural progression in his teaching if technology became as common as books in his lessons.

> *We are in the technological age. The kids now are more knowledgeable. I should think of myself as technologically clued up*

They are used to technology now. So I think it's actually almost more natural for them to look at a tablet than to look at a book at this stage. So it is the way the world's going. (Johno)

4.3.8 Summary of findings

The qualitative data for Case Study two was presented in this subsection. Data from the interviews with the Economic and Management Sciences (EMS) teachers, documents and lesson observations were presented.

The data indicated that the EMS teachers experienced Lesson Study for the integration of ICTs in their teaching as an effective form of teacher development. Teachers' responses were generally positive, with teachers mentioning several advantages to being involved in the Lesson Study programme. Teachers reported improvements in teaching methods, technology skills and knowledge, and intra-departmental collaboration. A critical barrier identified by all teachers was the amount of time required for participation in the programme.

Overall, teachers responded favourably to the programme citing many benefits such as improved collaboration and new and innovative approaches to the use of ICTs in teaching.

4.4 FINDINGS OF CASE STUDY THREE: MATHEMATICS

Case study one was conducted with the Mathematics department of Current High School. The participants of this study were a senior female teacher, Wendy, and two teachers with ten and eleven years of teaching experience, respectively, Marike and Dustin, and Shikaar- the youngest of the group. Their demographic information is presented in the table below.

Table 5: Demographic information of the participants of Case Study 3- Mathematics

NAME	SUBJECT	EXPERIENCE	EDUCATION
Wendy	Mathematics Mathematical Literacy	37 years – Level 1 Educator. Lead Educator for DOE for learners (Matric intervention Programme) and educators (capacity building). NSC Marker.	Senior certificate. JSED BA ACE – Maths FDE – Education Management
Marike	Mathematics (FET and GET) Mathematical Literacy Physical Sciences Life Orientation Technology	Educator since 2009 (10 years) Matric marker (marker of NSC November exams, Supplementary exams, remark in Feb) Attendance to several developmental workshops. Academic head of High school (Previous High)	BSc Health Sciences (Psychology and Nutrition) 2006 BA Honours (Humanities – Psychology) 2007 Registered counsellor (HPCSA) 2008 PGCE (2012)
Shikaar	Mathematics core Mathematical Literacy	Previous High (2015-2019) Current High School (2019 – current)	BEd (FET) Mathematics and Physical Sciences.
Dustin	Mathematics Natural Sciences	Department Head Mathematics – Previous High: 2009-2018. Subject Head Mathematics – Current High School: 2019 – present.	National Senior certificate Bed BEd : Hons

		Educators (11 years) counsellor. Examiner. Matric marker / Senior marker. Grade controller. Academic Grade Head.	

All Mathematics teachers were involved in the co-curricular programme at the school. Teachers were required to provide extra lessons after school or be involved with coaching or managing sport. Senior teachers had a maximum of two non-teaching lessons per day while junior teachers had one per day. Due to the limited amount of time available, previous professional development programmes were held on Friday afternoons.

The presentation of the findings is done based primarily on the research questions of the study:

> How do teachers' confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study?
>
> What are teachers' experiences in using Lesson Study as a strategy to develop their competence in integrating ICTs (information and communication technologies) in their teaching?
>
> Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do?

The findings are presented as cases and major themes listed as sub-categories within each case.

The following three items guided the presentation of data: the effect on teachers' confidence; Teachers' experiences of Lesson Study for ICT integration; and the explanations behind teachers' experiences. The qualitative findings are obtained from the interviews, document analysis and lesson observations. The bulk of the qualitative data was obtained from the interviews. Data obtained through document analysis and lesson observations were used to support the interview findings and assist with triangulation.

Pseudonyms were used for all participants to ensure anonymity. The pseudonyms used were chosen so that the gender and ethnicity of the participants were preserved. The findings of the study are presented below.

4.4.1 Facilitating effective communication and teamwork

The establishment of rules at the start of the programme was considered important. Shikaar mentioned that due to the different personalities present in the Mathematics department, the norms helped participants voice their opinions and be heard. Each member's opinions were heard, acknowledged and considered.

> *Because of those little norms and stuff we came to a general consensus rather than fighting with each other on topics, you know, as I said in the previous one where we were all bouncing ideas off each other. No idea went pretty much unacknowledged, you know, not acknowledged. We acknowledged all the ideas and obviously came to conclusions of which is the easiest and best ways to go about teaching this. (Shikaar)*

Shikaar reinforced his view that while some ideas may not have been considered to be suitable during discussions, all teachers were heard, and this was done respectfully. He mentioned that during the discussions teachers did not feel that their ideas were being quashed. This allowed teachers to express their opinions without fear.

> *You know obviously in every department there's going to be people that are a little bit more vocal than others. But again, even with that being said, we don't really experience many obstacles working together when I say that yes, they may have been some ideas that were not as good as others, but nobody actually, you know, put anybody down. Nobody made someone feel beneath what they are or anything like that. (Shikaar)*

Dustin, the Subject Head, said that the process made him listen to the members of his team and acknowledge and consider their views. While he was usually the one reporting to the mathematics in the past, this process represented a change in mind-set. Dustin had to acknowledge that others may have better ideas than him. He also reported developing other valuable teamwork skills like listening skills. By listening, he was able to reflect on his teaching.

> *At first, it's quite difficult because you want to talk when others are talking, and you want to give your input. But I think the nice thing about the process is you as an educator, even though you might be the fountain of knowledge you've actually got to sit down and you listen which is something which I took*

back from this whole entire process is that you might be good, but you can be better at your subject.

Dustin also mentioned that the process gave teachers, who were usually reserved, a chance to voice their opinions.

When we have our meetings etc. so that sometimes educators they'll be very knowledgeable, but they won't talk in the meeting and they very reserved, but when it comes to action and teaching they're phenomenal. I think that actually helps with future lesson planning. (Dustin)

4.4.2 Teachers' experiences of the Lesson Study process

Dustin stated that the process was logical streamlined and effective

I think the whole entire process with a lesson study, setting up the norms, the topics, identifying the goals, lesson plan etc. It was very effective.

Teachers stated that the process was valuable and had several advantages. They reported that they were able to collaborate and share ideas and experience.

Obviously, the process was advantageous for all of our teachers. Okay. So the four of us that took part, the sharing of ideas, the experiences and it really helped. There were teachers in our department obviously that are not so technologically advanced. You seize the opportunity, and it is nice to bounce ideas off of them. (Dustin)

Marike said that it was an interesting programme and appreciated the fact that teachers worked together and learnt together. She said that this helped teacher feel more comfortable while working through the programme.

I think it will actually get peoples interest. So there's pros and cons. I think if we all incorporate the technology, we'll feel comfortable. We are not alone in this. There is someone who can help. We are going with the future with technology, and you also learn. (Marike)

4.4.3 Intra-departmental Collaboration

One of the critical advantages reported by the teachers was the collaboration that was made possible through involvement in the programme.

Teachers reported that the Lesson Study programme facilitated formal collaboration to occur. While teachers did say that they had worked together in the past, the type of collaboration experienced was different.

> *We were given an allocated time like we did after school where we sat down, and we properly discussed the section. That differs from; I'd say, what I've experienced in the past. (Dustin)*

> *We can learn from each other, which is hard to do at the moment. Yeah. You know, because you might have a method that's different from mine that might be better than mine but at the moment, we don't have that time to actually sit and look at different ways of doing things. We also used to doing it our way. We just continue doing that. And this way we actually looked at things differently when we were sitting together, but that's because we were forced to sit together. (Wendy)*

Shikaar stated that it was an advantage to have everyone from the department working together on a joint project.

> *I would say the fact that we could have our department there and obviously work together was a good advantage … It was nice to have everybody there putting their input and obviously learning together towards achieving the goal of getting technology pushed into our classrooms.*

By being able to discuss different aspects of the lesson, teachers were able to reflect on what they were doing thereby enabling them to learn from one another.

> *You know, sometimes people don't get time to discuss things, and you just get stuck. So, you know, using different ways maybe, and I think also discussed. This didn't work. This did work. I think we learn. We grow.*

> *So we learn on a daily basis from one another. You know, like how would you approach this? How would you approach it? (Marike)*

Dustin's views were similar to those of Marike. He also said that teachers were able to discuss aspects of their teaching that could help them improve their instruction.

> *You never really get the opportunity to sit down and really discuss weaknesses, where learners make common mistakes etc. because of time constraints. So I'd say that this kind of collaborative teaching and working with the teachers was really beneficial. (Dustin)*

Wendy mentioned that teachers were able to work together. Due to time and work constraints, this usually did not happen. The Lesson Study process was different because teachers were "forced" to work together.

> *But we were put in a position where we were together, and we needed to act together. Which doesn't normally happen, not because we don't like each other. We don't want to work with each other, but each one is obviously focused on what they need to do, and we're doing it ... We're going to sit and work together, even if we just do one topic at a time. (Wendy)*

4.4.4 Collaboration

4.4.4.1 Collaboration: Knowledge sharing

The mathematics department was made up of teachers from different age groups. Dustin stated that there were differences in teaching styles and techniques. He found it important that teachers were able to share and observe the different ways others taught.

> *It's nice to see how his techniques and teaching certain things about probability compared to maybe Wendy (pseudonym) who's been teaching for 40 odd years, her techniques. So it was nice with the bouncing off of ideas. I really enjoyed that aspect.*

Wendy noted that while she was comfortable with various teaching methods and the mathematical content, she had to learn from others in the team. She stated that she was comfortable with the team and had no problem learning from other teachers.

> *I had to take a bit of a backseat and learn, which is a good thing because I need to learn. But it is definitely different because if I'm doing a general discussion about how to teach, what to teach, whatever, I'm absolutely*

comfortable with, I know what I'm doing. This, I don't know. So it is definitely different. So when we have got together in your room, you know that every time that we had those meetings and whatever, I had to listen to what they were seeing and follow their lead and things like that, which I was happy to do. (Wendy)

Teachers who were more confident in using technology in the classroom assisted others who were not. The collaboration involved teachers working to their strengths and helping each other.

We collaborated with almost everyone in our department and obviously bounced off our ideas on them, and you know, we taught them how to use things as well as they also taught us in terms of methods how they would go about it not using ICT and what actually came of it was a little bit of coherence between the two of us that using the visual aids, using the technologies that actually did work a little bit better to get our concepts across. (Shikaar)

Teachers were exposed to different teaching methods and reported to have learned new skill and knowledge through collaboration.

I know Marike (pseudonym) showed me some amazing little techniques while we were doing this in terms of the probability section that we did our lesson on… I may do it one way. You may do it another way, and we'll come to the exact same answer, and I think working together with collaborating we all sort of learn something new like this is how you do it. And this is how I do it and we kind of figure out which way is easier to go about doing it which would have never happened if we were sitting in different classrooms.

Marike noted that by being able to collaborate, she was able to reflect on her teaching approach. She remarked that it was easy for a person to continue doing the same thing all the time. However, when teachers could reflect on what they did, they were able to make changes.

You know, sometimes people don't get time to discuss things, and you just get stuck. So, you know, using different ways maybe, and I think also discussed. This didn't work. This did work. I think we learn. We grow. (Marike)

The dissemination of knowledge was not only the duty of the Subject Head during the Lesson Study process. This helped reduce pressure on the Subject Head and provide others within the department with leadership opportunities. Teachers who were more confident with ICTs lead the process of integrating ICTs in the lessons and also assisted others.

> *We had one educator who's highly advanced with ICT and gone on many workshops who trained us basically into how to incorporate the technology into our classroom. (Dustin)*

> *In terms of the planning process again was the fact that we were lucky enough to have someone like (Marike) who's very, very technologically inclined and she did help us in terms of that. (Shikaar)*

> *(Marike) more. I think, actually lead the way because she's younger, she's more into the technology. So we learnt a lot from her, and I think we need to learn a lot more. (Wendy)*

4.4.4.2 Collaboration and planning

Marike stated that she was not good at planning, and working with her team helped her plan more effectively.

> *It helps us in our lesson planning as well, because I'm very bad, at least in planning.*

> *To hear how do teachers teach it and approach it from various ways was very, very helpful and then helped us to actually construct this one lesson and the results were quite good. (Marike)*

This helped her plan better and developed better lessons as a result.

Shikaar also reported an improvement in his planning. Through collaboration with the mathematics department, more "interesting and dynamic" lessons were developed.

> *I think also using those things kind of improved how we, how we set out our lessons, how we planned our lessons*

> *But it did improve our lessons as well as the planning of our lessons because it made it more, you know, interesting and dynamic. (Shikaar)*

Dustin said that the Lesson Study process was effective in planning and presenting relevant lessons provided it was done collaboratively.

> *I think you can incorporate this lesson study process very effectively in planning how you're going to teach the syllabus, how you're going to teach sections etc. Provided you sit down in a group, and you discuss it properly.*

The collaboration helped to integrate ICTs in teaching since the technology was not usually the focus of the planning process. In the past, the focus was on content coverage. Teachers were able to work together in a supportive environment to plan with a new direction in mind – technology integration.

> *Because technology is never really a part of the topic, mainly content and approaches and not being forced to go with technology, that was the focus point. And that was completely different because we were focused on not really the content at first, but how are we going to incorporate technology. (Marike)*

Dustin stated that the Lesson Study process allowed for the planning and generation of new ideas and methods due to the collaborative nature of the planning process.

> *It's always nice when you have fresh ideas, like the younger teachers coming in with new ideas, new methodologies to get across to the learners. (Dustin)*

Marike and Shikaar said that the Mathematics department had people with a variety of skills that could be used in the classroom; whether it be technological, pedagogical, content or combinations of these skills. By working collaboratively, they were able to assist each other. For example, the teachers who were more confident with technology helped others who were not.

> *You know where we help one another with certain skills, different approaches which we can use in the classroom to assess. You know, does this way work does it not then discuss it and in the end, it's actually for the learners. (Marika)*

> *There's such a wide range of educators firstly with different styles, different age groups and everything like that, we, kind of as a youngster, I would say*

that I would possibly use technology in most of my lessons, whereas an elderly teacher, well-seasoned teacher would probably not and the thing is that we as youngsters also start pushing these elderly teachers or these well-seasoned teachers to start using it as well. So in this process that we actually did with the ICT training and stuff like that. (Shikaar)

4.4.4.3 Collaboration and teacher isolation

Discussions with teachers revealed that their earlier practices were characterised by limited collegial interaction and isolation. Wendy reported that the Lesson Study process was important since it resulted in reduced teacher isolation when compared to previous interactions with colleagues.

Normally we work more or less in isolation. Not that we don't do things together, but mostly it's all about WhatsApp, what we meet at our meetings because all of us have a different workload. We are not free at the same time. And it's, and we've got different grades to teach. So each one more or less, as long as you've got the syllabus in front of you, you're more or less doing your own thing. (Wendy)

Through Lesson Study, teachers were able to work together, facilitating discussions, academic and moral support, which allowed them to be more innovative.

You know, and also feeling that you're not alone. You're not on your own. You know, all I need to do this. And, you know, how am I going to do it? How am I going to do it? Because we're all busy. So sometimes you can't really talk to a colleague and ask, how do you do this? But we were quite forced to make time. And then, you know, the input is like, okay, if this fails, it's not only on me. (Marike)

By working together, teachers were able to provide support and guidance. Working together resulted in reduced pressure on the teachers as each lesson developed was a shared responsibility of the group, and the success or failure of the task was due to the group, not any individual. The feedback, discussion and the reduced amount of work were appreciated.

You get much more feedback from everybody this way compared to if you just had to prepare your lesson on your own and you know, even if you make a *mistake with that lesson then it's you involved only, you know, whereas if it goes through a couple of people, if we all sitting, we all chatting then those mistakes those little mistakes are easily corrected even if you miss it. (Dustin)*

Teachers mentioned that working together allowed them to voice their ideas on how technology should be integrated. The collaborative work undertaken helped them put innovative ideas into practice.

I'd say just the fact that we could all come together instead of being in our own little spots and you know rather than doing this on our own. We actually got to integrate our ideas of using technology. (Shikaar)

4.4.5 Insights into teaching through reflective practices

A key aspect of the Lesson Study process was the reflection that was required. Trough reflection, teachers were able to identify problems and look at ways to improve the lesson.

Reflecting back on the lesson that we taught, we could see that there's a lot of weaknesses. There's, you identify problem areas where when we got matric marking you make little notes of where the question that you're marking, where the issues lie, and I think this whole entire process ties up to that where when you reflect back on the lesson, what could you have done better? (Dustin)

Teachers were able to identify weaknesses in their teaching approaches and were able to develop lessons that were structured for the perceived academic level of learner that they had in front of them.

Would it have been more feasible to teach it in a different manner to the actual course that you're teaching but we learned very quickly that a 10.1 class teaching probability to them using technology is very different to teaching a 10.6 class using technology. (Dustin)

Teachers said that by reflecting on their teaching approach, they realised that they had to consider various methods carefully before using it in the classroom. Reflective practices helped them develop more effective lessons using technology.

How are we going to incorporate technology because it's you know, there are so many YouTube videos that learners can go and watch on their own? So when you hear technology, we think, okay, maybe show them a video. And that's not teaching because learners shut off. I mean, they can do it at their own home. So you can't just put a video on and then expect learners to learn from it. (Marike)

Being able to reflect on the lesson was considered a valuable aspect of the Lesson Study process. Reflecting helped teachers to analyse their teaching critically and make changes where necessary. It was reported to prevent teachers from becoming complacent.

In constant reflection of how I used it, was it effective, did I keep the kids interested? Where did I lose them? Being able to record a lesson and going back, how could I change it for next year's lesson? Its constant improvement. (Marike)

And sometimes you become complacent thinking that you actually know the work perfectly. You've got so much experience teaching grade 12's. You've done marking. You've done all this that you become complacent in your teaching style. (Dustin)

4.4.6 The effects of Lesson Study on teachers' confidence

Teachers reported being more confident in the use of ICTs. Marike, who was the most technologically confident of the group, claimed to have learned more about the use of ICTs in teaching by being engaged in the Lesson Study process.

I spent a lot of time doing research because I had not known some things

So my focus groups, the one was grade 10, with the PowerPoint presentation, animation, upping my skills and the other one was you know, getting learners involved where the parents could also be involved on the site. And I got reports. So it's Grade 8 and grade 10. I feel like I've improved. I know now how to do it. (Marike)

Wendy, who was the least technologically proficient, said that she benefited from the process. She claimed to have become motivated to try to integrate ICTs into her lessons.

I am useless when it comes to technology, and it helped me. I do know that learners have different ways of learning, and it will help me and other teachers to teach more effectively using the technology. And I'm guilty of not doing it too much. So this has forced me to use it a little bit and obviously with more practice, I'm hoping to use it a little more in the classroom. (Wendy)

Wendy had seen the advantages of using ICTs in her lessons, and through her involvement in the Lesson Study programme and the support of her team, had made attempts to use it.

So I've actually taken some of the stuff that he'd put up on Google classroom and printed stuff from there, and I have been using it. (Wendy)

4.4.7 Barriers experienced

4.4.7.1 Time as a barrier

The most significant barrier that teachers experienced during the Lesson Study process was time. The Mathematics teachers were involved in the co-curricular programme at the school and were required to provide extra tuition for underperforming learners after regular school hours. Teachers said that it was difficult to find a time when all were available to meet.

I also think to do a lesson involving ICT; it requires some, it requires that set up initially. Yes. It's easy to use the same power points, the same things over and over once you've done the first initial lesson, but that initial lesson takes a lot of time, and we found that was our greatest obstacle in preparing was getting a time where we can all discuss. (Dustin)

When it came to commitments of time after school, a time during the morning to prepare the numbers suddenly went to fall. (Teachers were) hoping there was going to be another course but the back of their mind they were probably thinking no, we still won't have time for that. (Dustin)

Marike stated that since teachers were heavily committed to the co-curricular programme, they found it challenging to be available as a team all the time. The process, therefore, took longer than it would have had everyone been present when required.

Because we're all very, very heavily loaded in terms of teaching time, extra murals and then obviously the matric block lessons and so and coaching. So finding the time to actually sit and really take this serious was a problem. (Marike)

Not being able to work collaboratively often resulted in many becoming frustrated and demotivated.

I think it was mainly the time and the frustration of not being able to, you know, all of us sit together, because one on one I spoke to the one this, this, this, and I shrugged. But I think as a team, we couldn't have enough time to really all of us sit together at the same time. And it was frustrating. (Marike)

Wendy had a similar view to Marike. She suggested that a particular lesson should be timetabled. By having a timetabled lesson, all members of the department would be able to meet together.

It's difficult at school. And then in the afternoons, everyone's got their own things to do. And it was definitely the time constraint because we had to find time now to actually sit together and do it. So if because last year I know we used to have a period that we were all free together with the year before, where we used to sit and do the planning and whatever. Now it's difficult with a new workload. (Wendy)

Shikaar mentioned that if the team had spent more time working together, the quality of the lessons developed would be better.

I think the biggest disadvantage was the time constraints because obviously, I think if we had to sit for a little bit longer, we could have come up with a little bit better ideas if not to use technology in our classrooms. (Shikaar)

Apart from making time for participating in the Lesson Study programme, Marike reported that teachers had to attend to other personal and professional matters. The limited-time available resulted in anxiety which caused a loss of focus.

Like I say, time was a big, big issue. And for myself as well, when I'm pushed for time, I get anxious, I get anxious. It feels like I can't really focus entirely *on something that's really important because you're kind of scatter-brained. You sometimes feel like learners need you. You know, you need to tend to your own personal, you know, stuff like SARS and I really get anxious because, like, you know what, I'm very perfectionistic as well. (Marike)*

4.4.7.2 ICT Related barriers

While most of the classrooms in the school had projectors, laptops and access to Wi-Fi, teachers claimed that they had difficulty using ICTs in their lessons because they lacked resources.

The sad thing is that in a school like this, there's some classes that have the technology and there are others that don't. Like my class, I'd love to use technology all the time, but budget constraints. I don't have a visualiser (Desktop camera that can connect to a projector or interactive screen). (Dustin)

Shikaar also stated that some resources were not available.

If you want to integrate the technology, you're going to have to have the resources to integrate it into your lessons. (Shikaar)

One of the barriers listed by teachers that prevented them or others from using ICTs in their teaching was the teachers' perceptions of the ICTs as learning resources. Some teachers in the Mathematics department were resistant to the use of ICTs in teaching.

We had such a range of teaching experience where we had one member who can't. When we discuss technology, switches off immediately, and I come from a department where I've got very seasoned educators where they are very negative to using technology. They are very old school, and they are reaching the age where they are coming to retirement. So they feel there's no need to use technology. (Dustin)

Marike noted that people who are generally resistant to change are not comfortable with the use of technology. She suggests that these teachers be guided through the process of integrating technology.

The use of the technology, where many people show resistance because they feel like they are technologically challenged, (is a barrier to the process). So *in especially older ones when you want to propose maybe let's do this. Let's try to incorporate technology, as many shut off because they don't even know where to start. (Marike)*

4.4.7.3 Learner Factors

Dustin said that the behaviour of learners during one of the research lessons was a problem. Classes at the school were streamed according to academic performance. The research lesson was conducted with a class with low mathematical scores. The section that was taught was difficult, and learners were not as focused as they should have been.

> *The disadvantage obviously was the discipline of the learners. The set that we had chosen was a bottom grade 10 set. Also, the topic that we chose was probability, which is one of the most abstract topics in the maths syllabus. I think being at the end of the day, discipline, they weren't as focused as maybe it would have been if the lesson was at the beginning of the day with the top set. (Dustin)*

Due to the choice of class, the lesson could not be complete. However, this lesson resulted in teachers reflecting on their teaching and use of appropriate resources. This gave rise to a meaningful learning experience.

> *We didn't manage to finish what we had planned for that hour lesson because we had to keep going back to basics. (Dustin)*

Learners perceptions of the ICTs used resulted in disruptions. Learners did not view ICTs as educational resources. Teachers believed that it was because of this that learners were not focused during the lesson.

> *The maturity factor (of learners) also plays a part. As soon as the lights went off for technology, you get the oohs and aahs, and it was inappropriate. (Marike)*

> *When you put on a projector or computer in front of them (learners) they feel like they have to do no work because the computers is just going to do everything for them. Whatever you are projecting is gonna, you know, automatically be absorbed into their brains whereas that's not how it works. (Shikaar)*

4.4.8 Teachers' perceptions of the Lesson Study process

Teachers said that the Lesson Study process helped with developing self-reflection skills. By reflecting on their teaching, teachers were able to identify their strengths and weaknesses and make changes where necessary.

> *I think in terms of the collaboration of the teachers, you learn where your weaknesses are, you learn where other teachers' strengths lie and also where you can improve because you know teaching is a lifelong experience. (Dustin)*

Teachers viewed the Lesson Study process as a valuable way of conducting professional development. The advantages given were: improved collaboration; improved staff morale; and the development of reflection skills, among others. Teachers viewed the process as enjoyable and one that got them to think about their learning.

> *As you said the collaboration between the members of the department was insanely good. I mean even in the other departments you could see people chatting and it actually it looked good. You feel like you came out with some sort of knowledge that you didn't have when you went in. (Shikaar)*

Teachers mentioned that they felt like they gained something valuable from the process.

> *I think doing something like this on a yearly basis, even if it's just for one lesson to start off with will actually boost the morale of all the teachers that are not so, you know technologically inclined. (Shikaar)*

> *I really felt like I've actually gained a skill. Moving with the future. Helping the old ones to actually like it. (Marike)*

Marike stated that they benefited from their interaction with one another.

> *That brought us closer together because now we have a task that we need to complete successfully together. Learning from one another and you know the vibe was good. (Marike)*

Wendy noted that although she had low technical skills, the process had helped her realise the importance of ICTs. It also helped motivate her to make necessary changes.

It's given me that, you know opened my mind a bit to say you what I need to go in this route. For me, it's going to be a long learning process.

I must admit, I'm a lot more into the technology than I was. I mean, at least now I can do the SA SAMS. I've been using the laptop a lot more. I carry it around a lot more that you might have noticed. I'm trying. (Wendy)

Wendy appreciated that the process involved the actual content she taught. She was able to develop a technology-integrated lesson that could be used in the classroom.

It was because we took a topic that we were currently teaching in grade 10 and then adapted it to use technology. (Wendy)

A significant advantage given by the teachers was the structure of the process. By employing a structured approach, teachers had a clear idea of what was expected. They were able to work more effectively.

We all learnt a lot. In terms of how to work together. You know setting boundaries. There's a leader. You know. Rules. Respect for one another. Giving one another a time to talk and then learning from one another with an open mind. Being positive about it. (Marike)

Teachers said that the team had enjoyed the process to integrate ICTs in teaching. The process was enjoyable and resulted in tangible benefits for them.

We actually enjoyed the process because of getting ideas on how to teach using technology. (Dustin)

I am really happy that I did this because I feel like I've really improved in terms of the use of technology. How to use it, when to use it and to reflect. (Marike)

Teachers said that plans were in place to use the Lesson Study process to help develop teachers' knowledge in some sections of the syllabus. These deficiencies in knowledge were said to have been identified through the Lesson Study process.

What we are going to be doing next year, which we've gauged from this (the Lesson Study process) is certain teachers that are currently teaching grade

12 classes that are not very confident in certain sections, and they are taking top classes. So what we're going to be doing next year using this (the Lesson Study process) is at least one Friday a month we are going to be focusing on certain sections. (Dustin)

When teachers compared the use of Lesson Study to previous forms of professional development, several differences were identified. Teachers stated that the Lesson Study process involved active learning. Teachers had to participate to benefit, whereas, in previous programmes, teachers could "switch off".

