THE USE OF MOBILE COMMUNICATION TECHNOLOGY IN PROFESSIONAL IDENTITY DEVELOPMENT: A CASE OF USING WHATSAPP MESSENGER TO TEACH INQUIRY-BASED PEDAGOGY TO UNIVERSITY CHEMISTRY TEACHERS

by

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DECLARATION

I, Patrick Mutanga, declare that:

THE USE OF MOBILE COMMUNICATION TECHNOLOGY IN PROFESSIONAL IDENTITY DEVELOPMENT: A CASE OF USING WHATSAPP MESSENGER TO TEACH INQUIRY-BASED PEDAGOGY TO UNIVERSITY CHEMISTRY TEACHERS is my own work and that all sources that I used or quoted have been indicated and acknowledged by means of complete references.

22 March 2021

…… ……

Signature Date

Student number: 55756999

DEDICATION

This thesis is dedicated to my late parents' memory. To my late father who always believed that this would be achieved, and to my late mother for her belief in hard work.

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SUMMARY

This study investigated the feasibility of using WhatsApp Messenger as a tool to enhance the professional identity and inquiry-based pedagogy through the professional development of university chemistry teachers. The epistemological interpretive paradigm was used to guide the study. The study assumed a naturalistic, exploratory investigation. The qualitative research methodology was used to conduct the study. Nine university teachers were purposively sampled from three universities (three teachers from each university) for the study. Data were collected through semi-structured interviews, participant observations, and focus group discussions. Data analysis was completed using the thematic networks analysis. Ethics considerations were observed by not disclosing personal information of the participants or information about the universities where they represented. This study was guided by four theoretical underpinnings: the connectivism theory, the transformative learning theory, the expectancy-value theory, and the dual systems theory. The primary research question guiding this study was: How does the professional identity of university chemistry teachers develop as they learn IBP through WhatsApp Messenger? A two-pronged approach was used in the research: (1) comparing the professional identity of the teachers before and after the course, and (2) observing and describing the professional identity process as the teachers undertook the course.

The results from the interviews conducted before the teachers undertook the WhatsApp Messenger-based IBP course showed that most teachers had a negative professional identity. They had become teachers for a variety of reasons, but they did not consider themselves teachers and believed they would leave university teaching if opportunities arose in the industry. They had no formal qualifications in pedagogy, and they did not believe that such knowledge was necessary. The majority of these teachers used teacher-centred approaches. Results from participant observations during the WhatsApp Messenger-based IBP course showed that the course slowly imparted to the teachers the norms associated with not only IBP, but other teaching approaches as well. WhatsApp Messenger provided a flexible online platform where the teachers interacted and exchanged ideas without the need to meet in a physical space. The results from the interviews conducted after the teachers participated in the WhatsApp Messenger-based IBP course showed that the participants' professional identity had changed positively. They now recognised the importance of pedagogy in teaching, they positively identified with the teaching profession, and some were considering acquiring formal qualifications in pedagogy.

Key words: Information and communication technology (ICT), mobile communication technology, WhatsApp Messenger, Community of Practice (CoP), professional identity, inquiry-based pedagogy (IBP), university chemistry teachers.

NGAMAFUPHI

Lolu cwaningo beluphenya ithuba lokusetshenziswa kwangempela kwe-*WhatsApp Messenger* njengethuluzi lokuqinisa isithombe sesisebenzi kanye nohlelo lokufundisa olwencike phezu kophenyo lothisha besifundo seKhemistri (chemistry) enyuvesi, ngohlelo lokuthuthukisa abasebenzi. Uhlelo lwepharadayimu echazayo ye-ephistemoloji lwasetshenziswa ukuhlahla indlela yesifundo, okuyindlela enqume ukulandela indlela yemvelo, ephenyayo. Umethodoloji wocwaningo olwencike kuKhwalithi (*Qualitative*) lusetshenzisiwe ukwenza ucwaningo, ndawonye nothisha basemanyuvesi ayisishiyagalolunye abakhethwe ngenhloso kumanyuvesi amathathu (abathathu kwinyuvesi eyodwa). Idatha yaqoqwa ngokusebenzisa izinhlolovo ezimbaxambili (*semi-structured interviews*), ngokubheka izenzo zomdlalindima (*participant observation*) kanye nezingxoxo zeqembu eliqondiwe (*focus group discussions*), kanti ukuhlaziywa kwedatha kwenziwa kwaqedwa ngokusebenzisa uhlelo lokuhlaziya oluwuthungelelwano lwendikimba (*thematic network analysis*). Kubonakele ukulandelwa komgomo wokuziphatha ngokungadaluli ulwazi lomuntu ongumdlalindima noma ulwazi olumayelana namanyuvesi ababewameleyo. Ucwaningo beluholwa yizinhlaka ezine zethiyori: i-*connectivism theory*, i-*transformative learning theory*, i-*expectancy-value theory* kanye nama-*dual systems theory*. Umbuzo wokuqala wezocwaningo ohola ucwaningo bewuthi: Ngabe isithombe sobizo lobuthishela wekhemistri enyuvesi sithuthukiswa kanjani ngesikhathi befunda uhlelo lwemfundo eyencike ekuphenyeni (*inquiry-based pedagogy (IBP*) ngokusebenzisa i-*WhatsApp Messenger*? Indlela embaxambili iye