You are actively involved. You don't just sit and listen to a presenter. You have to give your input. You have to be part of the team, and you have to help for this project to be successful. Normally professional development, you sit and listen to someone. Many people switch off. Here you can't because you have to do it to make it happen. (Marike)

It can't be effective if we all just sitting and you know listening to what one person is saying. (Shikaar)

Teachers considered Lesson Study to be more effective than previous professional development activities since they were able to interact with each other and produce something that could be used in the classroom.

It was more us doing stuff. It wasn't you giving us stuff. You've obviously helped us along the way, but we needed to do it. So when you actually do things, you learn. So it was effective. I mean, I actually did stuff

I mean, the normal professional development is sitting there, and somebody is talking and you listening, and yes, you think you've learned quite a bit while you're there. But you walk out the door, and you've forgotten it. (Wendy)

Shikaar supported Wendy's views. He added that it was important that teachers were able to discuss and voice their opinions over issues that arose and that decisions were made through consensus.

It's only effective if we all get to put our inputs in and obviously come to that conclusion with I mean, we're just chatting and we said those developmental *meetings and workshops that we go for. It's usually just one person throwing the idea out there. As soon as you give feedback then all of a sudden it taboo, you know, so this way it was everybody in the department and we all kind of gave our little experience of how we would go about doing it and came to a general consensus. (Shikaar)*

More effective learning and retention of knowledge were said to occur using Lesson Study.

With the lecture form, you literally just hear what they have to say, and you leave whether you retain any of that knowledge, it makes no difference. Whereas if you actually in a conversation with someone and you are debating a little bit, that's okay.

Teachers preferred lesson study due to the active learning that occurred, the opportunities for collaboration and the process followed when making decisions.

It's normal in terms of in terms of teaching or even lesson planning because everybody has their own little style. So I feel like if it's in this manner where you collaborating with your peers you coming to a general consensus, it works much better than just being lectured of this is what you should do. (Shikaar)

4.4.9 Summary of findings

The qualitative data for Case Study three was presented in this subsection. Data from the interviews with the Mathematics teachers, documents and lesson observations were presented.

The data indicated that the Mathematics teachers experienced Lesson Study for the integration of ICTs in their teaching as an effective form of teacher development. Teachers' responses were generally positive, with teachers mentioning several advantages to being involved in the Lesson Study programme. Teachers reported improvements in teaching methods, technology skills and knowledge, and intra-departmental collaboration. Critical barriers identified by all teachers was the amount of time required for participation in the programme and ICT related issues like learners' perceptions of ICTs and the availability of resources.

Overall, teachers responded favourably to the programme citing many benefits such as improved collaboration and motivation. Teachers also reported having developed new ICT related skills which they could apply in classrooms.

4.5 SUMMARY OF THE FINDINGS OF THE THREE CASE STUDIES

The purpose of this study was to explore teachers' experiences of Lesson Study for integrating ICTs in teaching. A mixed-method approach was used to obtain qualitative and quantitative data. The findings of the qualitative data, primarily obtained from the interviews, and supporting data from documents and lesson observations, were presented in this chapter.

There were several shared experiences of the teachers in all the case studies. For example, all teachers reported having benefited from the collaboration that formed a significant part of the Lesson Study process and all teachers considered time to be a barrier.

The table below provides a summary of the findings of each case study. It is set out so that commonalities and differences could be viewed easily.

Table 6. A summary of the findings of the three case studies

	Case study 1	**Case study 2**	**Case study 3**
Teachers' confidence	•Better prepared to teach •Increased motivation •Increased creativity •Confidence with new technology	•Improved knowledge •Improved technological confidence •Development of trust and motivation	•Improved teaching approaches and skills •Motivation and improved self-efficacy •Improved technological skills
Teachers' experiences	•Improved collaboration ○ Division of responsibility ○ New opportunities for leadership ○ Reduced teacher isolation	•Improved collaboration ○ Better planning ○ Collegial support ○ Formalised collaborative work ○ Improved teamwork and communication ○ Reduced teacher isolation	•Collaboration ○ Effective communication and teamwork skills ○ Formal collaboration ○ Improved knowledge sharing and planning

			○ Reduced teacher isolation
	•Improved self-reflective practices through reflecting on the stages of the process	•Facilitating self-reflective practices ○ Resulted in changes in teaching	•Better use of ICTs in teaching •Variations of pedagogy for different learners •Assists with reflective practices •Acquiring knowledge of self
	•New approaches to teaching with technology	•New teaching methods	•New methods to integrate ICTs in lessons
	•Better than previous approaches ○ Active learning ○ Relevant content	•Better than previous professional development programmes ○ Relevant and practical	•More relevant to the classroom •A practical and logical approach
	•Barriers ○ Lack of Time ○ ICT related ▪ Power cuts ▪ ICT infrastructure ▪ Learner issues like the unavailability of devices	•Barriers ○ Lack of Time ○ ICT related ▪ infrastructure ▪ Learner issues ▪ Resistance to change	•Barriers ○ Lack of Time ○ ICT related ▪ Teachers' perceptions of ICTs ▪ ICT infrastructure ▪ Learner issues like perceptions of ICTs

Reason or cause for teachers' experiences	•Collegiality •Lesson Study is seen as being valuable •Improved teacher motivation and self-efficacy •Perceived effect on teaching •The logical process	•Easy to follow, logical process •Apprehension therefore hesitant to use ICTs •Improved pedagogy •Perceived benefit to learners •Teacher self-improvement/development •Perceived ability of the teacher	•An important role in teacher professional development •Positive attitude toward Lesson Study •Effective means to help teachers integrate technology •The importance of a structured approach

Chapter four contained the qualitative data that were generated primarily through the semi-structured interviews but included other forms of qualitative data generated through observations and document analysis. The findings of the data were presented. Chapter Five contains the results of the qualitative data obtained from the TPACK questionnaire. The quantitative results are presented in Chapter five, followed by a discussion of the findings and the results of the study in Chapter six.

Chapter 5

The Quantitative Results

5.1 INTRODUCTION

Quantitative data were collected using the TPACK questionnaire. The TPACK questionnaire validated by Schmidt, Baran, Thompson, Mishra, et al. (2009) was administered at the start and the end of the study. The questionnaire was administered at the beginning of the study to gauge teachers' confidence in each of the seven areas of the TPACK framework namely: content knowledge, technological knowledge, pedagogical knowledge, technological pedagogical knowledge, technological content knowledge, pedagogical content knowledge, and technological pedagogical content knowledge. Permission was sought from the author, Dr Denise Schmidt (dschmidt@iastate.edu), as per requirement on the questionnaire. An email was sent to the author explaining the intended use, the research questions, the location for the research and the population being surveyed.

Quantitative data were collected using the questionnaire (Appendix D1) by Schmidt, Baran, Thompson, Koehler, et al. (2009). The questionnaire consisted of 28 questions based on the TPACK framework with no negative questions. A five-point Likert scale was used for all the items ranging from strongly disagree (1) to strongly agree (5). For example, teachers were asked to indicate using the five-point scale, whether they could choose technologies that enhanced the teaching approaches for a lesson. The content areas contained in the original questionnaire consisted of mathematics, social studies, science, and literacy and was designed for primary school teachers. The content areas were adapted to suit the current research. Some questions were grouped while others were removed. For example, the following items: I have sufficient knowledge about science; I have sufficient knowledge about literacy; I have sufficient knowledge about mathematics, and I have sufficient knowledge about social studies were replaced with "I have sufficient knowledge about the subject I teach".

The modified questionnaire was then piloted with 22 teachers from the same school for reliability. The questionnaire was handed out to the teachers involved in the pilot study and of the 22 handed out 20 were returned. The returns represented a response rate of 91%.

The reliability of the TPACK questionnaire was also confirmed in studies by Schmidt, Baran, Thompson, Koehler, et al. (2009), and Albion et al. (2010), among others. Cronbach Alpha reliability coefficients in the original questionnaire are between 0.78 and 0.93.

The results obtained from the questionnaire were analysed at the beginning to determine teachers' confidence in using ICTs in teaching and learning. The results of the questionnaire were then entered into SPSS Statistics software version 26 and analysed.

Over approximately seven months, two lesson study cycles per learning area (a total of six complete cycles) were then conducted.

The validated TPACK questionnaire was then administered again. A comparison of the teachers' scores at the beginning and end of the study was made to determine if Lesson Study affected teachers' use of ICTs in teaching and learning.

Qualitative and quantitative data related to the teachers were collected to explore the critical research questions in this study:

> How do teachers' confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study?
>
> What are teachers' experiences in using Lesson Study as a strategy to develop their competence in integrating ICTs (information and communication technologies) in their teaching?
>
> Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do?

Data collected through qualitative methods were presented in the previous chapter; the quantitative data is presented in this chapter. This chapter contains the results of the intervention on the seven knowledge areas of the TPACK framework over the subjects of EMS, Life Sciences, Mathematics and composition of all subjects. The initial analysis presented shows a detailed analysis of each question used in the questionnaire for all teachers throughout the three subjects surveyed. This is followed by a summary of the merged results, for the seven knowledge areas of the TPACK framework. It was deemed necessary to conduct a separate analysis for each subject as a multiple case study approach was used so variances in subjects could be accounted for and analysed. A composite set of results of all teachers pre and post Lesson Study responses is provided, followed by a summary of the responses.

5.2 QUANTITATIVE TESTS CONDUCTED

A Two-Tailed Paired T-Test was used in this study to assess the change in Technological Pedagogical and Content knowledge before and after the Lesson Study programme (the intervention). Teachers participated in a Lesson Study programme to help them integrate ICTs into their teaching. The Lesson Study programme consisted of cycles of planning, observation, and reviewing lessons. The TPACK questionnaire was administered at the start of the programme and at the end. The results of the questionnaire were then compared.

The following pairs, representing the knowledge areas of the TPACK framework, denoted the various areas of knowledge that were assessed:

Pair 1 - Technological knowledge only

Pair 2 - Content knowledge only

Pair 3 - Technological, Pedagogical and Content knowledge

Pair 4 - Pedagogical and Content knowledge

Pair 5 - Technological and Content knowledge

Pair 6 - Technological and Pedagogical knowledge

Pair 7 - Pedagogical knowledge only

The results were divided into three areas and combinations thereof. A separate analysis was performed for each combination to determine if there was an overall improvement. It is important to note that the T-Test data given is for a Two-Tailed test, which means that the test was whether the intervention improved or reduces the confidence score. Paired Samples Correlations indicated the bivariate correlation coefficient for each pair of variables entered. Simple bivariate correlation was the technique used to determine relationships between the pre and post intervention scores.

The following key was used throughout the analysis to represent the different scenarios (with the number "1" representing the value before the intervention, and the number "2" representing the value after intervention): *T* – Technological; *P* – Pedagogical; and *C* – Content

For example, T1 represents the teacher's Technological confidence before the intervention; *PC*2 represents the teacher's Pedagogical Content confidence after the intervention.

The following assumptions were made:

***H_0*: There is no significant difference in sample means before and after the intervention.**

***H_1*: There is a significant difference in sample means before and after the intervention.**

All data was gathered from one particular population group.

The difference was calculated by subtracting the “After Intervention” score from the “Before Intervention” score. The difference scores were fairly Normally distributed.

The random variable of interest was the difference in knowledge before and after an intervention. The T-Distribution was used as the underlying distribution of this variable. This distribution was used since the sample size N of each pair was very small, and the underlying variance was unknown, leading to a distribution similar to a Normal distribution but with fatter tails implying significant variation in the results, which made a proper analysis difficult. However, a reasonable conclusion was possible given the sample data using statistical inference. The difference in knowledge was defined as the value before the intervention minus the value after the intervention (implying that a negative mean difference indicates an improvement in knowledge, and a positive difference indicates a deterioration in knowledge).

The null hypothesis (H_0) for this experiment was that there was no difference in knowledge before and after intervention for each pair (i.e. Mean difference = 0). The alternative hypothesis (H_1) was that there was a positive or negative difference in knowledge for each pair (i.e. Mean difference $\neq$ 0). A 95% confidence level was used to determine which pairs had a statistically significant mean difference.

This report examined the results of the intervention of these seven pairs over the subjects of EMS, Life Sciences, Mathematics and composition of all subjects. The initial analysis presented shows a detailed analysis of each question used in the questionnaire for all teachers throughout the three subjects surveyed. This is followed by a summary of the merged results, for the seven knowledge areas of the TPACK framework. It was deemed necessary to conduct a separate analysis for each subject as a multiple case study approach was used so variances in subjects could be accounted for and analysed. A composite set of results of all teachers pre and post Lesson Study responses is provided, followed by a summary of the responses.

5.3 DETAILED RESULTS OF THE QUESTIONNAIRE

5.3.1 Technological Knowledge

Table 7: Paired Samples Statistics, Correlations and Test for Technological Knowledge

Paired Samples Statistics		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	I know how to solve my technical problems	2.67	12	.985	.284
	TK1PST	3.42	12	1.165	.336
Pair 2	I can learn technology easily	3.00	12	1.044	.302
	TK2PST	3.75	12	.622	.179
Pair 3	I keep up with important new technologies	2.58	12	1.240	.358
	TK3PST	3.5000	12	.67420	.19462
Pair 4	I frequently play around the technology	3.08	12	1.084	.313
	TK4PST	3.6667	12	.77850	.22473
Pair 5	I know about a lot of different technologies	2.67	12	1.073	.310
	TK5PST	3.1667	12	.83485	.24100
Pair 6	I have the technical skills I need to use the technology	3.42	12	1.084	.313
	TK6PST	3.5833	12	.79296	.22891

Paired Samples Correlations		N	Correlation	Sig.
Pair 1	I know how to solve my technical problems & TK1PST	12	.687	.014
Pair 2	I can learn technology easily & TK2PST	12	.420	.174
Pair 3	I keep up with important new technologies & TK3PST	12	.489	.106
Pair 4	I frequently play around the technology & TK4PST	12	.575	.051
Pair 5	I know about a lot of different technologies & TK5PST	12	.575	.050
Pair 6	I have the technical skills I need to use the technology & TK6PST	12	.644	.024

Paired Samples Test		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	I know how to solve my technical problems - TK1PST	-.750	.866	.250	-1.300	-.200	-3.000	11	.012
Pair 2	I can learn technology easily - TK2PST	-.750	.965	.279	-1.363	-.137	-2.691	11	.021
Pair 3	I keep up with important new technologies - TK3PST	-.91667	1.08362	.31282	-1.60517	-.22816	-2.930	11	.014
Pair 4	I frequently play around the technology - TK4PST	-.58333	.90034	.25990	-1.15538	-.01129	-2.244	11	.046
Pair 5	I know about a lot of different technologies - TK5PST	-.50000	.90453	.26112	-1.07471	.07471	-1.915	11	.082
Pair 6	I have the technical skills I need to use the technology - TK6PST	-.16667	.83485	.24100	-.69710	.36377	-.692	11	.504

The mean of the difference $T1 - T2$ was negative for all possible pairs, which shows that the value of confidence after the intervention was consistently higher on average than the value before the intervention, thus providing evidence against H_0.

The 95% confidence interval for pair 5 and pair 6 contain zero, which meant that H_0 could not be sufficiently rejected for these pairs as there was the possibility of there being no difference in the means of these factors. However, it could be seen that the 95% interval for pairs 1 to 4 are strictly negative, implying that the mean of $T2$ was higher than $T1$ for these factors.

At the required 5% significance level, pairs 5 and 6 have a P-Value greater than 0.05, which means that for a 2-tailed test, H_0 could not be rejected at the 5% level. However, H_0 at the 5% level for all other pairs 1 to 4 could be rejected. Suppose a 1-tailed test is considered, H_0 for all pairs 1 to 5 could be rejected since all P-Values are less than 0.05. H_0 for pair 6, however, could not be rejected due to its high halved P-Value.

There was sufficient evidence that the intervention caused a significant improvement in confidence scores for pairs 1 to 5 in the Technological Knowledge category. The intervention did not improve confidence for pair 6.

5.3.2 Pedagogical Knowledge

Table 8: Paired Samples Statistics, Correlations and Test for Pedagogical Knowledge

Paired Samples Statistics		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	I know how to assess student performance in my classroom	4.33	12	.651	.188
	PK22PST	4.5000	12	.52223	.15076
Pair 2	I can adapt my teaching based on what students currently understand or do not understand	4.33	12	.492	.142
	PK23PST	4.6667	12	.49237	.14213
Pair 3	I can adapt my teaching style to different learners	4.00	12	.953	.275
	PK24PST	4.5000	12	.52223	.15076
Pair 4	I can assess student learning in multiple ways	4.17	12	.389	.112
	PK25PST	4.4167	12	.66856	.19300
Pair 5	I can use a wide range of teaching approaches in a classroom setting	3.67	12	.985	.284
	PK26PST	4.5000	12	.52223	.15076
Pair 6	I am familiar with common student understandings and misconceptions	4.42	12	.515	.149
	PK27PST	4.5000	12	.67420	.19462
Pair 7	I know how to organise and maintain classroom management	4.42	12	.515	.149
	PK28PST	4.5833	12	.51493	.14865

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	I know how to assess student performance in my classroom & PK22PST	12	.535	.073
Pair 2	I can adapt my teaching based on what students currently understand or do not understand & PK23PST	12	.500	.098
Pair 3	I can adapt my teaching style to different learners & PK24PST	12	.548	.065
Pair 4	I can assess student learning in multiple ways & PK25PST	12	.408	.188
Pair 5	I can use a wide range of teaching approaches in a classroom setting & PK26PST	12	.354	.260
Pair 6	I am familiar with common student understandings and misconceptions & PK27PST	12	.655	.021
Pair 7	I know how to organise and maintain classroom management & PK28PST	12	.714	.009

Paired Samples Test – Pedagogical Knowledge		Paired Differences Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	I know how to assess student performance in my classroom - PK22PST	-.166	.5773	.1666	-.53350	.20016	-1.000	11	.339
Pair 2	I can adapt my teaching based on what students currently understand or do not understand - PK23PST	-.333	.49237	.1421	-.64617	-.0205	-2.345	11	.039
Pair 3	I can adapt my teaching style to different learners - PK24PST	-.500	.79772	.2302	-1.00685	.00685	-2.171	11	.053
Pair 4	I can assess student learning in multiple ways - PK25PST	-.250	.62158	.1794	-.64493	.14493	-1.393	11	.191
Pair 5	I can use a wide range of teaching approaches in a classroom setting - PK26PST	-.833	.93744	.2706	-1.42895	-.23771	-3.079	11	.010
Pair 6	I am familiar with common student understandings and misconceptions - PK27PST	-.083	.51493	.1486	-.41050	.24384	-.561	11	.586
Pair 7	I know how to organise and maintain classroom management - PK28PST	-.167	.38925	.1123	-.41398	.08065	-1.483	11	.166

The difference in means of $P1 - P2$ was negative for all possible pairs, which showed that the value of confidence after the intervention was consistently higher on average than the value before the intervention, thus providing evidence against H_0.

The 95% confidence interval for pairs 1,3,4,6 and 7 contained zero, which meant that H_0 could not be sufficiently rejected for these pairs as there was the possibility of there being no difference in the means of these factors. However, the 95% interval for pairs 2 and 5 were strictly negative, implying that the mean of $P2$ was always higher than $P1$, for these factors. At the required 5% significance level, pairs 1,3,4,6 and 7 had a P-Value greater than 0.05, which meant that for a 2-tailed test, H_0 could not be rejected at the 5% level, but could be rejected for the other pairs, 2 and 5.

For a 1-tail test, H_0 could be rejected for pairs 2,3 and 5 since all halved P-Values were less than 0.05. The discrepancy of pair 3 could have been a result of sampling errors, but its P-Value was very close to 0.05, and its confidence interval was hugely skewed to the negative side.

There was sufficient evidence that the intervention caused a significant improvement in confidence scores for pairs 2 and 5 in the Pedagogical Knowledge category. It could be inferred that intervention did not significantly improve confidence scores for pairs 1,4,6 and 7. It was not certain whether the score for pair 3 had been enhanced after the intervention, but it was extremely likely as the P-Value was close to 0.05.

5.3.3 Content Knowledge

Table 9: Paired Samples Statistics, Correlations and Test for Content Knowledge

Paired Samples Statistics		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	I have sufficient knowledge about the subject I teach	4.50	12	.522	.151
	CK7PST	4.583	12	.51493	.14865
Pair 2	I can use a way of thinking that is required by the subject I teach	4.50	12	.522	.151
	CK8PST	4.667	12	.49237	.14213
Pair 3	I have various ways and strategies of developing my understanding of the subject I teach	4.17	12	.835	.241
	CK9PST	4.5833	12	.51493	.14865

Paired Samples Correlations		N	Correlation	Sig.
Pair 1	I have sufficient knowledge about the subject I teach & CK7PST	12	.845	.001
Pair 2	I can use a way of thinking that is required by the subject I teach & CK8PST	12	.354	.260
Pair 3	I have various ways and strategies of developing my understanding of the subject I teach & CK9PST	12	.176	.584

Paired Samples Test		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	I have sufficient knowledge about the subject I teach - CK7PST	-.08333	.28868	.08333	-.26675	.10008	-1.000	11	.339
Pair 2	I can use a way of thinking that is required by the subject I teach - CK8PST	-.16667	.57735	.16667	-.53350	.20016	-1.000	11	.339
Pair 3	I have various ways and strategies of developing my understanding of the subject I teach - CK9PST	-.41667	.90034	.25990	-.98871	.15538	-1.603	11	.137

The mean of the difference $C1 - C2$ was negative for all possible pairs, which showed that the value of confidence after the intervention was consistently higher on average than the value before the intervention, thus providing evidence against H_0.

The 95% confidence interval for all pairs contained zero, which meant that H_0 could not be sufficiently rejected for these pairs as there was the possibility of there being no difference in the means of these factors. At the required 5% significance level, all 3 pairs had a P-Value greater than 0.05, which meant that for a 2-tailed test, H_0 could not be rejected at the 5% level.

There was sufficient evidence that the intervention did not cause a significant improvement in confidence scores for all pairs in the content category.

5.3.4 Technological Pedagogical Knowledge

Table 10: Paired Samples Statistics, Correlations and Test for Technological Pedagogical Knowledge

Paired Samples Statistics		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	I can choose technologies that enhance the teaching approaches for a lesson	3.08	12	1.084	.313
	TPK13PST	3.8333	12	.93744	.27061
Pair 2	I can choose technologies that enhance students' learning for a lesson	3.08	12	1.084	.313
	TPK14PST	3.7500	12	.96531	.27866
Pair 3	My teacher education programme has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom	3.17	12	1.337	.386
	TPK15PST	3.9167	12	.79296	.22891
Pair 4	I am thinking critically about how to use technology in my classroom	3.67	12	1.073	.310
	TPK16PST	4.3333	12	.77850	.22473
Pair 5	I can adapt the use of technologies that I am learning about different teaching activities	3.58	12	1.165	.336
	TPK17PST	3.8333	12	.71774	.20719
Pair 6	I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn	3.25	12	1.055	.305
	TPK18PST	3.9167	12	.79296	.22891
Pair 7	I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom	3.42	12	1.084	.313
	TPK19PST	3.9167	12	.79296	.22891
Pair 8	I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district	2.83	12	1.337	.386
	TPK20PST	3.3333	12	1.23091	.35533
Pair 9	I can choose technologies that enhance the content for a lesson	3.25	12	1.138	.329
	TPK21PST	4.2500	12	.75378	.21760

Paired Samples Test		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	I can chose technologies that enhance the teaching approaches for a lesson - TPK13PST	-.75000	.62158	.17944	-1.14493	-.35507	-4.180	11	.002
Pair 2	I can chose technologies that enhance students' learning for a lesson - TPK14PST	-.66667	.77850	.22473	-1.16130	-.17203	-2.966	11	.013
Pair 3	My teacher education programme has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom - TPK15PST	-.75000	1.13818	.32856	-1.47317	-.02683	-2.283	11	.043
Pair 4	I am thinking critically about how to use technology in my classroom - TPK16PST	-.66667	1.07309	.30977	-1.34847	.01514	-2.152	11	.054
Pair 5	I can adapt the use of technologies that I am learning about to different teaching activities - TPK17PST	-.25000	.75378	.21760	-.72893	.22893	-1.149	11	.275
Pair 6	I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn - TPK18PST	-.66667	.77850	.22473	-1.16130	-.17203	-2.966	11	.013
Pair 7	I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom - TPK19PST	-.50000	.90453	.26112	-1.0747	.07471	-1.915	11	.082
Pair 8	I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district - TPK20PST	-.50000	1.00000	.28868	-1.1353	.13537	-1.732	11	.111
Pair 9	I can choose technologies that enhance the content for a lesson - TPK21PST	-1.00000	.73855	.21320	-1.4692	-.53075	-4.690	11	.001

The mean of the difference $TP1-TP2$ was negative for all possible pairs, which showed that the value of confidence after the intervention was consistently higher on average than the value before the intervention, thus providing evidence against H_0.

The 95% confidence interval for pairs 4,5,7 and 8 contained zero, which meant that H_0 could not be sufficiently rejected for these pairs as there was the possibility of there being no difference in the means of these factors. However, at the 95% interval, pairs 1,2,3,6 and 9 were strictly negative, implying that the mean of $TP2$ was always higher than $TP1$ for these factors.

At the required 5% significance level, pairs 4,5,7 and 8 have a P-Value greater than 0.05, which means that for a 2-tailed test, H_0 could not be rejected at the 5% level for these factors. H_0 could be rejected at the 5% level for the other pairs 1,2,3,6 and 9.

There was sufficient evidence that the intervention caused a significant improvement in confidence scores for pairs 1,2,3,6 and 9 in the Technological Pedagogical Knowledge category. It could be inferred that the intervention did not significantly improve confidence scores for pairs 5 and 8. It is still not certain whether the score for pairs 4 and 7 have improved after intervention, but due to the very negatively biased confidence-interval, it was likely that the scores for pairs 4 and 7 did improve.

5.3.5 Technological Content Knowledge

Table 11: Paired Samples Statistics, Correlations and Test for Technological Content Knowledge

Paired Samples Statistics		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	I know about technologies that I can use for understanding and doing the subject that I teach	2.67	12	1.303	.376
	TCK12PST	3.5833	12	1.08362	.31282

Paired Samples Correlations		N	Correlation	Sig.
Pair 1	I know about technologies that I can use for understanding and doing the subject that I teach & TCK12PST	12	.794	.002

Paired Samples Test		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	I know about technologies that I can use for understanding and doing the subject that I teach - TCK12PST	-.91667	.79296	.22891	-1.42049	-.41284	-4.005	11	.002

The mean difference $TC1 - TC2$ was negative for the pair, which shows that the value of confidence after the intervention was consistently higher on average than the value before the intervention, thus providing evidence against H_0.

At the 95% interval, the pair is strictly negative and does not contain zero, implying that the mean of $TC2$ was always higher than $TC1$.

At the required 5% significance level, the pair has a P-Value less than 0.05, which means that for a 2-tailed test, H_0 could be rejected at the 5% level.

There was sufficient evidence that the intervention caused a significant improvement in confidence scores for the pair in the Technological Content Knowledge category

5.3.6 Pedagogical Content Knowledge.

Table 12: Paired Samples Statistics, Correlations and Test for Pedagogical Content Knowledge

Paired Samples Statistics		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	I can select effective teaching approaches to guide student thinking and learning in the subject I teach	4.17	12	.835	.241
	PCK11PST	4.4167	12	.51493	.14865

Paired Samples Correlations		N	Correlation	Sig.
Pair 1	I can select effective teaching approaches to guide student thinking and learning in the subject I teach & PCK11PST	12	.670	.017

Paired Samples Test		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	I can select effective teaching approaches to guide student thinking and learning in the subject I teach - PCK11PST	-.25000	.62158	.17944	-.64493	.14493	-1.393	11	.191

The mean difference $PC1 - PC2$ was negative for the pair, which showed that the value of confidence after the intervention was consistently higher on average than the value before the intervention, thus providing evidence against H_0.

The 95% confidence interval for this pair did contain zero, which means H_0 could not be sufficiently rejected yet for this pair as there was the possibility of there being no difference in the means. The interval was, however, more skewed towards the negative side.

At the required 5% significance level, the pair has a P-Value greater than 0.05, which means that for a 2-tailed test, H_0 could not be rejected at the 5% level for this factor.

There was sufficient evidence that the intervention did not cause a significant improvement in confidence scores for the pair in the pedagogical content category

5.3.7 Technological Pedagogical Content Knowledge.

Table 13: Paired Samples Statistics, Correlations and Test for Technological Pedagogical Content Knowledge

Paired Samples Statistics		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	I can teach lessons that appropriately combine the subject content I teach, technologies and teaching approaches	3.25	12	1.215	.351
	TPACKPST	3.8333	12	.57735	.16667

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	I can teach lessons that appropriately combine the subject content I teach, technologies and teaching approaches & TPACKPST	12	.583	.047

Paired Samples Test		Paired Differences					t	df	Sig.(2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	I can teach lessons that appropriately combine the subject content I teach, technologies and teaching approaches - TPACKPST	-.5833	.996	.2875	-1.216	.04963	-2.028	11	.067

The mean difference $TPC1 - TPC2$ is negative for the pair, which showed that the value of confidence after the intervention is consistently higher on average than the value before the intervention, thus providing evidence against H_0.

The 95% confidence interval for this pair did contain zero, which meant that H_0 could not be rejected for this pair as there was the possibility of there being no difference in the means. The interval is, however, very skewed towards the negative side. At the required 5% significance level, the pair has a P-Value greater than 0.05, which meant that for a 2-tailed test, H_0 could not be rejected at the 5% level for this factor. However, the P-Value is still quite close to 0.05. If a 10% significance level is used instead, then H_0 could have been rejected.

There was evidence that the intervention did not cause a significant improvement in confidence scores for the pair in the combined technological, pedagogical & content category.

5.4 A SUMMARY OF THE COMPOSITE TPACK RESULTS IN ALL SUBJECTS

It is important to note that in this composite set of results, there were eleven degrees of freedom (as opposed to three degrees of freedom in each of the three subjects). This meant that the results tested allowed for a greater degree of accuracy, as the T-distribution was more well defined and exhibited less variability. The results are presented below, followed by a graphical representation of the vital components of the results.

Table 14: Paired Samples Statistics, Correlations and Test for the Composite Results

Paired Samples Test		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig.(2-tailed)
Pair 1	Technological Knowledge	-.61167	.60865	.17570	-.99838	-.22495	-3.481	11	.005
Pair 2	Content Knowledge	-.22250	.50024	.14441	-.54034	.09534	-1.541	11	.152
Pair 3	Technological Pedagogical Content Knowledge	-.58333	.99620	.28758	-1.21629	.04963	-2.028	11	.067
Pair 4	Pedagogical Content Knowledge	-.25000	.62158	.17944	-.64493	.14493	-1.393	11	.191
Pair 5	Technological Content Knowledge	-.91667	.79296	.22891	-1.42049	-.41284	-4.005	11	.002
Pair 6	Technological Pedagogical Knowledge	-.63917	.59911	.17295	-1.01982	-.25851	-3.696	11	.004
Pair 7	Pedagogical Content Knowledge	-.33333	.44901	.12962	-.61862	-.04805	-2.572	11	.026

Paired Samples Statistics		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Technological Knowledge - Pre	2.9025	12	.95003	.27425
	Technological Knowledge - Post	3.5142	12	.57110	.16486
Pair 2	Content Knowledge - Pre	4.3883	12	.54822	.15826
	Content Knowledge - Post	4.6108	12	.44612	.12878
Pair 3	Technological Pedagogical Content Knowledge - Pre	3.2500	12	1.21543	.35086
	Technological Pedagogical Content Knowledge - Post	3.8333	12	.57735	.16667
Pair 4	Pedagogical Content Knowledge - Pre	4.1667	12	.83485	.24100
	Pedagogical Content Knowledge - Post	4.4167	12	.51493	.14865
Pair 5	Technological Content Knowledge - Pre	2.6667	12	1.30268	.37605
	Technological Content Knowledge - Post	3.5833	12	1.08362	.31282
Pair 6	Technological Pedagogical Knowledge - Pre	3.2592	12	1.01235	.29224
	Technological Pedagogical Knowledge - Post	3.8983	12	.74249	.21434
Pair 7	Pedagogical Content Knowledge - Pre	4.1905	12	.49612	.14322
	Pedagogical Content Knowledge - Post	4.5238	12	.41909	.12098

5.4.1 Technological knowledge

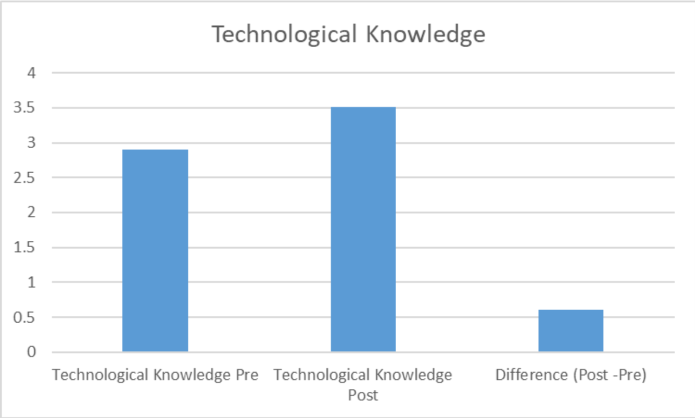

Figure 5.1: Graph of Technological Knowledge

Pair 1 (Technological knowledge) had a negative mean difference of -0.61167, which suggested an improvement in knowledge after the intervention for this specific sample. At a 95% confidence level, the P-value of 0.005 was statistically sufficient to reject H_0, as it falls within the 95% rejection region defined at the start of the experiment. The interval contained entirely negative values, and it does not include the null value of 0. Hence it provided sufficient evidence against H_0. There was thus enough overall evidence to reject the null hypothesis and conclude that the intervention did significantly change technological knowledge.

5.4.2 Content knowledge

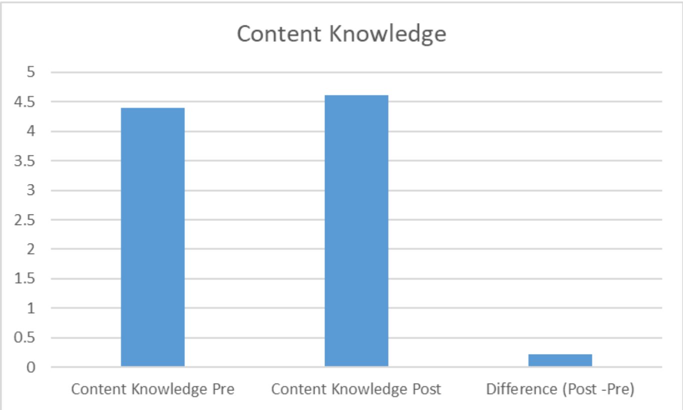

Figure 5.2: Graph of Content Knowledge

Pair 2 (Content knowledge) had a negative mean difference of -0.22250, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.152 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start of the experiment. At the 95%

confidence interval, pair 2 contains the null value of 0. Hence H_0 could not be rejected. There was insufficient overall evidence to reject the null hypothesis. The conclusion was that the intervention did not significantly change content knowledge.

5.4.3 Technological Pedagogical Content knowledge

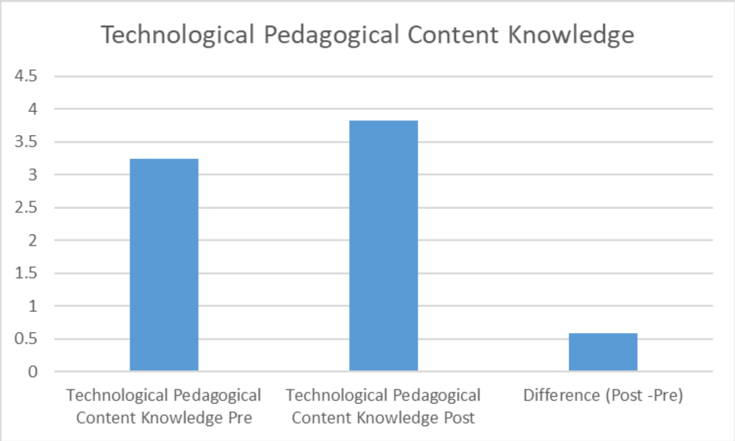

Figure 5.3: Graph of Technological Pedagogical Content Knowledge

Pair 3 (Technological Pedagogical Content knowledge) has a negative mean difference of -0.58333, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.067 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start of the study. If a 90% confidence level was used instead, then H_0 could be rejected, since the P-value was less than 0.100.

The 95% confidence interval contains the null value of 0, hence providing insufficient evidence against H_0. There is thus inadequate overall evidence to reject the null hypothesis providing evidence that the intervention did not significantly change technological pedagogical content knowledge.

5.4.4 Pedagogical Content knowledge

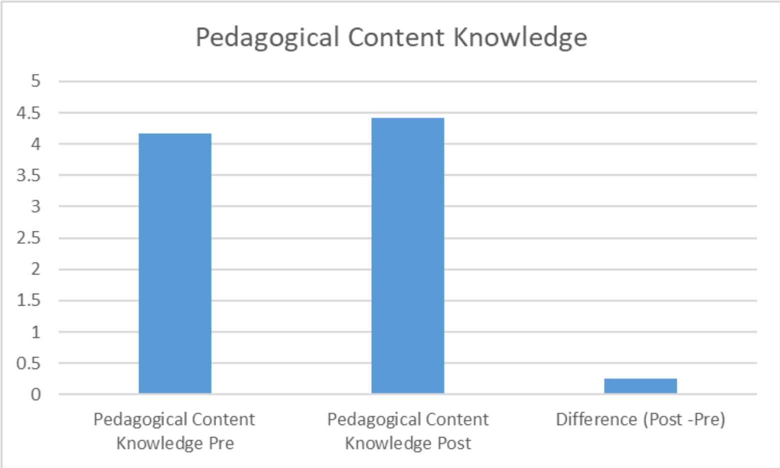

Figure 5.4: Graph of Pedagogical Content Knowledge

Pair 4 (Pedagogical Content knowledge) had a negative mean difference of -0.25000, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.191 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start. The 95% confidence interval contained the null value of 0. Hence H_0 could not be rejected.

There was thus insufficient overall evidence to reject the null hypothesis; therefore, the intervention did not significantly change pedagogical content knowledge.

5.4.5 Technological Content knowledge

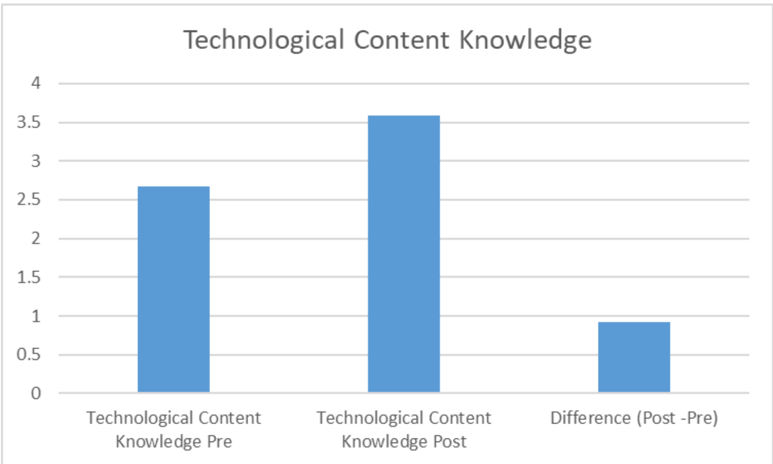

Figure 5.5: Graph of Technological Content Knowledge

Pair 5 (Technological Content knowledge) had a negative mean difference of -0.91667, which suggested an improvement in knowledge after the intervention for this specific sample. At a 95% confidence level, the P-value of 0.002 is statistically sufficient to reject H_0, as it fell within the 95% rejection region defined at the start of the experiment.

The interval contained entirely negative values, and it did not include the null value of 0. Hence it provided sufficient evidence against H_0. There was thus enough overall evidence to reject the null hypothesis and conclude that the intervention did significantly change technological content knowledge.

5.4.6 Technological Pedagogical knowledge

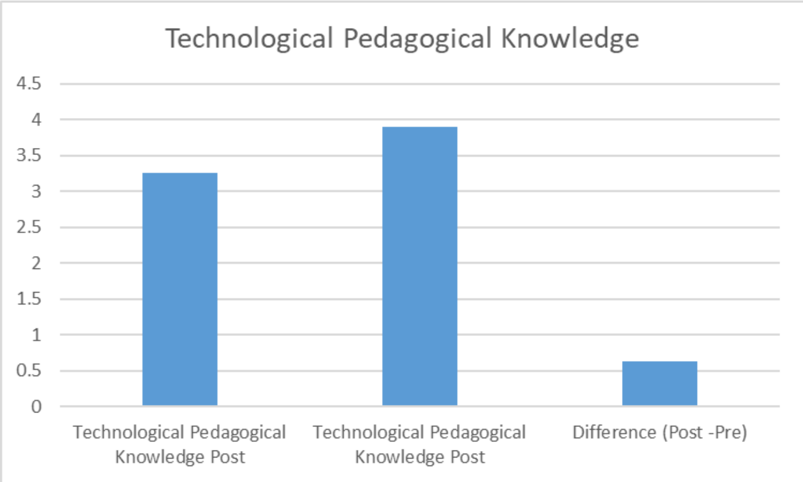

Figure 5.6: Graph of Technological Pedagogical Knowledge

Pair 6 (Technological Pedagogical knowledge) had a negative mean difference of -0.63917, which suggested an improvement in knowledge after the intervention for this specific sample. At a 95% confidence level, the P-value of 0.004 was statistically sufficient to reject H_0, as it fell within the 95% rejection region defined at the start of the study. The interval contained entirely negative values and did not have the null value of 0. Hence it provided sufficient evidence against H_0.

There was thus enough overall evidence to reject the null hypothesis and conclude that the intervention did significantly change technological pedagogical knowledge.

5.4.7 Pedagogical knowledge

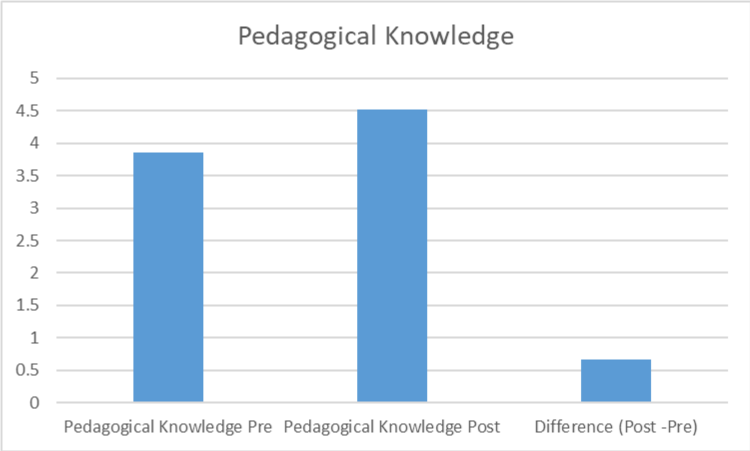

Figure 5.7: Graph of Pedagogical Knowledge

Pair 7 (Pedagogical knowledge) has a negative mean difference of -0.33333, which suggested an improvement in knowledge after the intervention for this specific sample. At a 95% confidence level, the P-value of 0.026 was statistically sufficient to reject H_0, as it fell within the 95% rejection region. The interval contained entirely negative values and did not contain the null value of 0. Hence it provided sufficient evidence against H_0. There was thus sufficient overall evidence to reject the null hypothesis. Therefore, it could be concluded that the intervention did significantly change pedagogical knowledge.

In summary: After considering the statistical significance of the differences in mean knowledge before and after intervention for all pairs, it was concluded that in the Composite of all subjects, the intervention did significantly change the resulting mean score of Pair 1 (Technological knowledge), Pair 5 (Technological Content knowledge), Pair 6 (Technological Pedagogical knowledge) and Pair 7 (Pedagogical knowledge). There was insufficient evidence to conclude that the intervention changed the resulting mean score for all other pairs 2 (Content Knowledge), 3 (Technological Pedagogical Content Knowledge) and 4 (Pedagogical Content Knowledge).

5.5 RESULTS PER CASE STUDY

The following sub-sections present the data from each case study independently. While the results generated were more difficult to generalize, it was important to consider each case separately and together to draw comparisons. The results for Life Sciences were presented first, followed by Mathematics and EMS.

5.5.1 Results for case study one - Life Sciences

Table 15: Paired Samples Test for Life Sciences

Paired Samples Test		Paired Differences					t	df	Sig.(2-tailed)
		Mean	Std. Deviation	Std.Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Technological Knowledge - Pre -	-.6275	.71220	.35610	-1.76076	.50576	-1.762	3	.176
Pair 3	Technological Pedagogical Content Knowledge	-1.0000	.81650	.40825	-2.29923	.29923	-2.449	3	.092
Pair 4	Pedagogical Content Knowledge	-.2500	.50000	.25000	-1.04561	.54561	-1.000	3	.391
Pair 5	Technological Content Knowledge	-1.2500	.95743	.47871	-2.77348	.27348	-2.611	3	.080
Pair 6	Technological Pedagogical Knowledge	-.7500	.24806	.12403	-1.14472	-.35528	-6.047	3	.009
Pair 7	Pedagogical Knowledge	-.28571	.42056	.21028	-.95492	.38349	-1.359	3	.267

The figure below provides a graphical representation of the Life Sciences results.

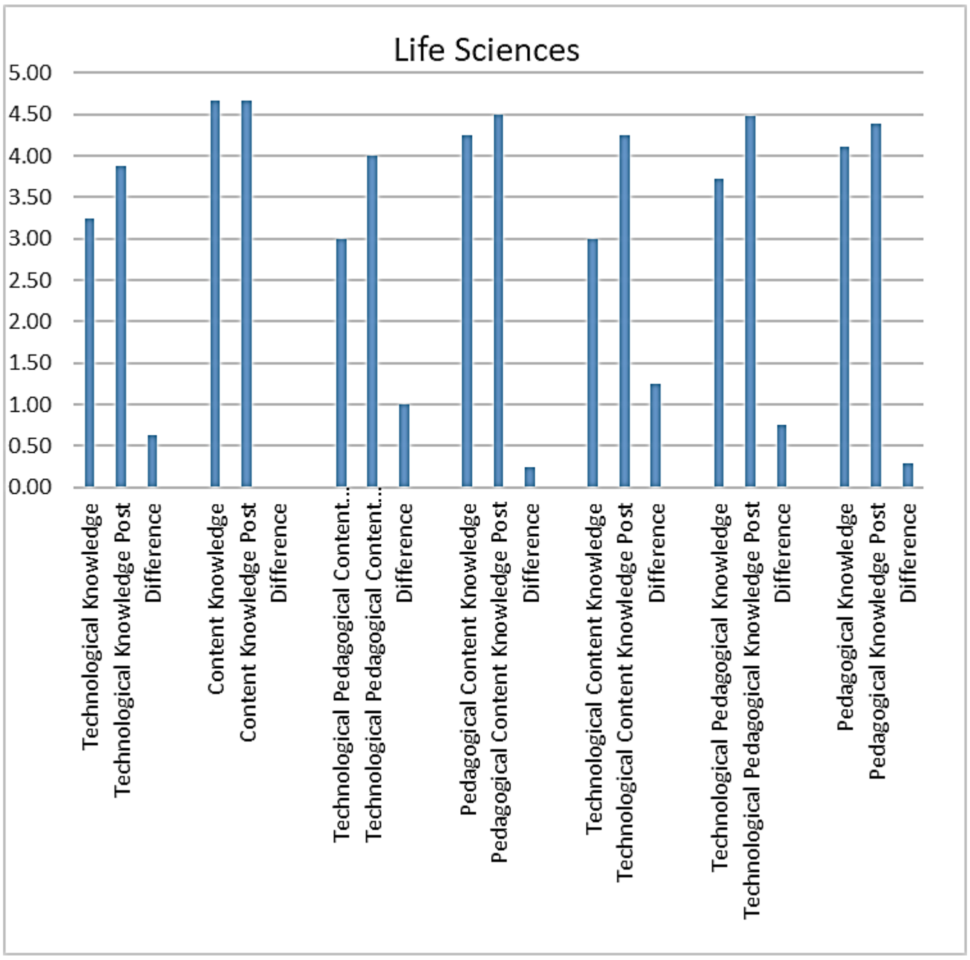

Figure 5.8: Graph of Life Sciences TPACK Knowledge areas

Pair 1 (Technological knowledge) had a negative mean difference of -0.62750, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.176 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start. The 95% confidence interval was relatively wide due to the high standard deviation, indicating a large variance in the resulting difference in means. Even though this interval was biased towards the negative side, it contains the null value of 0. Hence H_0 could not be rejected. There was thus insufficient overall evidence to reject the null hypothesis, and therefore the conclusion was that the intervention did not significantly change technological knowledge.

Pair 2 (Content knowledge) resulted in a mean difference of exactly 0, which indicates no difference in knowledge after the intervention. With a T-statistic of 0, it means that the resulting mean score before and after the intervention was identical, which meant that the null hypothesis could not be rejected. The conclusion was, therefore, that the intervention had not significantly changed content knowledge.

Pair 3 (Technological Pedagogical Content knowledge) had a negative mean difference of -1.000, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.092 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the beginning. If the confidence level was set at 90%, then there may have been a possibility of rejecting H_0. The 95% confidence interval was extensive due to the high standard deviation. This interval was symmetrical around 0, which indicated that it was equally likely that knowledge would improve or deteriorate, although it contained the null value of 0, hence providing insufficient evidence against H_0. There was thus inadequate overall evidence to reject the null hypothesis, and the conclusion was that the intervention did not significantly change technological pedagogical content knowledge.

Pair 4 (Pedagogical Content knowledge) had a negative mean difference of -0.25000, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.391 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start. The 95% confidence interval contained the null value of 0. Hence H_0 could not be rejected. There was thus insufficient overall evidence to reject the null hypothesis. The conclusion was, therefore, that the intervention had not significantly changed pedagogical content knowledge.

Pair 5 (Technological Content knowledge) had a negative mean difference of -1.25000, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.080 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start. At a 90% confidence level, however, H_0 could be rejected. The 95% confidence interval contained the null value of 0. Hence H_0 could not be rejected, even though the interval was heavily biased to the negative side. There was thus insufficient overall evidence to reject the null hypothesis. Therefore, the conclusion was that the intervention did not significantly change technological content knowledge.

Pair 6 (Technological Pedagogical knowledge) had a negative mean difference of -0.75000, which suggested an improvement in knowledge after the intervention for this specific sample. If the P-value of 0.009 was considered, it could be seen that this fell within the rejection region and was indeed statistically significant. At the 95% confidence interval, it was seen that it was very narrow due to the low standard deviation. This indicated that there was more certainty that the mean difference fell within this limited range. The 95% confidence interval only contained negative values and did not include 0, which provided evidence against H_0. Therefore, the conclusion was that intervention significantly improved technological pedagogical knowledge.

Pair 7 (Pedagogical knowledge) had a negative mean difference of -0.28571, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.267 was not statistically sufficient to reject H_0, as it does not fall within the 95% rejection region defined at the start of the experiment. The 95% confidence interval was slightly biased towards the negative side. However, it contained the null value of 0. H_0 could, therefore, not be rejected. There was thus insufficient overall evidence to reject the null hypothesis. The conclusion was that the intervention did not significantly change pedagogical knowledge.

In summary: After considering the statistical significance of the differences in mean knowledge before and after intervention for all pairs, it was concluded that in the subject of Life Sciences, the intervention only significantly changed the resulting mean score of Pair 6 (Technological Pedagogical knowledge), and there was insufficient evidence to conclude that the intervention changed the resulting mean score for all other pairs 1-5 and 7.

5.5.2 Results for case study two - Mathematics

Table 16: Paired Samples Test for Mathematics

Paired Samples Test		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Technological Knowledge	-.20750	.61435	.30717	-1.18507	.77007	-.676	3	.548
Pair 2	Content Knowledge	-.25000	.32031	.16016	-.75969	.25969	-1.561	3	.216
Pair 3	Technological Pedagogical Content Knowledge	-.50000	1.00000	.50000	-2.09122	1.09122	-1.000	3	.391
Pair 5	Technological Content Knowledge	-.25000	.50000	.25000	-1.04561	.54561	-1.000	3	.391
Pair 6	Technological Pedagogical Knowledge	-.58250	.55476	.27738	-1.46525	.30025	-2.100	3	.127
Pair 7	Pedagogical Knowledge	-.28571	.40406	.20203	-.92867	.35724	-1.414	3	.252

The figure below provides a graphical representation of the Mathematics results.

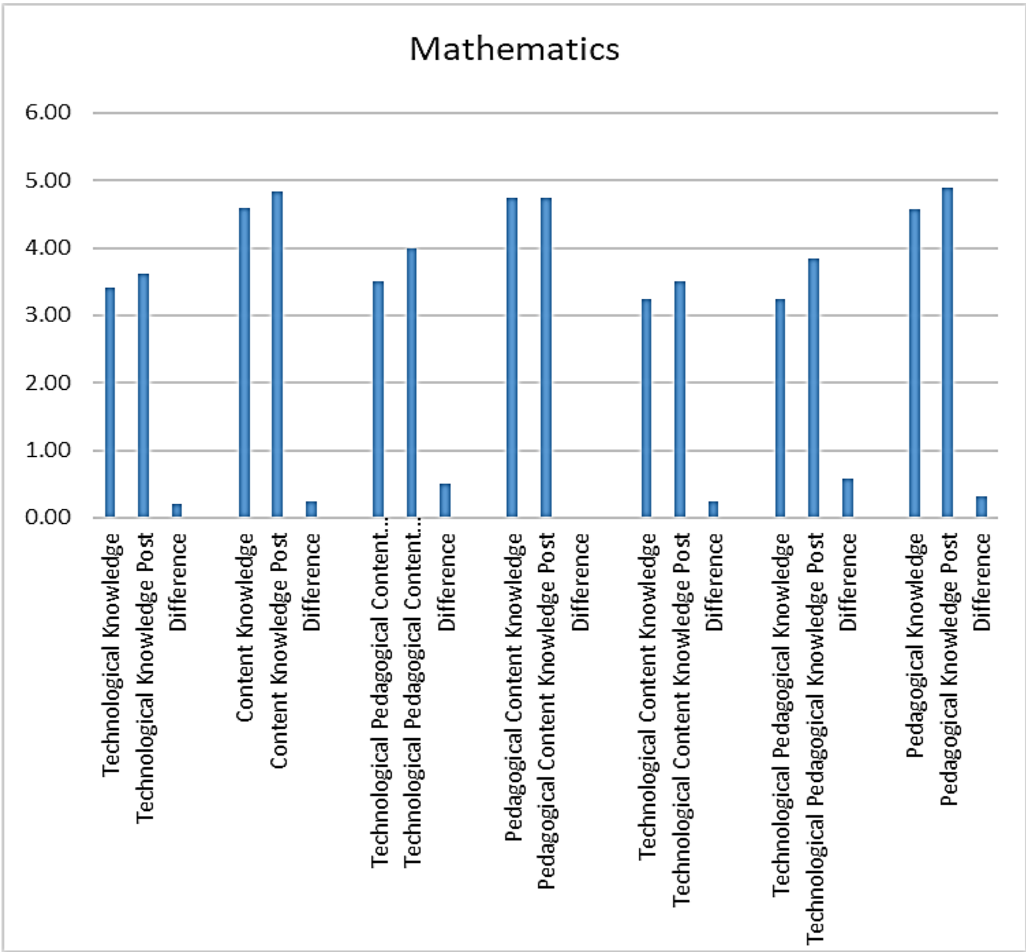

Figure 5.9: Graph of Mathematics TPACK Knowledge Areas

Pair 1 (Technological knowledge) had a negative mean difference of -0.20750, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.548 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start. The 95% confidence interval was relatively wide due to the high standard deviation, indicating a large variance in the resulting difference in means. Even though this interval was biased towards the negative side, it contained the null value of 0. Hence H_0 could not be rejected. There was thus insufficient overall evidence to reject the null hypothesis, and the conclusion was that the intervention did not significantly change technological knowledge.

Pair 2 (Content knowledge) had a negative mean difference of -0.25000, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.216 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start of the study. The 95% confidence interval contained the null value of 0, H_0 could not be rejected. There was thus insufficient overall evidence to reject the null hypothesis, and the conclusion was that the intervention did not significantly change content knowledge.

Pair 3 (Technological Pedagogical Content knowledge) had a negative mean difference of -0.50000, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.391 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start. The 95% confidence interval was extensive due to the high standard deviation. This interval contained the null value of 0, hence providing insufficient evidence against H_0. There was thus inadequate overall evidence to reject the null hypothesis; hence the conclusion was that the intervention did not significantly change technological pedagogical content knowledge.

Pair 4 (Pedagogical Content knowledge) resulted in a mean difference of exactly 0, which indicated no difference in knowledge after the intervention. With a T-statistic of 0, it meant that the resulting mean score before and after the intervention was identical, which meant that the null hypothesis could not be rejected and therefore concluded that the intervention did not significantly change pedagogical content knowledge.

Pair 5 (Technological Content knowledge) had a negative mean difference of -0.25000, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.391 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start. The 95% confidence interval contained the null value of 0. Hence H_0 could not be rejected, even though the interval was biased to the negative side. There was thus insufficient overall evidence to reject the null hypothesis; hence the conclusion was that the intervention did not significantly change technological content knowledge.

Pair 6 (Technological Pedagogical knowledge) had a negative mean difference of -0.58250, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.127 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start. The 95% confidence interval was biased towards the negative side. However, it contained the null value of 0; hence H_0 cannot be rejected. There was thus insufficient overall evidence to reject the null hypothesis. This indicated that the intervention did not significantly change technological pedagogical knowledge.

Pair 7 (Pedagogical knowledge) had a negative mean difference of -0.28571, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.252 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start of the experiment. The 95% confidence interval contained the null value of 0; hence H_0 could not be rejected. There was thus insufficient overall evidence to reject the null hypothesis. The conclusion was, therefore, that the intervention did not significantly change pedagogical knowledge.

In summary: After considering the statistical significance of the differences in mean knowledge before and after intervention for all pairs, it was concluded that in the subject of Mathematics, there was insufficient evidence to show that the intervention significantly changed the resulting mean score of any pairs 1-7.

5.5.3 Results for case study three - Economic and Management Sciences

Table 17: Paired Samples Test for Economic and Management Sciences

Paired Samples Test		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Technological Knowledge	-1.000	.23338	.11669	-1.37136	-.62864	-8.570	3	.003
Pair 2	Content Knowledge	-.4175	.83500	.41750	-1.74617	.91117	-1.000	3	.391
Pair 3	Technological Pedagogical Content Knowledge	-.2500	1.2583	.62915	-2.25225	1.75225	-.397	3	.718
Pair 4	Pedagogical Content Knowledge	-.5000	1.000	.50000	-2.09122	1.09122	-1.000	3	.391
Pair 5	Technological Content Knowledge	-1.2500	.5000	.25000	-2.04561	-.45439	-5.000	3	.015
Pair 6	Technological Pedagogical Knowledge	-.5850	.96033	.48016	-2.11310	.94310	-1.218	3	.310
Pair 7	Pedagogical Knowledge	-.42857	.61721	.30861	-1.41070	.55355	-1.389	3	.259

The figure below provides a graphical representation of the Economic and Management Sciences results.

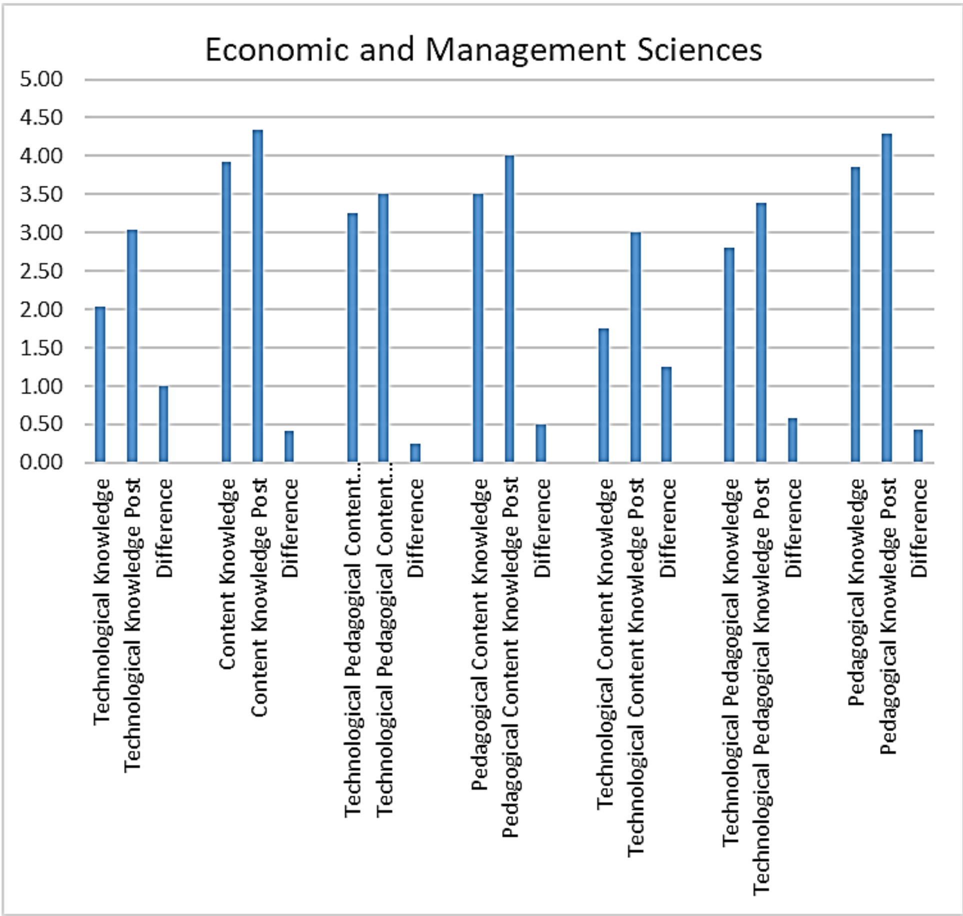

Figure 5.10: Graph of Economic and Management Sciences TPACK Knowledge Areas

Pair 1 (Technological knowledge) had a negative mean difference of -1.00000, which suggested an improvement in knowledge after the intervention for this specific sample. At a 95% confidence level, the P-value of 0.003 was statistically sufficient to reject H_0, as it fell within the 95% rejection region defined at the start of the experiment. The 95% confidence interval was relatively narrow due to the low standard deviation, indicating relative certainty that the resulting difference in means would have fallen within this limited range. The interval contained entirely negative values, and it did not have the null value of 0; hence it provided sufficient evidence against H_0. There was thus enough overall evidence to reject the null hypothesis. The conclusion was, therefore, that the intervention had indeed significantly changed technological knowledge.

Pair 2 (Content knowledge) had a negative mean difference of -0.41750, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.391 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start of the experiment. The 95% confidence interval contained the null value of 0; hence H_0 could not be rejected. There was thus insufficient overall evidence to reject the null hypothesis. The conclusion was, therefore, that the intervention did not significantly change content knowledge.

Pair 3 (Technological Pedagogical Content knowledge) had a negative mean difference of -0.25000, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.718 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start of the experiment. We also found that the 95% confidence interval was extensive due to the high standard deviation. This interval contained the null value of 0, hence providing insufficient evidence against H_0. There was thus inadequate overall evidence to reject the null hypothesis. The intervention, therefore, had not significantly changed technological pedagogical content knowledge.

Pair 4 (Pedagogical Content knowledge) had a negative mean difference of -0.50000, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.391 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start of the experiment. The 95% confidence interval was extensive due to the high standard deviation. The 95% confidence interval contained the null value of 0. Hence H_0 could not be rejected. There was thus insufficient overall evidence to reject the null hypothesis indicating that the intervention had not significantly changed pedagogical content knowledge.

Pair 5 (Technological Content knowledge) had a negative mean difference of -1.25000, which suggested an improvement in knowledge after the intervention for this specific sample. At a 95% confidence level, the P-value of 0.015 was statistically sufficient to reject H_0, as it fell within the 95% rejection region defined at the start of the experiment. The interval contained entirely negative values, and it did not have the null value of 0; hence it provided sufficient evidence against H_0. There was thus enough overall evidence to reject the null hypothesis. Therefore, the intervention had indeed significantly changed technological content knowledge.

Pair 6 (Technological Pedagogical knowledge) had a negative mean difference of -0.58500, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.310 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start. The 95% confidence interval was extensive due to the high standard deviation. This interval contained the null value of 0 and hence provided insufficient evidence against H_0. There was thus inadequate overall evidence to reject the null hypothesis; hence the conclusion was that the intervention had not significantly changed technological pedagogical knowledge.

Pair 7 (Pedagogical knowledge) had a negative mean difference of -0.42857, which suggested an improvement in knowledge after the intervention for this specific sample. However, at a 95% confidence level, the P-value of 0.259 was not statistically sufficient to reject H_0, as it did not fall within the 95% rejection region defined at the start of the experiment. The 95% confidence interval was slightly biased towards the negative side. However, it contained the null value of 0. Hence H0 could not be rejected. There was thus insufficient overall evidence to reject the null hypothesis. Hence, the intervention had not significantly changed pedagogical knowledge.

In summary: After considering the statistical significance of the differences in mean knowledge before and after intervention for all pairs, it was concluded that in the subject of Economic and Management Sciences, the intervention significantly changed the resulting mean score of Pair 1 (Technological knowledge) and Pair 5 (Technological Content knowledge). There was insufficient evidence to conclude that the intervention changed the resulting mean score for all other pairs 2, 3, 4, 6 and 7.

5.6 SUMMARY OF RESULTS

This study aimed to analyse whether a teacher's knowledge in seven key areas would change after being exposed to an intervention. Using a Likert scale questionnaire, teachers were asked to rate their knowledge in Technological, Pedagogical, Content and combinations of these areas on a scale from 1 to 5. The mean response after the intervention was subtracted from the mean response before the intervention. This difference was assumed to follow a t-distribution. The t-statistic was a sufficient representation of the entire information known about the respective area of knowledge. With a 95% confidence level set as the standard, the null hypothesis for this experiment was that the intervention caused no statistically significant difference in mean response. A two-tailed test was chosen to be conducted, which meant the alternative hypothesis was that there was a statistically significant difference in mean response (either an improvement or a deterioration) after the intervention.

After careful analysis of these seven critical areas across the subjects of EMS, Life Sciences, Maths and a Combination of the three subjects, the following conclusions were made.

In the **subject of Life Sciences**, the intervention caused the teacher's technological pedagogical knowledge to change significantly (more specifically, to improve).

In the **subject of Mathematics**, while an improvement was noted in most areas, the intervention caused no statistically significant change in the teacher's knowledge across any area.

In the **subject of Economic and Management Sciences**, the intervention caused the teacher's technological knowledge and their technological content knowledge to change significantly (more specifically, to improve).

The Composite analysis indicated that the intervention caused a significant change (an improvement) to some areas of teachers' knowledge. These areas were the teacher's technological knowledge; their technological content knowledge; their technological pedagogical knowledge; and their pedagogical knowledge. At a 95% confidence level, there was insufficient evidence to conclude that the intervention caused any statistically significant change in knowledge in any other area over the subjects.

Chapter six provided an analysis of the quantitative results and qualitative findings. The quantitative results were discussed together with the qualitative findings in this chapter. The discussion that followed was framed by the research questions and the theoretical frameworks.

Chapter 6

The discussion of the findings and results

6.1 INTRODUCTION

This chapter contains an analysis of the results and a discussion of the findings of the study. This chapter contains four main sections. It begins by providing a brief introduction and restating the research questions, which guides the discussion. A summary of the qualitative findings and quantitative results is provided in the introduction. Each of the three research questions is then discussed separately, followed by a summary of the findings and the results. Three frameworks guided the discussion and analysis: the TPACK framework, Guskey's framework for evaluating professional development, and the theory of planned behaviour. An indication of how these frameworks are used is provided later in this section.

This study employed mixed methods to explore teachers' experiences of Lesson Study for integrating ICTs in teaching using multiple case studies. A discussion of the findings and the results are presented in this chapter.

The multiple case study approach was used due to differing interactions occurring within subject departments as a result of the varying levels of experience, the social interactions, the subject content and the preferred teaching methods. Participants were separated into subject departments and worked through the Lesson Study cycles as separate units. A discussion of the findings and the results are presented separately since each department represents a unique case. A cross-case summary is then presented.

The discussion divided into three sections and was based primarily on the research questions of the study:

How do teachers' confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study? The TPACK framework was the guiding framework for this discussion.

What are teachers' experiences in using Lesson Study as a strategy to develop their competence in integrating ICTs (information and communication technologies) in their teaching? The TPACK framework and Guskey's professional development evaluation framework guided this discussion.

Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do? The Theory of Planned Behaviour guided this discussion.

The following three items were considered during the discussion: the effect on teachers' confidence; teachers' experiences of Lesson Study for ICT integration; and the explanations behind teachers' experiences. The qualitative findings were obtained from the interviews, document analysis and lesson observations. The bulk of the qualitative data was obtained from the interviews. Data obtained through document analysis and lesson observations were used to support the interview findings and assist with triangulation.

6.2 SUMMARY OF RESULTS AND FINDINGS

A summary of the quantitative results is provided first. Teachers were asked to rate their knowledge in Technological, Pedagogical, Content and combinations of these areas on a scale from 1 to 5 using a Likert scale questionnaire. The mean response after the intervention was subtracted from the mean response before the intervention. This difference was assumed to follow a t-distribution. The t-statistic is a sufficient representation of the entire information known about the respective area of knowledge. With a 95% confidence level set as the standard, the null hypothesis for this experiment was that the intervention caused no statistically significant difference in mean response. A two-tailed test was chosen to be conducted, which meant the alternative hypothesis was that there is a statistically significant difference in mean response (either an improvement or a deterioration) after the intervention.

The Composite analysis indicated that the intervention caused a significant change (an improvement) to some areas of teachers' knowledge. The areas of improvement were teacher's technological knowledge (TK), their technological content knowledge (TCK), their technological pedagogical knowledge (TPK), and their pedagogical knowledge (PK). At a 95% confidence level, there is insufficient evidence to conclude that the intervention caused any statistically significant change in the other knowledge areas over the subjects.

The graph below provides a visual representation of the pre and post Lesson Study scores, the difference in means and the p-values for each knowledge area.

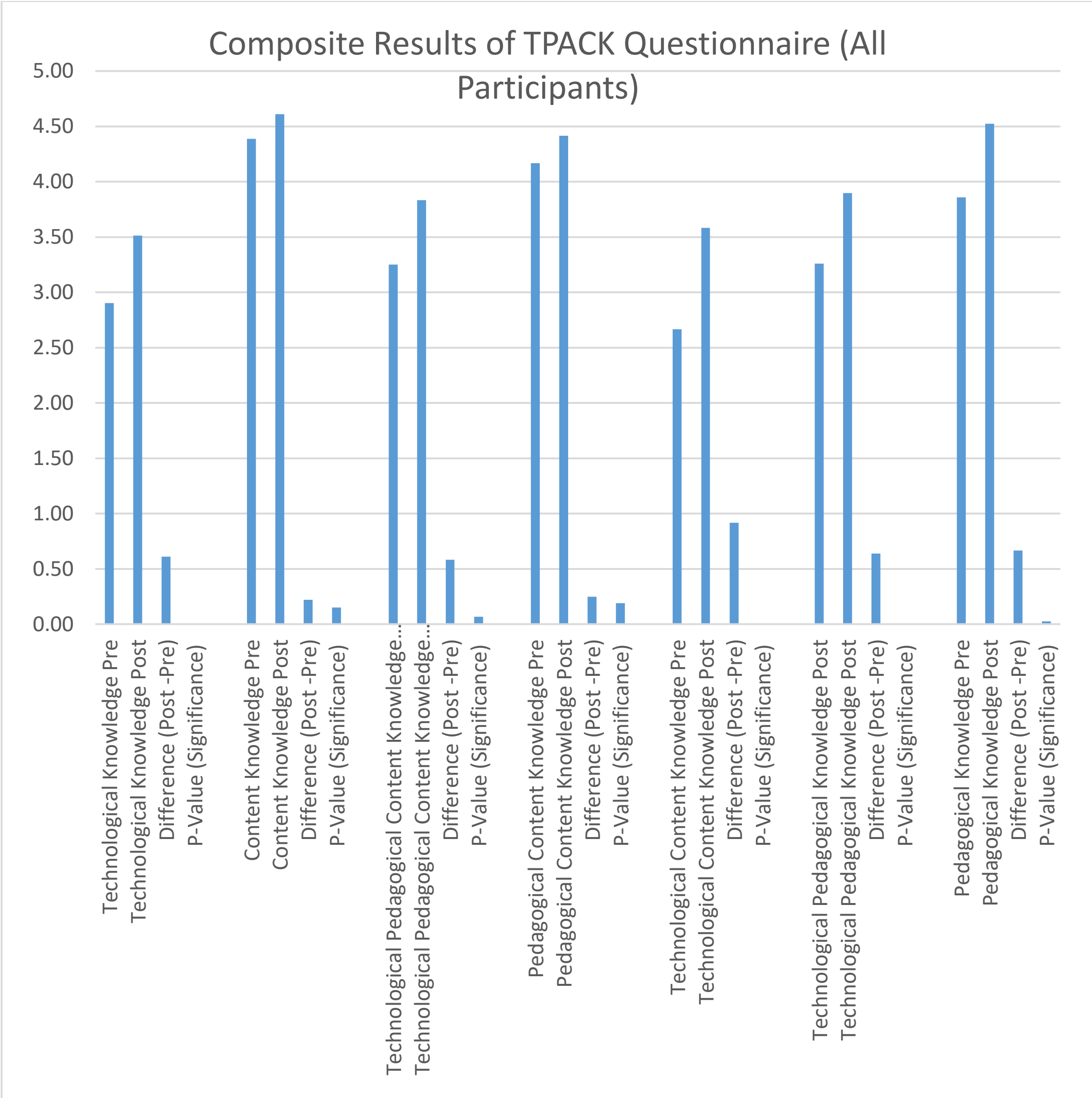

Figure 6.1: Composite Results of Participants TPACK Knowledge Areas

The table below is a summary of the chapter and the sections discussed.

Table 18: A Summary of the Critical Areas for Discussion

Research Question	**Discussion**	**Framework used**
How do teachers' confidence in integrating ICTs in their teaching change through the use of Lesson Study?	- Collegial support - Reduced teacher isolation - Teacher workload - Learners' responses - Teacher confidence in Technology, Pedagogy and Content Knowledge	TPACK Framework
What are teachers' experiences in using Lesson Study as a strategy to develop their competence in integrating ICTs in their teaching?	- Participants reactions o Lesson Study structure o Lesson Study vs previous forms of professional development o Time as a barrier - Participants learning o Knowledge and skills o Reflective practices - Organisational support and change o Support from school personnel o Problems and perceived limitations o Effect on school climate and procedures	TPACK Framework Guskey's Framework for evaluating professional development

	- Teachers use of new knowledge and skills - Learners' learning outcomes	
Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do?	- Attitudes - Behavioural intentions - Subjective norms - Social norms - Perceived behavioural control	The Theory of Planned Behaviour

The above table indicates the key topics that were discussed in this chapter. The quantitative results were discussed together with the qualitative findings in this chapter. The discussion that follows is framed by the research questions and the theoretical frameworks.

6.3 RESEARCH QUESTION ONE: TEACHERS' EXPERIENCES OF LESSON STUDY TO DEVELOP THEIR CONFIDENCE IN USING ICTS FOR TEACHING

The word confidence is used interchangeably with efficacy in this study. While Bandura (1997) considers confidence to mean strength of belief, it does not necessarily indicate a belief in the ability to perform a task. Instead, it could indicate that the teacher is confident in not being able to perform a task. Self-efficacy, however, is described as the belief in being able to attain a level of achievement. The first research question, therefore, explored teachers' experiences of Lesson Study to develop their belief that they will be able to attain a satisfactory level of achievement in using ICTs in teaching.

Current research shows that for teachers to improve their confidence in education they need to engage in novel ways of thinking, use new and unfamiliar teaching methods and engage in reflective activities (Axelsen, Galligan, & Woolcott, 2017). Nolan and Molla (2017) found that teacher confidence is strongly linked to the acquisition of new knowledge and skills and participation in collaborative learning.

Similar findings were obtained in this study, and each of these is discussed in more detail below. The study found that the factors reported affecting teacher confidence were collegial support and reduced teacher isolation, collaboration, preparation, resources, teacher workload, and learner responses.

6.3.1 Collegial support

Collegial support played a critical role in developing teachers' confidence to integrate ICTs in teaching. Within the Life Sciences department, the junior teachers, Bruce and Selena, had only six years of teaching experience while Tina and Coraline had more than 30 years of teaching experience each. While Tina had claimed that she was not comfortable using ICTs, she appreciated the assistance, encouragement and support provided by the other members of her department. In discussion with Tina, she remarked how her department tried to keep her updated and involved in the process.

Similarly, within the Economic and Management Sciences (EMS) department, teachers mentioned that the support they received from each other helped them cope with the challenges they faced while participating in the Lesson Study programme. Lisa mentioned that without the aid of her team, she would not have been able to succeed in integrating ICTs in her teaching.

I think we all managed together. If it was just thrown at me. I certainly wouldn't have been able to do it. We all just worked together, and everybody was sort of committed to helping each other, so teamwork was good. (Lisa)

The support provided by members of the department extended beyond content coverage. Instead, teachers focused on doing what was best for their learners. The discussions dealt with helping children develop a better understanding while at the same time allowing teachers the opportunity to express their opinions on the challenges they faced. The fact that teachers were able to share their feelings indicates a level of trust and support among them. Shikaar (Mathematics) indicated that *"we were all bouncing ideas off each other. No idea went pretty much unacknowledged. Nobody made someone feel beneath what they are or anything like that."*

Teachers of the mathematics department noted that by working together, they were able to provide and receive support and guidance. Working together resulted in reduced pressure on the teachers as the workload became a shared responsibility of the group, and the success or failure of tasks was due to the group, not any individual. The feedback, discussion and the reduced amount of work were appreciated. Teachers were able to put innovative ideas into practice through the support they received from one another.

These findings are indicative of the role that support from colleagues plays when teachers use Lesson Study to integrate ICTs in their teaching. The tentative evidence suggests that the collegial support experienced had a positive effect on teachers' confidence in integrating ICTs in teaching. The findings suggest that a supportive environment, shared responsibility, assistance, and encouragement motivated teachers to engage positively with the Lesson Study process. Wendy (Mathematics) indicated that she was more willing to use ICTs in her teaching after working collaboratively and receiving support from her department.

"Before I would not have even bothered. That's it. So I've actually taken some of the stuff that we'd put up on Google classroom and printed stuff from there, and I have been using it. So this has forced me to use it a little bit and obviously with more practice, I'm hoping to use it a little more in the classroom."

Hashim, Tahir, and Musah (2020) identified collegial support and the support of superiors, in this case, those who were more knowledgeable in the use of ICTs, as influential in respect of teachers' perceived mastery of teaching. Further, the findings are consistent with Hatlevik and Hatlevik (2018), who stated that collegial support helped provide teachers with informal opportunities to learn to use ICTs in teaching together. Collegial support helps to foster ICT self-efficacy and helps teachers develop an understanding of the use of ICTs for teaching (Hatlevik & Hatlevik, 2018). Through the support received, teachers were more confident in the lessons they developed, the presentation of those lessons and the use of ICTs in those lessons.

6.3.2 Reduced teacher isolation

The teaching profession is regarded as one that usually occurs in isolation (Vangrieken & Kyndt, 2020). Ostovar-Nameghi and Sheikhahmadi (2016) identified several reasons for teacher isolation in schools. These are the time table and school structure which may result in a lack of time to engage with colleagues. Discussions among colleagues, when they occur, are often related to cordial talks rather than student learning or planning (Ostovar-Nameghi & Sheikhahmadi, 2016).

While all departments indicated that they had worked collaboratively in the past, these interactions were limited to routine discussions. For example, Life Sciences teachers reported that they had often worked collaboratively in the past. They worked together in designing worksheets, electronic presentations like PowerPoints and setting tests; however, the type of collaborative work done during the Lesson Study process was considered different.

"The normal working together would be the run-of-the-mill, talking about those syllabus content and marking and who sets what test." (Coraline)

The collaboration experienced before the Lesson Study process involved no more than routine discussions on syllabus coverage and assessments. However, engagement in the Lesson Study process was considered different and resulted in many advantages.

"It added another dimension to our professional relation to one another which is quite good. So we enjoy rather than sitting around saying where are we in the syllabus." (Bruce, Life Sciences)

"This took us away from all that, you know, this was completely away. It was a different mind-set. It was fresh." (Coraline, Life Sciences)

Planning and presentation of lessons were previously done individually while limited lesson observations occurred. Teachers knew little about each other's planning or teaching styles. The usual interactions occurred during subject meetings or during informal meetings where discussions revolved around content and syllabus completion.

While the argument for collaboration in schools is strong, collaboration occurs minimally within the teaching profession since "most schools embrace a culture of isolation" (Mitchell & Sackney, 2011, p. 71). This means that unless a conscious effort is made, by the school community, management of a school or people developing professional development courses, collaboration will not occur.

While teachers had worked collaboratively in the past, they agreed that teaching was viewed as a profession where one would usually work in isolation with minimal interaction. Wendy (Mathematics) stated that

"normally, we world more or less in isolation. Not that we don't do things together, but mostly it's all about WhatsApp, what we meet at our meetings because all of us have a different workload. We are not free at the same time. And it's, and we've got different grades to teach. So each one more or less, as long as you've got the syllabus in front of you, you're more or less doing your own thing."

Through engagement in the Lesson Study programme, teachers were able to work collaboratively. As a result of the collaboration, teachers were encouraged to work together more often than they usually did. Vashnie (EMS) pointed out that *"lots of people tend to work alone. Keep information to themselves. This forced us if you want to use the word forced; it forces you to work together."*

Collaboration among teachers improved communication which facilitates the sharing of concerns, ideas and best practices (Darling-Hammond et al., 2017). This is reflected by Lisa's (EMS) statement, *"We all just worked together, and everybody was sort of committed to helping each other, so teamwork was good."*

By feeling more supported and therefore, less isolated, teachers were more willing to seek help from colleagues. This meant that more experienced teachers were comfortable getting assistance from junior teachers within their departments. Bruce (Life Sciences) said that teachers worked together with *"one another in a kind of almost unnatural way because it is often the older teacher helping, the younger. In this case, the youngest often like trying to teach a skill to the older teachers."*

Due to the focus of the Lesson Study programme being ICT integration, it was the junior teachers who assumed the leadership roles since they had more experience using ICTs. Coraline (Life Sciences) said that *"I was really being guided by the two younger teachers in my department."* Selena (Life Sciences) mentioned that it was useful that they were able to work together since they were able to help others.

"If you have a cross-generational department to help teachers who aren't naturally inclined to use ICT's, then it's helpful because you working in collaboration with each other." (Selena)

These sentiments were echoed by Tina (Life Sciences) who acknowledged the support provided by her department.

"They were very helpful, and they try to keep me in the loop. They were very willing to share with me even though I couldn't do it. They would say these are the answers to the questions and whatever. You know, this is what we said, and I think this is very good."

Teachers, therefore, reported feeling less isolated and more involved with the department. Some studies have indicated that it may also result in participants developing a sense of mutual trust through their participation (Sánchez-Cardona et al., 2012). Through collaboration, teachers experienced more collegial support than they would usually have and hence experienced less teacher isolation. By working collaboratively, teachers were able to develop their confidence in planning and designing ICT integrated lessons. The collaboration experienced through the Lesson Study process, therefore, helped improve teachers' confidence in using ICTs in their teaching.

While collaboration was reported to have positive results on teacher confidence, teacher workload, and learners' responses to ICT integrated lessons proved to be deterring factors.

6.3.3 Teacher workload

One of the factors that affected the involvement of all teachers in the Lesson Study programme was the workload that teachers had. Involvement in the Lesson Study programme required teachers to be available for participation for large amounts of time. While previous professional development programmes required a minimal involvement of between one to two hours, involvement in the Lesson Study programme required teachers to be available for several hours per session. Further, each cycle consisted of multiple sessions which occurred over a sustained period. For example, a single cycle of planning, presentation, observation and review could last more than two months. While teachers reported positive experiences through the Lesson Study process, their workload negatively affected their involvement and hence their confidence. The excerpts below illustrate this point.

It's hard to get everything else done, especially if you're a teacher involved in sport and other things. It's an extra workload (Johno, EMS)

Because we're all very, very heavily loaded in terms of teaching time, extra murals and then obviously the matric block lessons and so and coaching. And for myself as well, when I'm pushed for time, I get anxious, I get anxious. It feels like I can't really focus entirely on something that's really important because you're kind of scatter-brained. (Marike, Mathematics)

Within our department, they were two or three meetings/trainings and one of us wasn't able to be at because of something like detention duty or extramural activity or batting, so that was probably the only thing in terms of all four of us being available at the same time without some other commitment getting in the way. (Selena, Life Sciences)

Due to the high teachers' workload, many were unable to be as fully involved as they would have preferred. Marike also reported that not being able to meet whenever teachers needed to result in *"frustration"*. The high teacher workload meant that meetings for each cycle were fragmented and continuity of the cycle was affected. The results of the OECD's Teaching and Learning International Survey (TALIS) (Sellen, 2016) indicated similar results to the findings in this study. The report found that teacher workload was considered to be a significant barrier in teachers participating in professional development activities. The study also found that teachers who were confident and well prepared were less likely to complain about unmanageable workloads meaning that the effect of a high workload on professional development activities may be resulting in a cycle which negatively affects teacher confidence and participation. Similar findings were reported from a study conducted in Ethiopia (Tulu, 2019). The study found that teachers' workload was a significant factor impeding teacher participation in professional development activities. Similar findings were reported by Ogegbo et al. (2019) in their small scale research on the use of Lesson Study in Physical Sciences.

While these studies support the negative effect of teacher workload on professional development activities, these studies are generally based on traditional forms of professional development. Traditional forms of professional development are usually one-day courses that take place over a few hours (Darling-Hammond et al., 2017; Elliott, 2017). The Lesson Study programme is a sustained form of continuing professional development which involved cycles of participation. It is, therefore, understandable that the high workload would be a significant factor for teachers.

The second factor reported affecting teachers' confidence was learner responses.

6.3.4 Learner responses

Learner responses to the ICT integrated lessons had positives and negatives implication on teacher confidence during the Lesson Study process. Teachers reported that learners viewed ICT resources as social tools rather than educational resources. The behaviour of learners when teachers used ICTs in teaching indicated their attitude.

"As soon as the lights went off for technology, you get the woos and aahs, and it was inappropriate." (Dustin, Mathematics)

"you put on a projector or computer in front of them, then they feel like they have to do no work because the computers is just going to do everything for them or whatever you are projecting is gonna, you know, automatically be absorbed into their brains. (Shikaar, Mathematics)

The attitude of learners to the ICTs indicated that they did not view these resources as tools for education. When teachers are exposed to this type of attitude from learners, they may become demoralised or unconfident in their teaching. Belle and Horil (2020) also indicated that teachers might become demotivated by a lack of discipline and unwillingness to participate on the part of the learners. The lack of confidence could lead to teachers questioning their use of ICTs and even the involvement in the programme resulting in teachers not using technology as Dustin's statement indicated. *"It would have been more feasible to teach it in a different manner."*

While learner responses lead to teachers questioning the use of ICTs, it also produced a significant positive outcome. Teachers began questioning their approach to teaching classes and by doing so, began to reflect more meticulously on their teaching.

Dustin (Mathematics) pointed out that *"we learned very quickly that a 10.1 (Advanced class) class teaching probability to them using technology is very different to teaching a 10.6 (Low mathematical ability) class using technology."*

After teaching the lesson to the Grade 10 class, Marike noted that changes would have to be made to her teaching. She stated that to improve her lesson, she would have to engage *"in constant reflection of how I used it (ICTs), was it effective, did I keep the kids interested? Where did I lose them? How could I change it for next year's lesson?"*

While learner responses did result in demotivation and reduced confidence in the developed lesson, a positive consequence was that the teachers developed reflective practices. By reflecting carefully, more effective ICT integrated lessons could be developed that could be more suitable for the group of learners taught.

6.3.5 Teachers' confidence in Technology, Pedagogy and Content Knowledge

The TPACK questionnaire (Schmidt, Baran, Thompson, Koehler, et al., 2009) was used to determine teachers' confidence in each aspect of the TPACK framework. The TPACK-Likert questionnaire was administered at the start and, after the completion of two Lesson Study cycles. A comparison of teachers' scores was made. The data obtained from the questionnaire was used to determine whether the means of the two sets of data are different from each other. This data, together with the qualitative findings, was used to help determine whether the use of Lesson Study played a role in improving teachers' confidence in using ICTs in teaching and learning. The comprehensive set of results was presented in the previous chapter. A summary of the findings of the questionnaire of all teachers is presented below.

The graph below (Figure 6.2) is a representation of the means of all twelve teachers Pre-Lesson Study confidence, Post Lesson Study confidence and the difference between the two (Post

Lesson Study score minus Pre-Lesson Study score). Any value above the X-axis indicated that the Post Lesson Study confidence was greater than Pre-Lesson Study confidence while values below the X-axis meant that the confidence after the Lesson Study programme was greater than before. Therefore, the positive difference indicated that teachers' confidence had improved, while negative values indicated a decline in confidence.

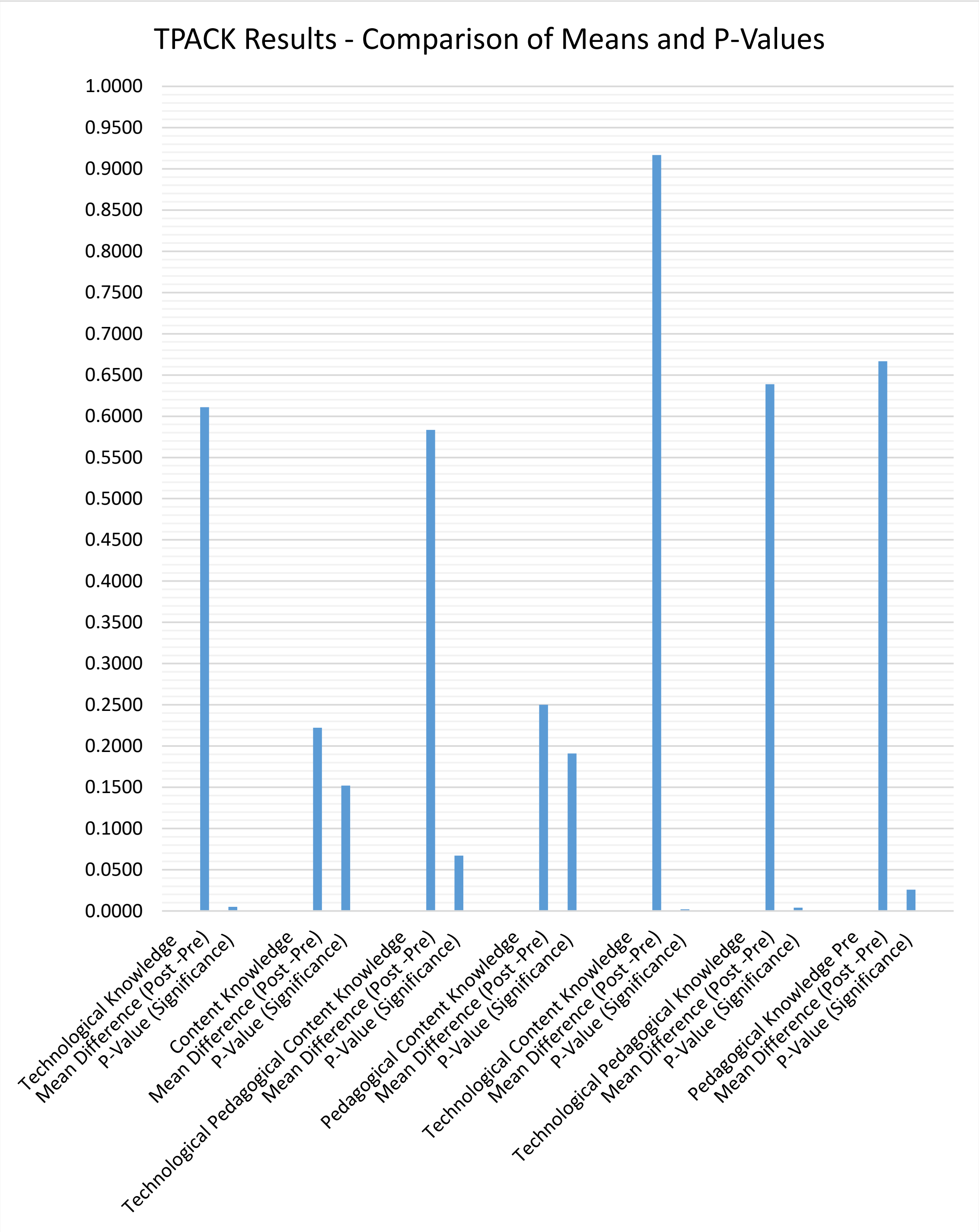

Figure 6.2: Graph Showing the Comparison of Means and P-Values

The analysis of the graph indicates that there was a positive difference in means of the post Lesson Study to the pre-Lesson Study values indicating an improvement in each of the TPACK (Technological Pedagogical Content Knowledge) areas. However, the p-value is a more robust indicator of statistical significance. P-values less than 0.05 are considered statistically significant. Therefore, after the p-values of each knowledge areas were considered, statistically significant changes were noted in only four knowledge areas. When the results for all twelve teachers within the three subjects were analysed, it was evident that the intervention significantly changed the resulting mean score of Technological Knowledge, Technological Content Knowledge, Technological Pedagogical Knowledge and Pedagogical Knowledge. While an improvement was noted in teachers Content Knowledge, Technological Pedagogical Content Knowledge and Pedagogical Content Knowledge, at a 95% confidence level, this improvement was not statistically significant.

The results, therefore, indicated that through engagement in the Lesson Study process, teachers' confidence improved significantly in the areas of Technological Knowledge, Technological Content Knowledge, Technological Pedagogical Knowledge and Pedagogical Knowledge. It is interesting to note that the intervention had a statistically significant, positive effect on teachers' confidence in all the Technological Knowledge areas except for Technological Pedagogical Content Knowledge TPACK). A possible explanation for the lack of a positive statistically significant improvement in teachers TPACK confidence could be the emphasis they placed on content. Teachers reported no change or no significant change to Content Knowledge. The great emphasis they ascribed to content in the syllabus could have affected their responses to their TPACK score.

Teachers reported that by engaging in the Lesson Study process, they felt compelled to examine their teaching methods. Bruce (Life Sciences) mentioned that the Lesson Study process *"forced me to look for innovative ways to actually teach a topic because it's very easy, especially if you're charismatic or you know the material and you know, kind of what you need to go, to just do the old traditional style of teaching, where you are standing up in front holding their attention."* Through examination and reflection of his teaching, Bruce was able to develop different approaches to teaching.

Thiro (EMS) also indicate an improvement in pedagogy as follows: "*You can deliver a lesson or(using) one methodology in which kids, if you're looking at it from different angles, you see a little bit more, you know, in terms of how you can improve things."* The pedagogical improvements were believed to be a result of the reflective activity done during each cycle. Teachers viewed the lessons that were recorded and were able to discuss important aspects and suggest improvements as a team. By doing so, teachers had to consider alternative strategies for the lesson.

In a study conducted by Abdella et al. (2018) to determine the impact of Lesson Study on Science teachers learning and classroom practice, similar results were on teachers' pedagogy were reported. Abdella et al. (2018) reported that “teachers claimed that they have conceptually developed, improved their skills in lesson planning and delivering science lessons, changed their attitudes, ultimately resulting in increased learning and changes teachers in classroom practice” (p. 23).

The findings, therefore, indicate that Lesson Study had a significant positive effect on teachers’ pedagogical confidence. The findings indicated that teachers employed a more holistic approach to planning and presentation of lessons that focused on more than just content. Through their participation, teachers believed this improved their teaching practices since the planning occurred in a real-world context. The work teachers engaged in was relevant, hands-on and done collaboratively. For these reasons, teachers reported an improvement in their pedagogical confidence.

The Lesson Study programme aimed to help improve teachers’ ability to integrate ICTs in their lessons. An indication of this was the way Marike described how the Mathematics department began its planning.

"How are we going to incorporate technology, something that's fun, colourful, grab learners’ attention while you're still in charge of the teaching process. So that was the focus, and that was really different, but I enjoyed it."

The focus was on the use of ICTs in teaching content in authentic situations. It was therefore interesting to note that teachers' confidence improved significantly in the areas of Technological Knowledge, Technological Content Knowledge, and Technological Pedagogical Knowledge. The improvements in these knowledge areas were reflected in discussion with teachers. Thiro (EMS) was motivated about the difference in his confidence with ICTs.

"I’m using ICT’s and using new technology. I mean, I could share information so much more easily through e-mail, through Google classrooms and through various other methods. You know, in the past that wasn’t so, easy to do.”

Vashnie (EMS) noted a similar improvement.

"I started using the (electronic white) board for my ledgers, and I started using my so it kind of made me realise no I can use the same ICT's in another subject which opens up now the ability for me to use it across my classroom."

While studies on the use of Lesson study for integrating ICTs in teaching are scarce and therefore, evidence supporting improvements in teacher confidence is limited, studies do suggest that involvement in Lesson Study programmes have a positive impact on teacher learning. Several studies have reported an improvement in teacher learning as a result of participation in a Lesson Study programme. Cajkler and Wood (2016) reported that pre-service teachers who participate in a Lesson Study programme considered it to be an effective way to develop their teaching skills and knowledge. If ICTs are considered to be essential skills, this research suggests that it would improve. Pre-service teachers also reported that it represented a holistic approach to the study of teaching.

Widjaja et al. (2017) examined the learning experiences of teachers from a network of three schools who participated in a Lesson Study project. Their results also reveal that through the participation in the programme, teachers reported improvements in teaching skills.

On analysis of the individual departmental results, it was found that for Life Sciences, although improvement in teacher confidence was noted in all areas, except Content Knowledge which remained unchanged, no improvement was statistically significant. Teachers claimed to have excellent knowledge of their subject, and therefore no improvement in Content Knowledge was evident. Tina and Coraline had been teaching Life Sciences for more than 30 years each, and although Bruce and Selena had only six years of teaching experience each, both had a Bachelor of Sciences degree. Also, Bruce had achieved his degree Cum Laude. The qualifications and years of teaching experience indicated that teachers were confident in the Life Sciences content that was required at school and therefore, could explain the lack of improvement in Content Knowledge.

The lack of a statistically significant improvement in other knowledge areas could have been as a result of Life Sciences teachers' participation in previous professional development programmes that were similar to the Lesson Study programme. Selena mentioned that *"our department, without nearly as much structure, kind of do what lesson study been anyway. It was kind of just, we always do it like, and because I suppose we were involved in the other training stuff, especially in the ICT's. We do our best to integrate ICT's anyway."*

The Life Sciences department had undertaken previous professional development in ICT integration, and due to the teachers claiming to have to maintain high standards for their department, they had actively worked on integrating ICTs into their teaching. Bruce stated that they had worked on integrating ICTs into their teaching since they *"want to be one of the best departments in the school. So we really do want to work towards that, and I think like this was just another area where we had to flex the muscle."* Due to their involvement in previous professional development, their motivation and the challenge that the Life Sciences department had set for themselves, they were confident in integrating ICTs in their teaching. However, this meant that when the Life Sciences teachers participated in the Lesson Study programme, the improvement noted in the TPACK confidence questionnaire was minimal and not statistically significant.

Researchers, however, point out that obtaining statistically significant difference or relations from small samples is difficult (Leppink et al., 2016). Van Calster, Steyerberg, Collins, and Smits (2018) stated that focussing on statistical significance for small samples could lead to overvalued effect sizes and false conclusions meaning that even if a great difference is present as is the case in some knowledge areas of this study, statistically significant results will not be obtained. The composite results, therefore, provided a greater indicator of changes in teacher confidence than the individual departmental results due to the larger sample size. While individual departmental results indicate few statistically significant results, the composite results show an improvement in teachers' confidence in Technological Knowledge, Technological Content Knowledge, Technological Pedagogical Knowledge and Pedagogical Knowledge.

6.3.6 Summary

The first research question set out to explore how teachers' confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study. This discussion in this sub-section indicated that there was an improvement in teachers' confidence after participating in the Lesson Study programme. Factors reported having affected teachers' confidence in integrating ICTs positively, were collegial support, reduced teacher isolation, and reflective practices developed through the Lesson Study process.

The two key factors that negatively affected teacher confidence in integrating ICTs in teaching were teacher workload and learner responses. High teacher workload resulted in time constraints which affected teacher participation while learner responses to the ICTs resulted in teachers becoming demotivated and questioning their use of ICTs in teaching.

6.4 RESEARCH QUESTION TWO: WHAT ARE TEACHERS' EXPERIENCES IN USING LESSON STUDY AS A STRATEGY TO DEVELOP THEIR COMPETENCE IN INTEGRATING ICTS (INFORMATION AND COMMUNICATION TECHNOLOGIES) IN THEIR TEACHING?

Guskey (2002) developed a framework consisting of five critical levels for evaluating professional development programmes. This framework provided questions and suggested how data could be collected in response to the questions. It also suggested what should be assessed and provided information on how the data could be used. This framework is used in this section to discuss teachers' experiences of Lesson Study as a professional development strategy to develop their competence in integrating ICTs in teaching. The evaluation consisted of the five levels as described by Guskey (2002) These are "participants' reactions; participants' learning; organisational support and change; participants' use of new knowledge and skills; and student learning outcomes" (Guskey, 2002, p. 48).

Guskey (2002) suggested that when evaluating a form of professional, it is essential to focus on the five critical levels when collecting and analysing data; therefore, teachers' experiences will be discussed in the following section by referring to Guskey's framework. The first level of evaluation relates to participants reactions. Guskey (2002) recommended asking questions like "Did they like it? Was their time well spent? Did the material make sense? and Will it be useful?"(p. 46). The following sub-section looks at the participants (teacher) Reactions to the Lesson Study programme.

6.4.1 Participants reactions

All teachers indicated positive responses to the Lesson Study programme. Teachers found the Lesson Study programme to be a valuable way to help them develop their competence in integrating ICTs in their teaching. They appreciated the logical, cyclic structure of the programme, the relevance to the syllabus and their teaching, and the collaboration that occurred. Teachers also said that Lesson Study was a better approach than previous professional development courses that they had attended. However, teachers did find that the amount of time required for participation was a significant barrier. These, among other teacher reactions, are discussed further.

6.4.1.1 The Lesson Study structure

The Lesson Study programme was made up of cycles of five stages each. Part one was the research and goal setting stage, followed by the planning of the lesson. The research lesson was then presented by one member of the group and observed by the other participants. The penultimate part of the cycle involved reflecting on the lesson together so that the lesson could be improved. When this was done, the lesson was revised and taught to other classes. Teachers appreciate the structure that Lesson Study provided. Lisa (EMS) and Johno (EMS) stated that

"I do think it is effective because it gives you a very like a nice breakdown in our structure in which to organise your activities. It is very like linear in a sense from A to B, which is nice to follow. So it does help the process being meaningful going into integrating something new." (Johno)

"It's pretty step by step by step… It is structured. (Lisa)

Teachers appreciated the structured approach to professional development. By discussing the outline of the Lesson Study programme at the start, teachers were aware of the process and the expectations at each stage. Vashnie (EMS) stated that

"y*ou knew which order things had to be done and it kind of also helped to plan the entire lesson properly. You could see shortfalls before the actual lesson took place."*

In this way, there were no surprises. Teachers knew ahead of time, what needed to be done and were able to plan for this. Nassira (2016) in the paper on the importance of teachers' professional development within an Algerian context eluded to the importance of structure in professional development programmes. Structured programmes that consist of a logical, easy to follow sequence is often preferred by teachers rather than workshop type professional development (Nassira, 2016).

Bruce (Life Sciences) stated that the process that was followed represented what good lesson preparation and teaching should resemble. He said that

"*It sounds, I think, like this idea of preparing something, thinking it through, executing it, reflecting on it and proving it, executing again. I think that's the foundation of what should be good teaching preparation and execution."*

Dustin (Mathematics) shared Bruce's views. He believed that the Lesson Study process was an effective one.

"I think the whole, entire process with a lesson study, setting up the norms, the topics, identifying the goals, lesson plan etc. It was very effective. (Dustin)

The first phase of the Lesson Study process involved a discussion and establishment of the rules that teachers would, among other things, follow while working through the various stages. Teachers welcomed the establishment of rules and guidelines for discussions and collaborative work. As Marike (Mathematics) pointed out,

"We all learnt a lot in terms of how to work together. You know setting boundaries. There's a leader. You know. Rules. Respect for one another. Giving one another a time to talk and then learning from one another with an open mind. Being positive about it."

Teachers stated that apart from the advantages that the structured approach provided, participation in the programme helped them develop some social skills, particularly those needed for collaboration. In a recent study, Stokes, Suh, and Curby (2020) also found that engagement in a Lesson Study programme helped develop teacher socially and emotionally. Their study also revealed that teachers felt more emotionally and educationally supported when teachers engaged in in-person Lesson Study programmes.

6.4.1.2 Comparison of previous professional development to Lesson Study

Teachers regarded the Lesson Study programme as more valuable than previous forms of professional development. Teachers had previously attended workshop and lecture type professional development courses. Some of their responses to previous courses were as follows:

"Normally professional development, you sit and listen to someone. Many people switch off." (Marike, Mathematics)

"The lecture form (of professional development) is very, very boring, you know. How can I say it without offending anybody? If you don't agree with what someone has to say as well, you should be given the opportunity to say. Okay. Well, I like what you've said, but this is what I feel, and you know, have a bit of a chat about that because with the lecture form, you literally just hear what they have to say and you leave whether you retain any of that knowledge, it makes no difference. (Shikaar, Mathematics)

"In the past professional development was not professional for teachers. They are from people who are not teachers. People who don't know a classroom. People who don't know learners." (Vashnie, EMS)

Teachers saw limited value in previous forms of professional development citing reasons such as being not relevant to teaching, being dreary, and allowing for minimal interaction. It is interesting to note that traditional forms of professional development like workshops are still common even though research shows that it may be ineffective (Ogegbo et al., 2019; Nassira, 2016).

In contrast, teachers found Lesson Study to be a valuable form of professional development.

Bruce considered the Lesson Study programme to be *"spaced out over a period of time. There's clear goals, there's clear application, there's you have to be engaged with it otherwise it's not going to work for you. So I think yes, I think it's a very effective tool."*

Vashnie and Coraline had similar views of the Lesson Study programme.

"With this (Lesson Study) we learned things that I can use in my classroom on a daily basis, so that's the big difference." (Vashnie, EMS)

"This (Lesson Study) was completely focused on what we do in our lesson, in life sciences. So I quite like that because you know, it's useful, usable stuff. So definitely very effective." (Coraline, Life Sciences)

Teachers found the Lesson Study programme to be relevant to their teaching. The skills that were developed could be transferred directly to the classroom. Teachers reported the process to be valuable since it was hands-on and needed teachers to be actively involved rather than passive recipients of the information. The aspects of Lesson Study that teachers value are also considered to be vital aspects of effective professional development programmes. Caena (2011) mentions that effective professional development needs to be of suitable duration, involve collaboration and active learning, and focus on specific strategies or knowledge among others. Further, research has shown that successful professional development programs occur within learning communities and provide ongoing support enabling immediate and usable solutions that teachers may face (Darling-Hammond et al., 2017; Hannover Research, 2014). Teachers, therefore, regard Lesson Study to be a more effective form of professional development that previous approaches that they experienced.

6.4.1.3 Time as a barrier

While teachers found Lesson Study to be an effective means of helping them develop their competence in integrating ICTs in teaching, they did report challenges. The most significant challenge that teachers experienced was the limited time available for participation due to school responsibilities and extramural activities. The data from the interviews, reflections and discussions revealed that every teacher involved in the study experienced the lack of available time as a practical challenge. These were some of the responses.

"Time always seems to be the one, and I think that that's a common shared time that we can guilt-free use would be both our biggest obstacle because otherwise there is stuff to do." (Bruce, Life Sciences)

"Within our department, they were two or three meetings or training, and one of us wasn't able to be at because of something like detention duty or extramural activity or batting, so that was probably the only thing in terms of all four of us being available at the same time without some other commitment getting in the way." (Selena, Life Sciences)

"It was time-consuming." (Thiro, EMS)

"It was definitely the time constraint because we had to find time now to actually sit together and do it. So if because last year I know we used to have a period that we were all free together with the year before, where we used to sit and do the planning and whatever. Now it's difficult with a new workload." (Wendy, Mathematics)

A review of the literature reveals that time is a common challenge faced by teachers engaging in Lesson Study programmes (Handayani, Wilujeng, Prasetyo, & Triyanto, 2019; Kim, Douch, Thy, Yuenyong, & Thinwiangthong, 2019; Ogegbo et al., 2019). Teachers had different timetables, extramural activities and management duties. Making time available for all to meet was difficult. This meant that most meetings were held outside of regular school time. The different timetables of each teacher within departments meant that tradition lesson observations were not possible. Since the school was well resourced, and each classroom had cameras installed, lessons were recorded using the installed cameras and an additional one set up at the back of the classroom. While this did solve the problem of making time to observe lessons, teachers still had to meet to discuss and review the lesson.

Traditional forms of professional development generally require less time for participation than Lesson Study (Nassira, 2016). While the time required for participation was reported as a significant barrier, teachers felt that the benefits of Lesson Study outweighed the challenges they faced. Teachers felt that they would prefer to engage in a practical, sustained form of professional development where they could implement what they learnt, rather than a quick and ineffective form. Therefore, while time represented a significant challenge, it did not deter teachers from completing all cycles of the Lesson Study programme.

6.4.2 Participants Learning

6.4.2.1 Knowledge and skills

Level two of Guskey's framework (2002) focuses on the new knowledge and skills that the teachers gained through engagement in the Lesson Study programme. This means that teachers should also be able to report an improvement in knowledge and skills in addition to enjoying the learning experience. The focus of the research was to explore teachers' experiences of Lesson Study as a strategy to develop their competence in integrating ICTs in their teaching. Therefore, changes to teachers' technology, pedagogy and content knowledge (TPACK) was explored.

The analysis of the results of the TPACK questionnaire, before the commencement of the Lesson Study programme and after, revealed that teachers' confidence had improved significantly in the areas of Technological Knowledge, Technological Content Knowledge, Technological Pedagogical Knowledge and Pedagogical Knowledge. As this study focused on the development of teachers' ICT competence, it is interesting to note that the technological knowledge areas had shown the most noteworthy statistically significant improvement. Hence, teacher learning had occurred in technological knowledge areas.

Since the intervention focused on using ICTs, significant emphasis was placed on the use of ICTs in the planning phase. The choice and use of ICTs were given prominence, and the assistance provided by the IT Manager and the Head of Digital Learning allowed teachers the opportunity to experiment with new ICTs like Google Earth for Geography and Kahoots for Life Sciences. In this way, a conscious effort was made to integrate ICTs in the lesson rather than have it used to support instruction. While very few studies exist that consider the effect of Lesson Study on teachers' confidence to integrated ICTs in their teaching, studies following similar approaches such as those by Koh, Chai, and Lim (2017), Kurt, Mishra, and Kocoglu (2013) and Koh and Divaharan (2011) reported comparable results. These studies found that when teachers were actively involved in designing lessons that incorporated ICTs, an improvement was noted in their confidence in some or all the technological knowledge areas.

Similarly, this study indicated that, through engagement in the Lesson Study process, when teachers planned to integrate ICTs in their teaching actively, an improvement was noted in the standards for technology integration. This meant that conscious, considered, and varied decisions for the educational use of technology were made. Harris and Hofer (2011) also reported that instructional planning strategies that focus concurrently on technology, pedagogy, and content could help teacher diversify their pedagogical approaches while at the same time encouraging the appropriate use of ICTs; hence the improvement noted in Technological Pedagogical Knowledge and Pedagogical Knowledge.

The data from the interviews, reflections and the discussions revealed similar findings. Bruce (Life Sciences) reported improvements in the way he planned his lessons.

"I think it's been a good Improvement me and the preparedness even if to think through the syllabus instead of just saying what's on the next page? Where are we going really? It feels like you're being a much more authentic professional teacher actually to be prepared for a lesson in that way."

Teachers reported having focused on developing better lessons through planning. Planning is often a neglected part of teaching, and often, minimal emphasis is placed on planning in professional development programmes (Fujii, 2019). Lesson Study emphasises the importance of comprehensive planning, including planning and anticipating learner responses. A separate study by Juhler (2016) revealed that through a Lesson Study intervention, pre-service teachers showed a positive change in their pedagogical content knowledge. Johno (EMS) stated a similar improvement.

"But it did improve our lessons as well as planning of our lessons because it made it more, you know, interesting and dynamic."

Kanellopoulou and Darra (2018) showed that teachers participating in the Lesson Study programme reported having gained knowledge and experience due to the detailed planning of the research lessons. The detailed planning that teachers of this study had engaged in had helped them develop their abilities to integrate ICTs in their teaching effectively by making teachers focus on the aspects of the TPACK framework holistically.

Teachers also indicated that their abilities to use technology had improved. The results of the TPACK questionnaire showed a statistically significant improvement in teachers Technological

Knowledge confidence. This improvement was confirmed during the discussions and interviews with the teachers. Thiro's (EMS) response is an indication of this improvement.

"I'm using ICT's and using new technology. I mean, I share information so much more easily through e-mail, through Google classrooms and through various other methods. You know, in the past that wasn't so, so, so, so easy to do. And you're not so isolated as a teacher. I mean, I can communicate with my pupils, my colleagues on various platforms."

Thiro said that he had begun to use more new technologies than he had in the past and in doing so, was able to collaborate and communicate more effectively with his department. Teachers' use of new technologies was a significant change produced through involvement in the Lesson Study programme. This change meant that teachers had developed new skills that they could use in their interactions with each other and their teaching.

6.4.2.2 Reflective practices

The improvement of teachers' reflective practices was also a positive outcome of the Lesson Study process. A vital feature of the Lesson Study process was the reflective practices that were required. Teachers were required to reflect critically on the research lesson while observing the lesson and during discussions after to make improvements. Marike noted that the Lesson Study process made her continuously focus on what she was doing. By doing so, she had to be engaged in *"constant reflection of how I used it, was it effective, did I keep the kids interested? Where did I lose them? Being able to record a lesson and going back, how could I change it for next year's lesson?"*

In doing so, teachers were able to reflect critically on their teaching using ICTs, both individually and as a group. Bruce (Life Sciences) stated that *"with this process you're almost forced to stop, to reflect on actually how you can get that idea or explanation of a system or something like that across in a way that's different, new and possibly even more effectively for a generation that is very technologically saturated that everything they do is technology."*

These reflections often produced results that were surprising to the teachers. When Lisa reflected on her earlier teaching, she said the following:

"I think in my first couple of years how they hang did the kids actually understand what I was doing and, that probably was because in those days we didn't have to actually go through the whole, you know (reflection process). If I'd had to review my lesson, I probably would have realised that."

Leavy and Hourigan (2016) reported similar findings. They found that lesson study promoted and supported reflective activities. Through reflections, teachers in their study reported improvements in content and pedagogical content knowledge. Teachers were, therefore, able to make positive changes to their teaching through reflection.

Most teachers had assumed that their teaching and their use of ICTs were good; however, upon reflection, they saw that there was room for improvement. Coraline (Life Sciences) said that

"I always thought that I was quite good at this IT thing, you know, I thought I was on top of it, but I didn't realise they were so much more out there since the last time I looked."

Similar sentiments were echoed by Dustin (Mathematics).

"Reflecting back on the lesson that we taught we could see that there's a lot of weaknesses. There's, you identify problem areas where when we got matric marking you make little notes of where the question that you're marking, where the issues lie, and I think this whole entire process ties up to that where when you reflect back on the lesson, what could you have done better?"

Both Dustin and Coraline noted that through reflection, they were able to find weaknesses in their lessons and also plan to address these weaknesses. Dustin noted that teachers who have been teaching for a long time, often, become complacent and assume that they are doing a good job. However, it is only through reflection that they can critically assess their teaching.

"And sometimes you become complacent thinking that you actually know the work perfectly. You've got so much experience teaching grade 12's. You've done marking. You've done all this that you become complacent in your teaching style." (Dustin, Mathematics)

By reflecting on their teaching, teachers were able to make improvements, and this, therefore, resulted in professional growth. Through engagement in the lesson study process, teachers were also able to develop their skills to reflect critically. Research shows that reflections lead to self-awareness and have a positive effect on enhancing personal development (Jao, Sahmbi, & Huang, 2020; Yalcin Arslan, 2019). Yalcin Arslan (2019) in an article on the role of Lesson Study in teacher development, showed that there was a link between reflecting through lesson study and teachers' professional growth. In their study, Uştuk and De Costa (2020) also indicated that reflective practices are permeated throughout the Lesson Study process. Their research showed that the ability of teachers to direct their professional growth could be promoted through the reflective practices in Lesson Study.

Teachers had shown, both through the TPACK questionnaire and qualitative data obtained, that there was an improvement in their knowledge and skills. Teachers had shown significant improvements in Technological Knowledge, Technological Content Knowledge, Technological Pedagogical Knowledge and Pedagogical Knowledge. Also, teachers had indicated that they had improved their skills and their ability to use ICTs. A significant positive outcome was that teachers developed and used reflective practices which helped them make improvements to their teaching. Based on level two of Guskey's (2002) framework, this indicated that Lesson Study was successful in developing participant learning.

6.4.3 Organisation Support and Change

Guskey (2002) lists Organisation Support and Change as the third level of the evaluation framework. At this level, the focus shifts away from the participants to the organisation. Guskey (2014) states that even if most aspects of professional development are in place, without the from the school, these efforts could fail. Other professional development programmes can fail if appropriate resources are not available, and if the feedback is not provided timeously. Guskey (2002) suggested asking questions like: Did the organisation support and promote the implementation?; Were resources available?; and What was the effect on the organisation? This section looks at organisational support and change from the perspective of the participants of this study. The following areas that emerged from the research will be discussed: support from school personnel; successes, problems and perceived limitations; and the effect on climate and procedures at school.

6.4.3.1 Support from school personnel

The support received from the senior management of the school was evident when the presentation to recruit participants produced a small group. The school principal and the Director of Academics suggested that the presentation be made to the general staff instead, as they believed that participation in the Lesson Study programme would be of value to the staff. The Principal and Director of Academics did insist on two conditions. These were that the teachers would be able to withdraw at any time should they feel overwhelmed and that involvement in the study should not affect teachers' ability to perform their school duties. Due to the support received from the school management, thirty-eight teachers volunteered to participate in the study.

In addition to the support received, the school asked the IT Manager to be involved. The involvement of the IT Manager proved invaluable as he was able to provide technical support to the teachers when required. Teachers participating in the study were, therefore, aware that they had the support from the institution and knowledgeable members of staff from within who could assist.

Castro Silva, Amante, and Morgado (2017) in a recent study concluded that support from the school and senior management of the school, and support for professional development were significant predictors of teachers' involvement in collaboration and professional development. Similar findings were made in a study in Ghana. The results of the study showed that organisational support, management and leadership had a significant positive effect on the level of teachers' commitment (Nartey, Annan, & Nunoo, 2018). The evidence indicates that teachers' participation is influenced by the support they receive from the school and school management.

Apart from the support the teachers received from the senior management of the school, teachers within their department who had more knowledge or skills in specific areas supported their colleagues. Vygotsky (1980) termed these people, the more knowledgeable others and emphasised their importance within social structures. For example, teachers who were proficient at using ICTs were able to help others who were not comfortable using these resources. As Dustin and Shikaar stated:

"We had one educator who's highly advanced with IT and gone on many workshops who trained us basically into how to incorporate the technology into our classroom." (Dustin, Mathematics)

"In terms of the planning process again was the fact that we were lucky enough to have someone like Marike (pseudonym) who's very, very technologically inclined and she did help us in terms of that." (Shikaar, Mathematics)

Coraline (Life Sciences) stated that her department had received similar support.

"The process initially was actually quite easy for us or for myself because I was really being guided by the two younger teachers in my department."

Tina (Life Sciences) mentioned that she felt part of the team when her department supported her and kept her updated even though she was not comfortable with technology.

"They were very helpful, and they try to keep me in the loop. They were very willing to share with me even though I couldn't do it."

Teachers participating in this study felt supported and therefore continued to participate in the Lesson Study programme. Ogegbo et al. (2019) found that institutional support played a vital role in teachers' participation in a Lesson Study programme. They found that a lack of institutional support served as a threat to teachers' participation in this form of professional development. Coenders and Verhoef (2019) also indicated that professional development programmes like Lesson Study with well-organised support have a positive effect on teachers' well-being and teacher development. Vicarious experience through the observation of other teachers performing tasks may help teachers develop positive self-efficacy beliefs (Hendricks, 2016). When teachers observe colleagues perform tasks, it may result in a judgement being made about their abilities to perform the same task.

The teachers reported that they felt supported by the school management and their colleagues while engaging in the Lesson Study programme. The following statements reinforced this.

"We are not alone in this. There is someone who can help." (Marike, Mathematics)

"Everybody was sort of committed to helping each other." (Lisa, EMS)

The support teachers experienced played a vital role in their participation in the Lesson Study programme. Handtke and Bögeholz (2019) mentioned that enactive mastery influences teacher professional development. When teachers engaged in activities, the outcomes of their actions are interpreted, and beliefs are developed about their ability to carry out similar tasks. (Handtke & Bögeholz, 2019). In addition to the support teachers received being beneficial to their participation, Le Thi (2020) found that organisation support played a vital role in teachers willingness to integrate ICTs in their lessons. Therefore, without the support teachers received, participation may have declined, or teachers may not have been able to experience the full benefits of their participation.

6.4.3.2 Problems and perceived limitations

Guskey (2002) suggest that it is essential that the problems and limitations faced by the teachers are considered since any gains achieved could be cancelled out by problems experienced. The major problems experienced by the teachers were time constraints due to teacher workload, learners' perceptions of ICTs, and teachers perceived lack of resources. Teacher workload and learners' perceptions of ICTs were discussed earlier in this chapter. Teachers' perceived lack of resources are discussed further, and a discussion is presented on how teachers overcame difficulties where they were able to.

Teacher workload was a limiting factor in teachers' participation in the Lesson Study programme. While teachers did have difficulty making time to get together and participate effectively in the programme, arrangements were made to overcome these difficulties. Teachers were willing to meet after school hours so that they were able to work collaboratively. This demonstrated high levels of commitment and self-efficacy. Bandura (1997) stressed the importance of high levels of teachers' self-efficacy in professional development programmes. Teachers had made arrangements to have the research lessons recorded so that no class time would be lost. Recording the lesson resulted in time-saving time, and all teachers were available to review the lesson.

One minor limitation reported by teachers was the availability of resources. The school where the study was conducted was a well-resourced school with ICT resources available in all classrooms. However, teachers still reported the unavailability of resources as a limiting factor. Dustin and Shikaar (Mathematics) stated that they had limited resources due to budget constraints.

"Like my class, I'd love to use technology all the time, but budget constraints. I don't have a visualiser." (Dustin)

'If you want to integrate technology you're going to have to have the resources to integrate it into your lessons." (Shikaar)

It was interesting to note that while other ICT resources like projectors, laptops and tablets were available, these teachers focused on the availability of only the most recently purchased resources. While teachers said that the Visualiser would have made ICT integration easier, other resources could have been used instead. Therefore, rather than lack of resources, the barrier that teachers faced could be attributed to the lack of professional development on the use of available resources.

The two infrastructural barriers experienced that teachers experienced were electricity power cuts and Wi-Fi connectivity on learners' devices. The interruption of electrical power supply (termed load-shedding) frequently occurred during the year due to problems at the national power utility. The power cuts did affect teachers planning to integrate ICTs into their lessons. Teachers had to have back-up lessons ready in the case of interruptions of power supply.

"I think load shedding in the beginning part of the year is a bit tricky and so to conduct a lot of the technologically, exciting lessons because you never know if your lessons going to be interrupted or not." (Bruce, Life Sciences)

In addition to power cuts, pupils would sometimes arrive to class with devices that were not charged, or lost passwords, or connectivity problems. While the IT manager was available to assist, these factors did negatively affect the lesson.

"The fact that we sometimes battle to get their tablets connected to the school Wi-Fi. So we found that that took up a lot of time at the start of the lesson to get everybody connected and we actually had to have Mr. (IT Manager) in there to help with that." (Bruce, Life Sciences)

The perceived lack of resources and infrastructural limitations did affect teacher participation. The lack of ICTs and proper infrastructure is frequently reported as an inhibitor to ICT integration; however, the lack of knowledge and skills needed to use the ICTs is considered a significant barrier (Barakabitze et al., 2019). While ICTs were available at the school, teachers did state that lack of resources impeded their integration of ICTs in their teaching. This indicates that the problem may not be that resources were not available; instead, more professional development was needed so that teachers were able to use the available resources.

6.4.3.3 Effect on school climate and procedures

Guskey (2002) recommends that when evaluating a professional development programme, its effect on the school climate and procedures be examined. As previously discussed, teachers reported that the Lesson Study programme had resulted in greater intra-departmental collegiality, improvements in planning, and improvements in teachers' confidence in, and use of ICTs in teaching. Schipper, de Vries, Goei, and van Veen (2020) showed that school leaders could use Lesson Study practices to create and promote a culture of professionalism among teachers at schools. This study reported similar findings. Teachers were more supportive, felt less isolated, and were willing to use personal time to engage in professional development. Therefore, teachers' engagement did result in a positive effect on the school climate and procedures.

6.4.4 Teachers use of new knowledge and skills

Guskey's (2002) fourth level of the evaluation framework requires consideration of the participants' use of the knowledge and skills that they may have gained during the programme. The lesson study programme required that teachers plan and teach a lesson. In all cases, the planned lessons were used in the classroom. Therefore, a critical aspect of the lesson study programme is the use of new knowledge and skill that were developed collaboratively.

Teachers reported that engagement in the Lesson Study programme had helped them plan better lessons than they had previously done. The planning and reflective skills that teachers had developed were said to have been valuable, and teachers said that they were planning on using it in the future. The responses from the teachers below support this.

"To hear how do teachers teach it and approach it from various ways was very, very helpful … it helps us in our lesson planning as well." (Marike, Mathematics)

"It did improve our lessons as well as a planning of our lessons because it made it more, you know, interesting and dynamic." (Shikaar, Mathematics)

"I think like that for me that was a like a really helpful formative thing for me and it just like even well prepares you for your own lesson, because you are sitting thinking through the structure, the things that you will include in various times of your lesson. You have a much better idea what you're going in to do which is very helpful." (Bruce, Life Sciences)

Coenders and Verhoef (2019) also found in a study that teachers planning had improved as a result of participation in a lesson study programme. Teachers had developed lessons that were more learner-centred and therefore showed an improvement in pedagogical content knowledge, beliefs and attitudes.

A further indication of the success of Lesson Study programme is the use of, or the planning for the use of Lesson Study in the future. Tina (Life Sciences) confirmed that she had seen changes to the way teachers had worked.

"I saw people working that would never have got off their butt and done it."

Teachers had seen the value of the programme and were willing to put in the effort to achieve the results. Wendy (EMS), who claimed to have poor skills integrating technology into her teaching at the start of the study, said that she had begun trying to use ICTs in her teaching.

"*I've actually taken some of the stuff that he'd put up on Google classroom and printed stuff from there, and I have been using it."*

While Wendy's use of ICTs was limited to substitution or augmentation (Puentedura, 2010), this change in Wendy's approach is significant as she was a senior teacher who had previously had limited experience using ICTs.

Dustin (Mathematics) indicated that he would be using Lesson Study to help develop teachers' knowledge in certain mathematical concepts that he found were lacking.

"What we are going to be doing next year, which we've gauged from this (Lesson Study programme) is certain sections is teachers that are currently teaching grade 12 classes that are not very confident in certain sections, and they are taking top classes. So what we're going to be doing next year is at least one Friday a month, we are going to be focusing on certain sections using this (Lesson Study)."

Recent research does indicate that engagement in a Lesson Study programme increases teachers' pedagogical outcomes (Coenders & Verhoef, 2019; Godfrey, Seleznyov, Anders, Wollaston, & Barrera-Pedemonte, 2019). Therefore, by engaging in the Lesson Study programme teachers were willing to review their teaching approach and make changes where necessary.

6.4.5 Learners' learning outcomes

The final level (Level five) of Guskey's (2002) framework to evaluate professional development programmes focuses on the learners' learning outcomes. While learning outcomes from the learners' perspectives were not explored in this study, teacher responses indicated the impact on learning.

"You look forward to these lessons because the kids came to life, they so enjoyed it when we were sitting right? I think I was going to do this game on photosynthesis and you saw them getting all competitive and then it was a race between me and them and that brings in a new aspect to every lesson." (Bruce, Life Sciences)

I think it is very effective because the Young Generation obviously learn better with IT and screens and they interact better, that's what they are used to do in life out there. So I think if you bring it into the classroom, you can certainly make it a very effective method. (Corline, Life Sciences)

Teachers reported that the lessons they developed were more focused on learners' learning than in the past. The inclusion of technology in their teaching helped improve learners' enthusiasm. The reflective practices that teachers engaged in during each cycle of the Lesson Study programme had helped them focus their learners learning.

6.4.6 Summary

This sub-section explored teachers' experiences of Lesson Study for the integration of ICTs in teaching. The frameworks that guided the discussion were the TPACK framework (Koehler & Mishra, 2009) and Guskey's (2002) Five Levels of Professional Development Evaluation. While teachers did experience challenges like lack of time due to high workload and the perceptions of learners to ICTs, their responses indicated positive experiences. The quantitative analysis revealed that teachers Technological Knowledge, Technological Content Knowledge, Technological Pedagogical Knowledge and Pedagogical Knowledge improved significantly. The teachers appreciated the structure that was provided and ranked Lesson Study as better than previous approaches to professional development. Improvements were noted in reflective practices, intra-departmental and organizational support, and teachers' knowledge and skills. While challenges were present, teachers considered Lesson Study to be a valuable and effective form of professional development.

The following sub-section discusses the third research question.

6.5 RESEARCH QUESTION THREE: WHY DO TEACHERS EXPERIENCE THE USE OF LESSON STUDY TO INTEGRATE INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTS) IN TEACHING IN THE WAY THEY DO?

The Theory of Planned Behaviour (TPB) (Ajzen, 1991, 2011) is often used to explain the behaviour of individuals at a given moment in time. Therefore, in this study, TPB was used as a framework to discuss the third research question: Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do?

The Theory of Planned Behaviour was used extensively in education to predict and explain the behaviour of teachers and pre-service teachers. For example, it was used to understand the adoption of WhatsApp university students in learning (Nyasulu & Dominic Chawinga, 2019), pre-service teachers perceived usefulness of social media (Ugorji, 2019), and to predict the chance of teachers taking a competency-based approach to teaching (Lenski et al., 2019).

The TPB states that three factors influence any behaviour a person engages in. These are the beliefs about the consequences of an action; the beliefs about the expectations of significant others; and the beliefs about the factors that may enable or serve as a barrier to the action or performance of the behaviour. Behavioural beliefs affect the attitude toward the behaviour, while normative beliefs affect subjective norms and control beliefs affect perceived behavioural control (Ajzen, 1991, 2011). The greater these factors, the stronger a person's intention to perform the behaviour becomes.

The TPB states that motivation and ability are the key factors that determine behaviour achievement. The theory indicates three types of belief and constructs that represent an individual's control over a behaviour. These are attitudes, behavioural intentions, subjective norms, social norms, and perceived behavioural control (Ajzen, 1991). A brief description of each construct (Ajzen, 1991, 2011) is provided below.

Attitudes refer to the individual's evaluation of the behaviour. It involves considering the outcomes to evaluate the behaviour as either favourable or unfavourable.

Behavioural intention refers to the factors that influence behaviour. These are related to motivating factors, where there is a direct relationship between intention to perform behaviours and the performance of behaviours. The greater the intention, the more likely the behaviour will be executed.

Subjective norms refer to the beliefs about whether significant people approve or disapprove of the behaviour. It is related to whether colleagues or senior members of staff think that the individual should engage in the behaviour.

Social norms refer to the norms, standards or codes of behaviour expected within groups or cultures.

Perceived behavioural control refers to an individual's perception of how easy or difficult performing the behaviour would be. This construct was added to the Theory of Reasoned Action, which resulted in the Theory of Planned Behaviour. It is essential to point out that perceived behavioural control can vary as it is dependent upon situations and actions.

The TPD has proven to be a useful model for explaining behaviour and intentions (Conner, 2015). Attitudes and perceived behavioural control are successful predictors of behaviours. This indicates that TPB is a useful model that could be used to explain the behaviour of individuals in a given time and setting. Therefore, the TPB was used to discuss teachers' use of Lesson Study for the integration of ICTs in their teaching. Since the model is effective at predicting and explaining behaviour, it was used to frame the discussion around the third research question: Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do? Each construct is presented below and is used to guide the discussion.

6.5.1 Attitudes

Attitudes refer to the individual's evaluation of the behaviour. It involves considering the outcomes to evaluate the behaviour as either favourable or unfavourable (Ajzen, 1991; Gómez-Ramirez, Valencia-Arias, & Duque, 2019). The belief about behavioural outcomes affects behavioural intentions.

Teachers' evaluation of Lesson Study for the integration of ICTs in teaching was generally favourable. Bruce (Life Sciences) said that

"*I think our team loved the process, we loved what we got to do, and everyone was very keen and very on board. So it like it made it very easy to sit down, exchange ideas, show someone something with being very elated.*"

Lesson Study was seen as a new and innovative form of professional development; unlike the types they had experienced in the past. Teachers reported that Lesson Study provided a good structure within which teachers had to work. Marike (Mathematics) stated that *"We all learnt a lot. In terms of how to work together. You know setting boundaries. There's a leader. You know. Rules"*

The logical sequence and clarity of instructions provided a useful framework within which teachers were able to work.

"I think it's a very effective process and it's thorough you actually sit, and you think through what you're doing in the lesson, and you're able to structure it a lot more." (Bruce, Life Sciences)

The Lesson Study programme was considered to be more valuable than previous forms of professional development as Lesson Study involved active participation and was relevant to what teachers were doing in the classroom.

The intra-departmental support received played a vital role in teachers' sustained participation. The collegiality that resulted due to formalised collaboration occurring was appreciated. Teachers reported feeling less isolated and found themselves actively participating in the process. Due to the support received, teachers who had previously not used ICTs in teaching had made attempts to get assistance or use ICTs in teaching.

"So this has forced me to use it a little bit and obviously with more practice, I'm hoping to use it a little more in the classroom. ... I want to like even if I'm free go to her and say, you know what teach me or show me" (Wendy, Mathematics)

The two critical factors that negatively affected teachers' attitude toward the Lesson Study was the amount of time required for participation and learner perception of ICTs. Teachers in the study claimed to have high work-loads and therefore, had limited time available to participate in the Lesson Study programme. Many teachers who participated were involved in the co-curricular programme at school. Involvement in the co-curricular programme meant that teachers had to be available after school hours to assist with coaching, remedial lessons, and management duties. The Lesson Study programme itself involved sustained commitment over a long time. This was given as a reason for some teachers not being willing to participate. Dustin (Mathematics) stated that

"The reason many departments backed out was I don't think they realized how much work this actually entailed and once they saw the amount of work and the commitment that you have to do."

Since teachers had experienced Lesson Study for the first time in this study, Lesson Study was seen as an additional activity rather than a regular part of the teaching process. This finding was also reported by Ogegbo et al. (2019) in their study on the benefits and challenges of Lesson Study.

Teachers believed that learners regarded ICTs as social rather than educational resources. The behaviour of some learners, particularly in a mathematics research lesson, resulted in teachers questioning the use of ICTs in teaching. Teachers then questioned their participation in the Lesson Study programme; however, due to the support received, teachers indicated that the benefits of participation outweighed the challenges.

Teachers' perceptions of ICTs played a role in their attitude toward the programme. The focus of the Lesson Study programme was on integrating ICTs into teaching. Teachers who had negative perceptions of ICTs said that they would be less likely to use ICTs in their teaching or that they would be selective in when they would choose to use ICTs. Dustin's reflection after a poor research lesson was as follows:

"The set that we had chosen was a bottom grade 10 set. Also, the topic that we chose was probability, which is one of the most abstract topics in the maths syllabus. I think being at the end of the day, discipline, they weren't as focused."

As a result, Dustin had to reconsider his use of ICTs in teaching. "*What we also learned with the grade 10.6 is that if we use the technology and then only on the side go back to real basics."*

Lisa (EMS), who claimed to have the least technical knowledge of the group said

"*I'm, it's more the use of the technology because as you know, I'm a little bit limited. I just think I'm very set in my ways. And it's not probably that I can't do it, but at this stage, why invent the wheel?"*

Her attitude is an indication of the reasons behind her limited technological knowledge and skills. By being unwilling to change initially, she was unable to develop her knowledge and skills to integrate ICTs in teaching.

Positive perceptions of ICTs, however, resulted in teachers being more likely to use ICTs in their lessons. For example, Bruce LS who had used ICTs stated that *"It was fun sitting there with two older teachers and then the younger ones or like trying to figure out software together, figure out apps and things like that."*

Generally, teachers saw the benefits of ICTs in their lessons and were enthusiastic about developing their abilities to use ICTs effectively.

6.5.2 Behavioural intention

Behavioural intentions refer to the factors that influence behaviour. These are related to but not limited to motivating factors. In this study, behavioural intentions were the factors that influenced teachers' participation in the Lesson Study programme and their intentions to use ICTs in their teaching.

Collegial support played a vital role in teachers' participation in the programme. Without the support teachers received from each other, it is unlikely that many would have continued with the programme. As Lisa indicated "*we all just worked together, and everybody was sort of committed to helping each other, so teamwork was good. I think we all managed together. If it was just thrown at me. I certainly wouldn't have been able to do it."*

Teachers felt that they were able to participate in a non-threatening environment. Added to this, was the encouragement received from colleagues.

"Seeing a teacher who's being a teaching for 30 years doing a Kahoot! in her classroom or a mind mapping software and coming out successfully was very, very cool." (Bruce, Life Sciences)

"They were very helpful, and they try to keep me in the loop." (Tina, Life Sciences)

The encouragement and support helped teachers realise that they were not alone in the programme and therefore felt more comfortable with the Lesson Study programme.

The norms and rules, established at the beginning of the programme, was perceived as valuable since teachers were guided on expected behaviour during the programme. As Dustin indicated,

"I think the whole entire process with Lesson Study, setting up the norms, the topics, identifying the goals, lesson plan etc. It was very effective as a team."

These rules helped ensure that all views were taken into consideration, and therefore teachers felt comfortable sharing ideas within the group.

Through collaboration, teachers were able to divide up the responsibility and overcome a significant challenge that they faced – the lack of time. By dividing up the workload and each teacher assuming leadership in their perceived area of expertise, the programme was completed successfully, and teachers had the opportunity to learn from more knowledgeable others within their department.

Through engagement with the Lesson Study programme, teachers reported seeing changes to the teaching. Marike (Mathematics) mentioned that *"I really felt like I've actually gained a skill. Moving with the future."*

Teachers reported that their use of ICTs in teaching had improved and teachers were also more willing to try to use ICTs. Teachers said that they were supported and that the integration of ICTs was something that they were capable of doing by observing and participating in the planning and reviewing of the research lesson.

6.5.3 Subjective norms

Subjective norms refer to the beliefs about whether significant people approve or disapprove of the behaviour. It is related to whether colleagues or senior members of the school thought that the individual should have engaged in the Lesson Study programme.

All teachers were aware that the Lesson Study programme had the support and backing of the senior management of the school. This was made explicitly clear to the staff during the presentations held to recruit participants. The Director of Academics stressed the importance of professional development and getting involved in the programme at that meeting. To further reinforce the support for the programme, the Director of Academics asked the IT Manager to become involved in the programme. Every group that participated had at least one senior teacher in the group, and the Subject Head of all participating groups were present.

The effect of this support was evident during the programme. Teachers were more willing to be involved with many assuming leadership roles within each group. While teachers experienced challenges, they persevered and remained in the programme. Murphy et al. (2017) stated that when teachers received support from school leaders they "valued the external training and the structured, timetabled peer collaboration that this programme offered; these were generally viewed as new and as supporting continued engagement" (p. 5). Takahashi and McDougal (2016) support this in stating that in order for the impact of Lesson Study to maximised institutional practices and structure need to be in place.

The support from colleagues played a vital role in this aspect. Teachers were able to motivate and assist each other. Therefore, there was a clear indication that colleagues and senior members of staff approved of and supported the Lesson Study programme. This support played a vital role in the teachers' sustained participation in the programme.

6.5.4 Social norms

Social norms refer to the norms, standards or codes of behaviour expected within groups or cultures.

A key motivating factor within the school where the study was conducted was the Digital Learning policy at the school. The policy stated that twenty-five percent of contact time with learners in the classroom must involve the use of ICTs. The school was advertised in promotional booklets as a "digital learning school". As a result, all teachers were required to be able to use ICTs. Professional development was provided regularly for teachers whose ICT knowledge and skills were considered inadequate. Therefore, the importance of ICT integration was stressed through the policy and the expectations of the school leaders. The Lesson Study programme was seen as a potential way to develop teachers' competence in the integration of ICTs in their teaching.

The integration of ICTs in teaching was seen as valuable to learners' learning. Teachers reported that the integration of ICTs in teaching was an important aspect of teaching as *"we forget about, you know, the pupil and how the pupil thinks. In this modern world, in the modern age of thinking and I think, you know, using lesson study in ICT's, integrating ICT's into that, actually opened our minds to the way learners learn nowadays*" (Thiro, EMS). Teachers said that the way pupils learn has changed and teachers have to adapt their teaching and prepare children for a life in a technological society.

Therefore, teachers had to develop their knowledge and skills so that they could prepare children for a world outside school. Teachers reported that the way children learn has changed and teachers would have to adapt to ensure that their teaching is effective.

6.5.5 Perceived behavioural control

In Ajzen's (1991) discussion of the theory of planned behaviour, it is stated that the construct of perceived behavioural control was derived from the concept of self-efficacy (Bandura, 1986). Self-efficacy could, therefore, be considered to be directly related to perceived behavioural control. Self-efficacy refers to the belief that a person can successfully perform an action or behaviour to produce the desired outcome. Perceived behavioural control, refers to an individual's perception of how easy or difficult performing the behaviour would be (Ajzen, 1991). It is essential to point out that perceived behavioural control can vary as it is dependent upon situations and actions. In the context of this study, Mohamad, Idrus, and Ibrahim (2018) showed that perceived behavioural control was a good indicator of ICT adoption and usage.

Teachers in the study demonstrated clear intentions to integrate ICTs in their teaching. Their intentions to use ICTs were translated into practice through engagement in the Lesson Study programme. Part of the reason why teachers planned to integrate ICTs in their teaching was that the focus of the Lesson Study programme was on the integration of ICTs in teaching. Teachers' willingness to participate, further indicated their intentions as participation in the programme was voluntary.

Self-efficacy beliefs are generally thought to be acquired from the individual's interpretation of experiences, reactions to situations that may be stressful, and verbal persuasions (Bandura, 1997; Klassen & Klassen, 2018). Past performance and experiences of teachers in professional development programmes will therefore affect teachers perceived behaviour control.

Teacher’s past performance is said to have a significant impact on the way teachers engage in pedagogical activities, group work or problem-solving tasks (Klassen & Klassen, 2018).

Teachers interpreted the results of their actions. These interpretations helped develop the beliefs about their abilities to integrate ICTs into their teaching through Lesson Study. Outcomes that were thought to be successful helped increase self-efficacy thereby promoting greater perceived behavioural control while outcomes that teachers perceived as failures lowered perceived behavioural control (Huang, Ball, Cotten, & O’Neal, 2020; Pajares, 1992). Where teachers perceived outcomes to be failures, low self-efficacy resulted, and this reduced the chances of teachers engaging in similar tasks in the future (Huang et al., 2020). This was demonstrated in one of the research mathematics lessons. The section chosen was said to be abstract, and therefore teachers attempted to teach it using ICTs. However, teachers were presented with several challenges during the lesson. Learners were not co-operative, the timing of the lesson, the last lesson of the day, was problematic, and learners perceived ICTs to be social rather than educational tools.

“The set that we had chosen was a bottom grade 10 set. Also, the topic that we chose was probability, which is one of the most abstract topics in the maths syllabus. I think being at the end of the day, discipline, they weren't as focused as maybe it would have been if the lesson was at the beginning of the day with the top set.” (Dustin, Mathematics)

“When you put on a projector or computer in front of them because then they feel like they have to do no work because the computer is just going to do everything for them or whatever you are projecting is gonna, you know, automatically be absorbed into their brains.” (Shikaar, Mathematics)

The result was hesitance on the part of the teacher to use ICTs in future lessons with that class. The challenges experienced by the teachers resulted in low perceived behavioural control and therefore were unwilling to continue using ICTs with that particular class. Dustin mentioned that the teachers would have to focus more on “basics” (using traditional teaching methods) than ICT integrated lessons as he believed that teachers would have more control of learners behaviour in that way.

Positive outcomes, however, like improved co-operation and enthusiasm increased teachers’ perceived behavioural control. Therefore, they were more likely to engage in these activities again.

"It kind of opened up a whole new world for me." (Vashnie, EMS)

"It opened my eyes to new and different ways of actually doing things. It gave me, it empowered me to a large extent." (Thiro, EMS)

"The normal working together would be the run-of-the-mill, talking about those syllabus content and marking and who sets what test. That's your normal mundane. This took us away from all that, you know, this was completely away. It was a different mind-set. It was fresh." (Coraline, Life Sciences)

The teachers who demonstrated high levels of enthusiasm were more willing to engage in the Lesson Study programme than those who were demotivated by the poor response from the learners. Bertills, Granlund, Dahlström, and Augustine (2018) showed that there was a link between learners' self-efficacy and their willingness to participate in tasks. Also, they also found that learners who had high self-efficacy were more likely to engage in challenging activities. Similar findings were reported for teachers in a study by Stanton, Cawthon, and Dawson (2018). Teachers with high self-efficacy therefore had greater perceived behavioural control.

Another significant factor affecting teachers perceived behavioural control was the ability to watch other teachers participate in the programme and teach ICT integrated lessons. Huang et al. (2020) mentioned that watching others succeed or fail can affect a teacher's belief in his ability to succeed. Teachers involved in the Lesson Study programme had the opportunity to observe colleagues planning, presenting and reviewing lessons. By observing others perform tasks, teachers made judgements about their own abilities. When teachers performing tasks responded positively, others were more likely to engage in those tasks.

Conversely, when teachers observed others fail at a task, their perceptions of their ability to engage in those tasks declined. This was evident in the first mathematics research lesson when the lesson did not go as planned. Teachers questioned their competences to use ICTs in low ability mathematics classes; however, when the second research lesson produced positive results, teachers were more willing to engage further in the process.

The final factor observed to have affected teachers' perceived behavioural control was verbal persuasion. Verbal persuasion was linked to positive reinforcement received by other colleagues. Teachers did elude to the fact that colleagues were very supportive during the Lesson Study programme. There was sufficient evidence to support this during the planning phase when teachers were observed to be working enthusiastically and giving encouragement to each other. Vashnie (EMS) said *"we all sitting together all our ideas come together, all our challenges come together. So we kind of just feed off that."* Feeling supported through verbal cues helped teachers become comfortable with the group. These feeling of support and comfort helped improve their self-efficacy and therefore, their perceived behavioural control.

6.6 CONCLUSION

This study set out to explore teachers' experiences of Lesson Study for integrating information and communication technologies (ICTs) in teaching. This study involved teachers engaging in a Lesson Study programme over seven months, where each group of teachers completed at least two Lesson Study cycles. The findings and the results revealed that while teachers experienced challenges like high workload and learners' unfamiliarity with the use of ICTs for education, their confidence in integrating ICTs in teaching did improve. Factors positively affecting teachers' confidence were collegiality and the reduction of teacher isolation due to the Lesson Study programme. A statistically significant improvement was also noted in Technological Knowledge, Technological Content Knowledge, Technological Pedagogical Knowledge and Pedagogical Knowledge.

Teachers' experiences of the Lesson Study programme was generally positive. They appreciated the structure that the process provided and considered Lesson Study to be a more effective form of professional development than other forms previously experienced. Key factors that played a role in teachers' experiences were the support from colleagues and school personnel. While the duration of the programme was considered a challenge to teachers participating in the programme, teachers reported improved knowledge and skills which they were able to use in their classrooms.

Teachers' and learners' attitudes affected the way teachers perceived the programme. Also, teachers perceived behaviour control was a significant factor in the way teachers participated in the Lesson Study process.

Chapter 7

Conclusions and Recommendations

7.1 INTRODUCTION

The purpose of this study was to explore teachers' experiences of Lesson Study for integrating information and communication technologies (ICTs) in teaching. The problems underlying this research were twofold. Firstly, the integration of ICTs in teaching was problematic for many teachers and secondly, professional development programmes that were undertaken to help teachers integrate ICTs were not effective at achieving the intended outcomes. Professional development programmes were usually short courses focussing on aspects of ICT integration, such as the use of specific ICTs. Professional development programmes were not specifically related to the content that teachers were working on in their classrooms. Therefore, a void often existed between what was learnt at these courses, and the translation into classroom practice. Few, if any at all, programmes were holistic. Most were fragmented and provided teachers with little room for feedback or interaction. Research into professional development initiatives for ICT integration in South Africa, at the start of the study, produced no results for the use of Lesson Study to help teachers integrate ICTs in their lessons. Also, a search for teachers' experiences of Lesson Study for ICT integration yielded no results in the South African context. While research had previously been conducted on the use of Lesson Study for teacher development, most of these studies were based on the improvement of Mathematics and Sciences teaching. Therefore, a gap in the research existed, which this study aimed to address.

This research took the form of a mixed-method, multiple case study approach. Twelve purposefully selected teachers from three learning areas participated. Four teachers each from Life Sciences, Mathematics, and Economic and Management Sciences formed the three case studies. Each group of teachers participated in at least two Lesson Study cycles. Data were collected through semi-structured interviews, document analysis, observations and the TPACK questionnaire. Quantitative data were analysed and used to support the findings from the qualitative data. The findings and results were discussed together based on the research questions.

This chapter is made up of five sections. A summary of the findings and the results are presented according to each research question first. The summary is followed by the conclusions for each research question and the contributions of this study. The limitations of the study, recommendations, and concluding remarks follow.

7.2 SUMMARY OF THE FINDINGS AND THE RESULTS

The study set out to explore teachers' experiences of Lesson Study for integrating ICTs in teaching.

Three research questions were developed to address this. These were:

> How do teachers' confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study?
>
> What are teachers' experiences in using Lesson Study as a strategy to develop their competence in integrating ICTs (information and communication technologies) in their teaching?
>
> Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do?

The summary of the results and findings presented below are based on these research questions.

Through engagement in the lesson study programme, teachers reported that they were better prepared to teach, and were also better prepared to teach using ICTs. Teachers reported improvements in teaching approaches and improved confidence with the use of new technologies. Through the collaboration, mutual trust and motivation were developed. The findings also suggested that improvements in knowledge areas were noted. The quantitative results indicated that significant changes were noted in teacher's technological knowledge (TK), their technological content knowledge (TCK), their technological pedagogical knowledge (TPK), and their pedagogical knowledge(PK).

Teachers were asked to rate their knowledge in Technological, Pedagogical, Content and combinations of these areas on a scale from 1 to 5 using a Likert scale questionnaire. The mean response after the intervention was subtracted from the mean response before the intervention. This difference was assumed to follow a t-distribution. The t-statistic is a sufficient representation of the entire information known about the respective area of knowledge. With a 95% confidence level set as the standard, the null hypothesis for this experiment was that the intervention caused no statistically significant difference in mean response. A two-tailed test was chosen to be conducted, which meant the alternative hypothesis was that there was a statistically significant difference in mean response (either an improvement or a deterioration) after the intervention.

After analysis of these seven critical areas, the following conclusions were made.

The composite analysis indicated that the intervention caused a significant change (an improvement) to some areas of teachers' knowledge. The areas of improvement were teacher's technological knowledge (TK), their technological content knowledge (TCK), their technological pedagogical knowledge (TPK), and their pedagogical knowledge (PK). While an improvement was noted in other knowledge areas, at a 95% confidence level, there was insufficient evidence to conclude that the intervention caused any statistically significant change in the other knowledge areas over the subjects.

One of the most significant outcomes reported by the teachers was the intra-departmental collaboration that resulted. Teachers had, before the Lesson Study programme, indicate that they usually worked in isolation. While teachers had attended regular meetings within their departments, these meetings were limited to routine discussions of syllabus coverage and learner achievement. During the Lesson Study cycles, teachers said that they felt less isolated, planned and communicated better, and felt more supported by their colleagues. Teachers who had claimed to have poor technological skills were more willing to use ICTs in their teaching after going through two Lesson Study cycles. The teachers were encouraged to participate in the Lesson Study programme for seven months. During this time, teachers planned together, viewed recordings of their lessons together and critically reflected on their teaching together. Through this prolonged interaction, teachers collaborated and supported one another. Working together for this period helped participants develop trust, motivation and self-efficacy. Therefore, Lesson Study could be seen as an important means of enhancing teachers' collaboration and reducing teacher isolation.

While teachers did experience several benefits of engaging in the Lesson Study programme, challenges like limited time due to high teacher workload and learners' perceptions of ICTs as social rather than education tools did serve as barriers to teachers' participation. Lack of time due to high teacher workload was a major constraint. Many teachers who participated were involved in the co-curricular programme at school. Involvement in the co-curricular programme meant that teachers had to be available after school hours to assist with coaching, remedial lessons, and management duties. The Lesson Study programme itself involved sustained commitment over a long time. Teachers, therefore, had difficulty finding a common time to meet. This challenge was overcome by exchanging management duty days or getting volunteer teachers to cover co-curricular activities. A further challenge was the timetable structure. The timetable was structured so that all teachers of a subject would be teaching at the same time, meaning that teachers were not available to observe research lessons. As all classrooms in the school had cameras, this challenge was overcome by recording research lessons. Recording the research lesson also meant that all teachers were able to review the lesson together.

Teachers reported that they were more inclined to participate in the Lesson Study programme due to the support they received from their colleagues and school personnel. The IT Manager was available to provide technical and technological support for every Lesson Study group. The Director of Academics at the school had at staff meetings encouraged teachers to participate, stating that Lesson Study was a valuable form of professional development. The support received helped teachers develop their self-efficacy, and this improved their attitude to the programme and their perceived behavioural control.

While challenges were present, teachers' experiences of Lesson Study for integrating ICTs in teaching were generally positive. Teachers viewed the stages of each cycle of the programme as being logical and well structured. The content and pedagogy were planned together with the ICTs so teachers could see how it would be used in the classroom. The lessons that teachers planned during each cycle could be internalised and implemented in their classrooms. The advantages presented above indicate that Lesson Study could serve as a suitable model to help teachers integrate ICTs in their teaching. The following section presents the conclusions obtained from the analysis of the results and the findings.

7.3 CONCLUSIONS

The conclusions presented in this section are based on the discussions in chapter six. The discussions focussed on the cross-case findings and results and were centred around the three research questions.

Research Question 1: How do teachers' confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study?

The first research question set out to explore how teachers' confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study. Through the discussion, it was seen that there was an improvement in teachers' confidence after participating in the Lesson Study programme. Factors reported having affected teachers' confidence in integrating ICTs positively, were collegial support, reduced teacher isolation, and reflective practices developed through the Lesson Study process. The two key factors that negatively affected teacher confidence in integrating ICTs in teaching were teacher workload and learner responses. High teacher workload resulted in time constraints which affected teacher participation while learner responses to the ICTs resulted in teachers becoming demotivated and questioning their use of ICTs in teaching. While improvement was noted in all knowledge areas except Content Knowledge, which remained unchanged, statistically significant improvements were noted in Technological Knowledge, Technological Content Knowledge, Technological Pedagogical Knowledge and Pedagogical Knowledge. The findings and the results revealed that while teachers experienced challenges like high workload and learners' unfamiliarity with the use of ICTs for education, their confidence in integrating ICTs in teaching did improve.

The conclusion is, therefore, that there was a significant improvement in teachers' confidence in integrating information and communication technologies (ICTs) in their teaching through the use of Lesson Study.

Research Question 2: What are teachers' experiences in using Lesson Study as a strategy to develop their competence in integrating ICTs (information and communication technologies) in their teaching?

This research question explored teachers' experiences of Lesson Study for the integration of ICTs in teaching. The frameworks that guided the discussion were the TPACK framework (Koehler & Mishra, 2009) and Guskey's (2002) Five Levels of Professional Development Evaluation. While teachers did experience challenges like lack of time due to high workload and the perceptions of learners to ICTs, their responses indicated positive experiences. While the time required for participation was reported as a significant barrier, teachers felt that the benefits of Lesson Study outweighed the challenges they faced. Teachers felt that they would prefer to engage in a practical, sustained form of professional development where they could implement what they learnt, rather than a quick and ineffective form.

The quantitative analysis revealed that teachers Technological Knowledge, Technological Content Knowledge, Technological Pedagogical Knowledge and Pedagogical Knowledge improved significantly. The teachers appreciated the structure that was provided and ranked

Lesson Study as better than previous approaches to professional development. Teachers found the Lesson Study programme to be relevant to their teaching. The skills that were developed could be transferred directly to the classroom. Teachers reported the process to be valuable since it was hands-on and needed teachers to be actively involved rather than passive recipients of the information. Improvements were noted in reflective practices, intra-departmental and organizational support, and teachers' knowledge and skills. Teachers were required to reflect critically on the research lesson while observing. By reflecting on their teaching, teachers were able to make improvements, and this, therefore, resulted in professional growth.

Teachers participating in this study felt supported and therefore continued to participate in the Lesson Study programme. Ogegbo et al. (2019) found that institutional support played a vital role in teachers' participation in a Lesson Study programme. They found that a lack of institutional support served as a threat to teachers' participation in this form of professional development.

While challenges were present, teachers considered Lesson Study to be a valuable and effective form of professional development. Key factors that played a role in teachers' experiences were the support from colleagues and school personnel. While the duration of the programme was considered a challenge to teachers participating in the programme, teachers reported improved knowledge and skills which they were able to use in their classrooms.

While teachers experienced some challenges, teachers' experiences of using Lesson Study as a strategy to develop their competence in integrating ICTs in their teaching were generally positive. Therefore, Lesson Study could serve as a suitable model to help teachers develop their competence in integrating ICTs in teaching.

Research Question 3: Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do?

The Theory of Planned Behaviour (TPB) has proven to be a useful model for explaining behaviour and intentions (Conner, 2015). Attitudes and perceived behavioural control are successful predictors of behaviours. This indicates that TPB is a useful model that could be used to explain the behaviour of individuals in a given time and setting. Since the model is effective at predicting and explaining behaviour, it was used to frame the discussion around the third research question.

Teachers' evaluation of Lesson Study for the integration of ICTs in teaching was generally favourable. Lesson Study was seen as a new and innovative form of professional development; unlike the types they had experienced in the past as Lesson Study involved active participation and was relevant to what teachers were doing in the classroom. Teachers reported that Lesson Study provided a good structure. The logical sequence and clarity of instructions provided a useful framework within which teachers were able to work.

The two critical factors that negatively affected teachers' attitude toward the Lesson Study was the amount of time required for participation and learner perception of ICTs. Since teachers had experienced Lesson Study for the first time in this study, Lesson Study was seen as an additional activity rather than a regular part of the teaching process. Teachers believed that learners regarded ICTs as social rather than educational resources. The poor behaviour of some learners resulted in teachers questioning the use of ICTs in teaching. Some learners were distracted and inattentive when ICTs were used. Generally, teachers saw the benefits of ICTs in their lessons and were enthusiastic about developing their abilities to use ICTs effectively.

Collegial support played a vital role in teachers' participation in the programme. Without the support teachers received from each other, it is unlikely that many would have continued with the programme. Teachers felt that they were able to participate in a non-threatening environment. Added to this, was the encouragement received from colleagues. The encouragement and support helped teachers realise that they were not alone in the programme and therefore felt more comfortable with the Lesson Study programme.

All teachers were aware that the Lesson Study programme had the support and backing of the senior management of the school. The effect of this support was evident during the programme. Teachers were more willing to be involved with many assuming leadership roles within each group. While teachers experienced challenges, they persevered and remained in the programme. The support from colleagues played a vital role in this aspect. Teachers were able to motivate and assist each other. Therefore, there was a clear indication that colleagues and senior members of staff approved of and supported the Lesson Study programme. This support played a vital role in the teachers' sustained participation in the programme.

A key motivating factor within the school where the study was conducted was the Digital Learning policy at the school. The policy stated that twenty-five percent of contact time with learners in the classroom must involve the use of ICTs. As a result, all teachers were required to use ICTs in teaching. The importance of ICT integration was stressed through the policy and the expectations of the school leaders. The Lesson Study programme was seen as a potential way to develop teachers' competence in the integration of ICTs in their teaching.

Teachers in the study demonstrated clear intentions to integrate ICTs in their teaching. Their intentions to use ICTs were translated into practice through engagement in the Lesson Study programme. Part of the reason why teachers planned to integrate ICTs in their teaching was that the focus of the Lesson Study programme was on the integration of ICTs in teaching. Teachers' willingness to participate, further indicated their intentions as participation in the programme was voluntary.

Teacher's past performance was said to have a significant impact on the way teachers engage in pedagogical activities, group work or problem-solving tasks (Klassen & Klassen, 2018). Teachers' interpretations of the results of their actions helped develop the beliefs about their abilities to integrate ICTs into their teaching through Lesson Study. Outcomes that were thought to be successful helped increase self-efficacy, thereby promoting greater perceived behavioural control while outcomes that teachers perceived as failures lowered perceived behavioural control (Huang et al., 2020; Pajares, 1992). Where teachers perceived outcomes to be failures, low self-efficacy resulted, and this reduced the chances of teachers engaging in similar tasks in the future (Huang et al., 2020).

The teachers who demonstrated high levels of enthusiasm were more willing to engage in the Lesson Study programme than those who were demotivated by the poor response from the learners. Teachers with high self-efficacy, therefore had greater perceived behavioural control and would therefore be more willing to engage in similar activities in the future.

Another significant factor affecting teachers perceived behavioural control was the ability to watch other teachers participate in the programme and teach ICT integrated lessons. By observing others perform tasks, teachers made judgements about their abilities. When teachers performing tasks responded positively, others were more likely to engage in those tasks. Conversely, when teachers observed others fail at a task, their perceptions of their ability to engage in those tasks declined. The final factor observed to have affected teachers' perceived behavioural control was verbal persuasion and positive reinforcement. Teachers did elude to the fact that colleagues were very supportive during the Lesson Study programme.

In conclusion, several factors played a role in why teachers experienced the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they did. Factors that improved teachers' attitude and their perceived behavioural control played a significant role in teachers' positive experiences of Lesson Study to integrate ICTs in teaching. Therefore, teachers' experiences of the use of Lesson Study to integrate ICTs in teaching was dependent on attitudes, support received, and on teachers' perceived behavioural control.

7.4 CONTRIBUTIONS OF THIS RESEARCH

7.4.1 Contribution to the field of scholarship

Lesson Study has been used extensively in Japan, and, more recently, increased attention has been directed toward the use of Lesson Study for teacher professional development in European countries. However, the use of Lesson Study in South Africa has been limited, but there has been an increasing focus on its use in recent years (Bayaga, 2013; Mokhele, 2017). Most of the research has, however, focused on Mathematics and Science education. There is limited research on the use of Lesson Study in South Africa. Furthermore, limited studies on the use of Lesson Study to integrate ICTs in teaching exist. This study is, therefore, significant because it contributes to the limited body of knowledge, on Lesson Study, that exists within a South African context.

7.4.2 Lesson Study is an effective form of professional development for the integration of ICTs in teaching

Effective teacher professional development, according to research, should involve active, collaborative learning experiences that provides teachers with the opportunity to adopt practices for their classrooms, be sustained over a long period and allow for follow-up and support (Darling-Hammond et al., 2017). These principles of effective professional development are elements that are contained in Lesson Study. Traditional forms of professional development that teachers were exposed to or participated in required that teachers be passive observers rather than active participants. During Lesson Study cycles, teachers worked collaboratively to design lessons that could be used in the classroom. The process followed involved teachers planning for ICT integration, teaching, observing and reviewing the use of ICTs over an extended period. Through engagement in the Lesson Study programme, teachers' confidence in the use of technology improved as was indicated by the results of the TPACK questionnaire. Teachers were more confident in using ICTs in lessons due to the collegial support they received. Based on Guskey's (2002), there is sufficient evidence to support Lesson Study as an effective form of professional development. It has the characteristics of an effective professional development model such as it is site-based and ongoing. Further evidence in the literature using Guskey's (2002) framework provide evidence to support this. This, therefore, means that Lesson Study can serve as a suitable model to help teachers integrate ICTs into their teaching.

Therefore, Lesson Study satisfies the criteria necessary to be an effective form of professional development for integrating ICTs in teaching.

7.4.3 Lesson Study contributes to the improvements in the social and professional climate at schools

The findings confirm that Lesson Study contributes to the improvements in the social and professional climate at schools. Teachers engaged in the Lesson Study process were required to meet for extended periods. These meetings were unlike previous interactions that teachers had experienced in the past. While previous interactions involved routine discussions about content coverage, meetings around the Lesson Study programme were more holistic. Teachers voluntarily met to design, implement, and review lessons. By doing so, teachers were able to identify and work on weaknesses and reinforce positive outcomes. The result of this was an improvement in the social development of teachers.

Through Lesson Study, teachers were able to work together and support each other, thus reducing teacher isolation that had previously existed. Teachers reported that the Lesson Study programme had resulted in greater intra-departmental collegiality, improvements in planning, and improvements in teachers' confidence in, and use of ICTs in teaching. Schipper et al. (2020) showed that school leaders could use Lesson Study practices to create and promote a culture of professionalism among teachers at schools. This study reported similar findings. Teachers were more supportive, felt less isolated, and were willing to use personal time to engage in professional development.

This study therefore established that Lesson Study contributes to the improvements in the social and professional climate at school.

7.4.4 Identification of factors affecting teachers' use of Lesson Study for ICT integration.

The findings of this study confirmed that perceived behavioural control, teacher attitudes and organisational support were significant factors that affected how teachers perceived Lesson Study for ICT integration.

Teacher attitudes were based on their evaluation of Lesson Study for ICT integration. It involves considering the outcomes to evaluate the behaviour as either favourable or unfavourable (Ajzen, 1991; Gómez-Ramirez et al., 2019). Teachers' evaluation of Lesson Study for the integration of ICTs in teaching was generally favourable.

Lesson Study was seen as a new and innovative form of professional development; unlike the types they had experienced in the past. Teachers reported that Lesson Study provided a good structure within which teachers had to work. The logical sequence and clarity of instructions

The Lesson Study programme was considered to be more valuable than previous forms of professional development as Lesson Study involved active participation and was relevant to what teachers were doing in the classroom.

The intra-departmental and organisational support received played a vital role in teachers sustained participation, and the collegiality that resulted due to formalised collaboration occurring was appreciated. Teachers reported feeling less isolated and found themselves actively participating in the process. Due to the support received, teachers who had previously not used ICTs in teaching had made attempts to get assistance or use ICTs in teaching. Therefore, the factors positively affecting teachers' perceptions were the structure that Lesson Study provided, the active participation, and the intra-departmental support.

The two critical factors that negatively affected teachers' attitude toward the Lesson Study was the amount of time required for participation and learner perception of ICTs. Teachers in the study claimed to have high work-loads and therefore, had limited time available to participate in the Lesson Study programme.

Since teachers had experienced Lesson Study for the first time in this study, Lesson Study was seen as an additional activity rather than a regular part of the teaching process. Also, teachers' perceptions of ICTs played a role in their attitude toward the programme. The focus of the Lesson Study programme was on integrating ICTs into teaching. Teachers who had negative perceptions of ICTs said that they would be less likely to use ICTs in their teaching or that they would be selective in when they would choose to use ICTs.

Teachers' perceived behavioural control was a significant factor affecting teachers' use of Lesson Study for integrating ICTs in their teaching. Perceived behavioural control was strongly related to teachers' self-efficacy. The three aspects affected teachers' perceived behavioural control were past performance, verbal persuasion, and observing colleagues work. Teachers perceived behavioural control were based on their interpretations of these factors. Where positive outcomes were perceived, teacher self-efficacy improved, and teachers were more willing to attempt to use Lesson Study to integrate ICTs in teaching. This study, therefore, established that perceived behavioural control, teacher attitudes and organisational support were significant factors that affected how teachers perceived Lesson Study for ICT integration.

7.5 LIMITATIONS OF THE STUDY

While limitations were identified in this study, it merely implies that the study needs to be viewed within the context of these limitations.

A case study approach was used since case studies explore and investigate existing real-life phenomenon through the analysis of a few events or conditions (Zainal, 2007). In this case, the research involved Lesson Study for the integration of ICTs in teaching, and their relationships in a particular context – teachers' experiences. Although case studies have various advantages like providing insights into the comprehensive behaviours of the subjects, they are also criticised for their inability to generalise their results (Cohen et al., 2017). The data collected is also open to different interpretations due to the richness and complexity. The case study approach was selected since the intention was not to generalise the results but to gain an in-depth understanding (Yin, 2009) of teachers' experiences of Lesson Study for integrating ICTs in teaching. The data collected were, therefore, unique to the three cases and the school where that research was conducted.

The quantitative data obtained during the study was from a small sample of only twelve teachers. Researchers generally agree that small sample sizes generally have limited statistical power for identifying differences between groups or variables (Anderson et al., 2017; Leppink et al., 2016). This means that even when a great difference in means was present, as seen in some of the TPACK knowledge areas, a statistically significant difference was difficult to obtain. Therefore, the null hypothesis could not be rejected. Larger sample sizes would have produced more statistically significant results. However, the quantitative results were not interpreted in isolation. It was used primarily to support or dispute the data from the qualitative findings.

The study was conducted in one well-resourced school. As the objective of the study was to explore teachers' experiences in using Lesson Study to integrate ICTs in teaching, the research school needed to have ICTs available for teachers to use in their teaching. Teachers' experiences in under-resourced school were not explored; therefore, the results of this study are only applicable to schools with similar resources. The findings of this study would have been more generalizable had more schools from different socio-economics backgrounds participated.

The coding and classification of the data were conducted using different methods to confirm the resulting codes and themes. Samples of the data were also given to colleagues to code so that comparisons could be made and the codes and themes confirmed. However, the issue of subjectivity of the coding process could be a limitation. It may be possible that other researchers may obtain different codes from the data. This is also a limitation of qualitative research.

7.6 RECOMMENDATIONS

Teachers viewed lesson Study as an effective way to help them integrate ICTs in teaching. Teachers of this study, generally, indicated a willingness to participate in the Lesson Study programme. However, high teacher workload and the lack of a suitable common meeting time proved challenging.

7.6.1 Recommendations for school leaders and managers

It is recommended that schools that intend to use Lesson Study to help teachers integrate ICTs in teaching allow teachers to meet regularly. This can be achieved by timetabling a common period when all teachers of a department are free at the same. By timetabling a common free lesson, teachers would be able to meet during the school day. This would ensure that duties that teachers are involved in after school hours would not be affected.

The findings of the study revealed that there was a link between teachers' positive experience of Lesson Study and the support teachers received. It is, therefore, important to involve school management and leaders in the Lesson Study programme. Further, school leaders should actively promote the benefits of Lesson Study.

The Lesson Study process needs to be sustained and ongoing and not once-off. By continuing the process, teachers will be motivated to implement what they learn due to the ongoing support they will receive.

Since the Lesson Study process relies heavily on lesson observation, ICTs, like cameras or digital recording devices, could be used regularly in classrooms. By doing so, teachers will become more comfortable with being observed and teachers observing the lesson do not need to be available when the lesson is being taught. A further advantage of recording the research lesson is that all teachers would be present to observe the lesson, including the teacher-presenter.

7.6.2 Recommendations for future research

While this study confirmed that teachers' experiences of Lesson Study were generally positive and that teachers perceived Lesson Study to be an effective way to help them integrate ICTs in teaching, the findings were based on one school and small sample size.

A recommendation for future research is that the research is conducted across a larger number of schools with more participants. The schools could also be from different socio-economic contexts. This could help establish whether it is the resources or other factors that affect teachers' participation in the programme. It would be interesting to explore teachers' experiences of Lesson Study for the integration of ICTs in teaching in schools with limited ICTs. Inviting teachers from under resourced schools could promote inter-school collaboration and in doing so help reduce the effects of the digital divide that may exist due to different socio-economic contexts. Also, the number of participants would have been increased to improve the quantitative aspect of the study.

While the TPACK questionnaire proved effective for this study, the focus could be placed on the development of a new questionnaire, specifically related to teachers' perceptions of the various stages of the Lesson Study process. In this way, the Lesson Study process could be modified or refined.

Finally, the one area that was not addressed in this study was the effect on learners' outcomes. Future research could focus on the effect that teachers' engagement in the Lesson Study for the integration of ICTs in their teaching has on learner achievement, knowledge and skills, and involvement in lessons.

7.7 CONCLUDING REMARKS

The findings and results of this study indicate that while teachers did experience challenges like limited available time and poor learner perceptions of ICTs, their viewed the Lesson Study process as an effective way to help them integrate ICTs in their teaching. It was seen as a holistic form of professional development where teachers were able to combine technology, pedagogy, and content to produce ICT integrated lessons collaboratively. The overall experience of the teachers was generally positive, but several factors played a role in the teachers' experiences. The support in the form of the provision of ICTs and physical resources, personnel like the IT manager, and collegial support were essential for the success of the Lesson Study programme.

7.8 PERSONAL REFLECTION

The PhD journey began after I had completed my Master's degree. My supervisor was very supportive and encouraged me to start working on a PhD.

I chose to teach when I was nineteen years old because I wanted to make a difference in the world. My love of teaching compelled me to consider things from the perspective of the learners. Through my twenty-two-year teaching career, I have seen changes in how learners interact with each other and learn. Hence, my interest in ICTs. At the time of the study, I was employed as a Physical Sciences teacher, but my role within the school had gradually begun to change. The management at the school had noticed my interest in ICTs and had given me more responsibility in that area. I was asked to assist with helping teachers integrate ICTs in their teaching. This is the reason for my interest in ICTs and professional development.

The school management and I had held several workshops on the use of ICTs in teaching, and teachers were still reluctant to use technology in their teaching. Many were unsure about how ICTs should be used. Many were very confident in the content and teaching methods that they had used previously and were reluctant to change. A turning point occurred when a teacher said the following, "I know how to use the technology, but how do I use it in teaching?" This question was the start of my PhD journey. I began researching professional development approaches and came across Lesson Study. Based on what I had read, Lesson Study represented, what seemed like, a suitable way of helping teachers integrate ICTs in their teaching in a holistic manner. The background information mentioned here is essential as it could be a potential source of subjectivity in this study.

This doctoral journey began in 2017 with fresh ideas about how this research would change the world. My thoughts of a school environment permeated with the wonderment of a Lesson Study type professional development was brought to a grinding halt when my research proposal was rejected for being too vague. This initially caused me to become demotivated, but through the support and encouragement from my supervisor, I decided to persevere. I spent a further month working on the proposal. The process of writing the proposal was vital as it had helped me focus the study and also help acquaint me with some of the research in the field. A substantially revised proposal was submitted and accepted. After that, an application was made for ethical clearance. This, too, was granted.

The review of the literature was one of the most challenging parts of the process. My style of writing at the beginning of the process was mediocre, and several revisions were necessary before the writing became of an acceptable standard to my supervisor. During this process, I faced several challenges. The vast quantity of literature available often resulted in confusion and was, at times, distracting. I had to learn to focus my research on specific topics of the study rather than looking at overviews. This was overcome by developing a flow diagram of the possible areas that the study would address. Also, the choice of the paradigm for the study proved to be a dilemma. On the one hand, the pragmatic paradigm proved to be suitable as it involved mixed-method research, but the interpretive paradigm also had its merits. After weeks of research and an analysis of the research questions, I decided that since the study was about teachers' experiences, the interpretative paradigm was best.

The second challenge was personal. I had a two-year-old son who required a great deal of attention at that time. Maintaining a balance between family time and finding time to write proved problematic. Most of the writing had to take place after my son had gone to bed. While there were challenges, I did develop time management skills that I had not previously had. While there is still room for improvement, my writing skills are better than they were at the start of the study.

The use of video recorded lesson proved very useful for the lesson observation stage. Due to time constraints at the research school, this initiative had to be put in place to allow the teachers to meet together to review lessons. Observations from recorded lessons could form part of the Lesson Study process in the future as all teachers were able to view and comment on the lesson, including the teacher-presenter.

The PhD journey has been long, challenging, and filled with emotionally charged moments. I feel that I have contributed to the field of research on Lesson Study for the integration of ICTs in teaching in South Africa and have learned along the way. I also feel empowered to help teachers to develop their skills so that they will be able to use technology in their teaching.

Footnote

A further indication of the success of the Lesson Study programme for the integration of ICTs in teaching, which was not reported in the study as it occurred when data collection had already taken place, came as a result of the Covid-19 pandemic. Due to the pandemic, teachers and learners at the research school had to remain at home for approximately three months. During this time, the school management required teachers to continue teaching using digital resources. Teachers who had participated in the Lesson Study programme had previously been exposed to or had used ICTs to develop and present lessons. Most of these teachers reported increased levels of confidence in using ICTs.

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Appendix A- Ethical clearance certificate

UNIVERSITY OF ™
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INYUVESI
YAKWAZULU-NATALI

27 November 2018

Mr Avashkumar Juggemath 944361584
School of Education
Edgweood Campus

Dear Mr Juggemath

Protocol reference number: HSS/2065/018D
Project Title: Exploring teachers' experiences of Lesson Study for Integrating Informaiton and Communication Technologies in Teaching.

Full Approval – Expedited Application

In response to your application dated 09 November 2018, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FUL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

[redacted]

Prof S Singh

/px

cc Supervisor: Prof Nadaraj Govender
cc Academic Leader Research: Dr Simon Khoza
cc School Administrator: Mr SN Mthembu, Ms S Jeenarain and Ms M Ngcobo

Humanities & Social Sciences Research Ethics Committee
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Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

Appendix B 1 – TPACK Questionnaire - Description of intended uses: Dr Schmidt

Gmail

Avash Juggernath <avash27@gmail.com>

TPACK questionnaire - Description of intended use

Avash Juggernath <avash27@gmail.com> Tue, Oct 30, 2018 at 2:09 PM
To: dschmidt@iastate.edu

Dear Dr Schmidt

My name is Avash Juggernath and I am a PhD student at UKZN. I am working on research on the use of Lesson Study for the integration of ICTs in teaching. I am intending to use the TPACK framework as an analytic framework and would like to use the questionnaire to assess if teachers' perceptions change after being exposed to Lesson Study.

The study will be conducted in a public high school in the KwaZulu-Natal province of South Africa.

12 to 18 teachers will be involved in the study.

My research questions are as follows
How do teachers' confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study?

What are teachers' experiences in using Lesson Study as a strategy to develop their competence in integrating information and communication technologies (ICTs) in their teaching?

Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do?

I hope that this request meets with a favourable response.

Thanks and kind regards

MR AVASH JUGGERNATH

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Appendix B 2

Informed Consent Document - Teachers

Dear Sir / Madam

My name is Avash Juggernath (*944361584*). I am a PhD candidate studying at the University of KwaZulu-Natal, Edgewood Campus.
The title of my research is: **Exploring Teachers' Experiences of Lesson Study for Integrating Information and Communication Technologies in Teaching**. Lesson Study is a collaborative teaching approach where teachers work together in order to examine, learn from and reflect on what happens in a classroom. The use of ICTs in teaching and learning has also proven to be problematic since it requires the development of new skills, attitudes and pedagogical approaches. Teachers are often unsure about how to use ICTs, what to use and the reason for its use in teaching and learning. This research thus aims to explore teachers' experiences of Lesson Study in integrating ICTs in teaching within the South African high school context.
I will appreciate it if you would consent to be part of this study.

PLEASE NOTE THAT:
All your responses will be treated with strict confidentiality.
Fictitious names will be used to represent your name and the name of your institution.
Your identity will not be divulged under any circumstance/s, during and after the reporting process.
There will be no financial benefits that participants may accrue as a result of their participation in this research project.
Participation is voluntary; therefore, you are free to withdraw at any time you wish without incurring any negative or undesirable consequences/penalty on your part.
All information will be used for scholarly purposes only
With your permission the interview will be audio recorded.

	Yes	No
Audio equipment		

For further information on this research project, please feel free to contact me using the following contact details: Avash Juggernath; Cell:0844477232; Email: avash27@gmail.com or my supervisor: Prof. Nadaraj Govender; Cell: 074 373 3259; Email: govendern37@ukzn.ac.za.

You may also contact the Research Office through: P. Mohun HSSREC Research Office, Tel: 0312604557 E-mail: mohunp@ukzn.ac.za. Thank you for your contribution to this research.

Your positive response in this regard will be highly appreciated.
Thanking you in advance

Yours sincerely

[redacted]

Appendix B 3: School Principal Consent Form

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School Principal Consent Form

Exploring Teachers' Experiences of Lesson Study for Integrating Information and Communication Technologies in Teaching

I hereby give consent for you to conduct research at this school and to approach teachers to participate in the above research.
I have read the Project Information Statement explaining the purpose of the research project and understand that:

- The role of the school is voluntary
- I may decide to withdraw the school's participation at any time without penalty
- Teachers will be invited to participate and permission will be sought from them
- Only teachers who consent will participate in the project
- All information obtained will be treated in strictest confidence.
- The teachers' names will not be used and individual teachers will not be identifiable in any written reports about the study.
- The school will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty.
- A report of the findings will be made available to the school.

Further information on the project may be sought from Avash Juggernath on 0844477232.

[redacted] 31.10.18

Principal Signature Date

Lesson Study Resources

Appendix C 1: The original lesson planning sheet

LESSON PLANNING SHEET

LESSON NUMBER ___________________________ **DATE ______________________**

SUBJECT: _______________________________________

CLASS	
PRESENTER	
TOPIC	
INTENDED OUTCOMES	
RESOURCES and TYPE OF SUPPORT REQUIRED (EG TRAINING TO USE SPECIFIC ICT TOOL ETC.)	

	CONTENT	TEACHING METHOD	RESOURCES INCL. ICTS
INTRODUCTION DURATION:			
BODY 1 DURATION:			
BODY 2 DURATION:			
CONCLUSION DURATION:			

NOTES

Appendix C 2: The revised lesson planning sheet

ICT Integration using Lesson Study

Phase 1 – The Lesson Planning process.

1) **Team Norms for Lesson Study**

We will listen without interrupting.
Our actions will be determined by what is best for our learners.
We will be open to changing our minds.
We will try to keep a sense of humour

1.1 Do the norms feel right for your team?

1.2 What revisions or additions, if any, do we want to make to the norms?

____
____
____
____
____
____
____
____

PLANNING CHECKLIST

_____ Determine which member of the group will deliver the lesson. Coordinate with a mentor teacher to identify a standard and objective to teach, and determine when the lesson will be taught (day and time)

_____ Define lesson goals, design the assessment, and brainstorm instructional strategies and methods.

_____ Working as a team, complete a written lesson plan and summarise it on the lesson planning template.

_____ Define group members' roles.

_____ Determine how the group members will collect data on student learning.

_____ Prepare all materials needed for the execution of the lesson.

Step 1: Identify the topic

- What areas are challenging to my learners?

- Which areas are challenging to explain?

- Will the topic fit in within the agreed upon schedule?

Topic: ____

Step 2: Identify the content; processes and the lesson goals

What are the lesson objectives?

- Content goals
  Identify the specific content or understanding that Learners will develop;

- What skills or habits of mind will the learners develop?

- What are the learning outcomes for the lesson?

Step 3: Plan a research lesson

(REMEMBER: ONE OF THE KEY THEMES IS ICT INTEGRATION)

Understanding your research lesson

- Why did you choose this topic?

- What are the critical instructional strategies needed for this lesson?

  - What ICTs will be incorporated into the lesson?

  - How and when will it be used?

- How does the lesson design support the lesson objectives?

- What previous knowledge of the topic should the learners have?

- Provide reasons for your choice of task?

- List key activities and questions that should be included?

- What learner responses have you anticipated?

- What evidence of learner understanding would you like to see

- What kinds of information would you use to evaluate the effectiveness of the lesson?

Step 4: Prepare to teach the research lesson.

Identify the teacher and classroom for the research lesson.

Schedule the research lesson.

- Confirm the details of the research lesson i.e. date, time, and location.

Prepare to collect lesson observation data

5. Reflect on the planning process.

Reflection Questions

5.1. How was the topic discussed by the team?

Did they refer to how learners learn and the essential elements of the subject/topic? In what ways?

5.2. Was the lesson linked to the goals? In what ways?

5.3. Was the conversation open to all participants? For example, were less experienced participants able to ask questions or propose ideas?

5.4. How did the team members reflect on:

Their teaching practice?

On learners learning?

On the collaborative process?

5.5 Did the group keep track of generated ideas and revisions to the lesson?

Appendix C 3: The lesson observation template

RESEARCH LESSON OBSERVATION FORM

Comments that come to your mind as you observe.

Critical things that are happening in the classroom.

Evidence of confusion.

Evidence of engagement.

Appendix: Technology Integration Assessment Rubric

Criteria	4	3	2	1
Curriculum Goals & Technologies (Curriculum-based technology use)	Technologies selected for use in the instructional plan are strongly aligned with one or more curriculum goals.	Technologies selected for use in the instructional plan are aligned with one or more curriculum goals.	Technologies selected for use in the instructional plan are partially aligned with one or more curriculum goals.	Technologies selected for use in the instructional plan are not aligned with any curriculum goals.
Instructional Strategies & Technologies (Using technology in teaching/ learning)	Technology use optimally supports instructional strategies.	Technology use supports instructional strategies.	Technology use minimally supports instructional strategies.	Technology use does not support instructional strategies.
Technology Selection(s) (Compatibility with curriculum goals & instructional strategies)	Technology selection(s) are exemplary, given curriculum goal(s) and instructional strategies.	Technology selection(s) are appropriate, but not exemplary, given curriculum goal(s) and instructional strategies.	Technology selection(s) are marginally appropriate, given curriculum goal(s) and instructional strategies.	Technology selection(s) are inappropriate, given curriculum goal(s) and instructional strategies.
"Fit" (Content, pedagogy and technology together)	Content, instructional strategies and technology fit together strongly within the instructional plan.	Content, instructional strategies and technology fit together within the instructional plan.	Content, instructional strategies and technology fit together somewhat within the instructional plan.	Content, instructional strategies and technology do not fit together within the instructional plan.

How well the ICT tools matched the instructional strategies and the content.

Were the ICT tools selected appropriate for the lesson?

What were learners' responses to the use of the ICTs?

What were pupils able to do at the end of the lesson? (Progress? Evidence?)

NOTES

Appendix C 4: The lesson review template

Review of the lesson

1) *What are some things we can say, objectively, about the information collected from the lesson?*

Include:
1.1 ICT use and its effect on understanding content,

1.2 Learner behaviour

1.3 Learner's responses and
What in the instruction might have contributed to students responding in this way that they did?

2) *Were the lesson objectives met? If so, how? If not, what happened instead?*

3) *ICT use*
3.1) Were the ICTs used suitable for the lesson? Did it serve its intended purpose?

3.2) Did the ICTs used fit in with the method of instruction?

3.3) Was it suitable for the subject content?

3.4) Could a more effective lesson have been developed if other ICT resources were used instead of the ones chosen for the research lesson?

4.1) *Reflections from the teacher who taught the lesson.*

4.2) What evidence, or lack thereof, of learner understanding did you see in learners' work?

5) How could the lesson be revised so that it may possibly be used in another class?

6) Based on your observations, what might make sense for the next lesson for these students? Why?

7) What does this lesson study experience reveal to you about the qualities of good lessons?

8) Identify issues that arose during this lesson study cycle?

9) How did your team work together during this lesson study cycle? Did you encounter any challenges?

10) What would you keep the same or do differently next time?

11) Any additional thoughts or questions that you may have

Appendix D 1: The TPACK Questionnaire

Technology is a broad concept that can mean a lot of different things. For the purpose of this questionnaire, technology is referring to digital technology/technologies. That is, the digital tools we use such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc. Please answer all of the questions and if you are uncertain of or neutral about your response you may always select "Neither Agree or Disagree"

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
TK (Technology Knowledge)					
1. I know how to solve my own technical problems.					
2. I can learn technology easily.					
3. I keep up with important new technologies.					
4. I frequently play around the technology.					
5. I know about a lot of different technologies.					
6. I have the technical skills I need to use technology.					
CK (Content Knowledge)	**SUBJECT / LEARNING AREA**				
7. I have sufficient knowledge about the subject I teach					
8. I can use a way of thinking that is required by the subject I teach					
9. I have various ways and strategies of developing my understanding of the subject I teach					
TPACK (Technology Pedagogy and Content Knowledge)					
10. I can teach lessons that appropriately combine the subject content I teach, technologies and teaching approaches.					

PCK (Pedagogical Content Knowledge)					
11. I can select effective teaching approaches to guide student thinking and learning in the subject I teach.					
TCK (Technological Content Knowledge)					
12. I know about technologies that I can use for understanding and doing the subject that I teach					

TPK (Technological Pedagogical Knowledge)					
13. I can choose technologies that enhance the teaching approaches for a lesson.					
14. I can choose technologies that enhance students' learning for a lesson.					
15. My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.					
16. I am thinking critically about how to use technology in my classroom.					
17. I can adapt the use of the technologies that I am learning about to different teaching activities.					
18. I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.					
19. I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom.					
20. I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district.					
21. I can choose technologies that enhance the content for a lesson.					

PK (Pedagogical Knowledge)					
22. I know how to assess student performance in a classroom.					
23. I can adapt my teaching based-upon what students currently understand or do not understand.					
24. I can adapt my teaching style to different learners.					
25. I can assess student learning in multiple ways.					
26. I can use a wide range of teaching approaches in a classroom setting.					
27. I am familiar with common student understandings and misconceptions.					
28. I know how to organize and maintain classroom management.					

Appendix D 2: The semi-structured interview schedule

RQ1	***How do teachers' confidence in integrating information and communication technologies (ICTs) in their teaching change through the use of Lesson Study?***
RQ2	***What are teachers' experiences in using Lesson Study as a strategy to develop their competence in integrating information and communication technologies (ICTs) in their teaching?***
RQ3	***Why do teachers experience the use of Lesson Study to integrate information and communication technologies (ICTs) in teaching in the way they do?***

SEMI-STRUCTURED INTERVIEW SCHEDULE

Would you consider Lesson study process as an effective method to help teachers integrate ICTs into their teaching?
Please give reasons for your answer.

What were some of the advantages of using Lesson Study for integrating ICTs in teaching and learning?

What were some of the disadvantages?

Did you encounter any barriers that prevented you from being fully involved in the process?

In your opinion, what aspects of your teaching, if any, has improved as a result of your participation in the Lesson Study?

To what extent did collaboration with your Lesson Study team help to improve your instruction?

During the Lesson Study process, you were required to collaborate with your colleagues. Is the collaboration you experienced in the Lesson Study process any different from collaboration you have experienced in the past? Please describe.

Did you experience any obstacles while working together with your colleagues?

One of the goals of Lesson Study is to reduce teacher isolation. Would you say that this was true in your experience during the Lesson Study cycles? Please describe your experience working with your team.

Did you experience the process of Lesson Study as an effective form of professional development? If so, how and in what ways?

Is Lesson Study a process that you would like to continue using to help develop your skills in integrating ICTs in teaching?
If so, why?
If not, what are the obstacles that cannot be overcome?

Can you suggest ways in which the Lesson Study process can be more useful?

How do you think Lesson Study could be adapted to suit your particular needs/circumstances?

Do you think it will impact on your teaching or the teaching of others in future? Please explain.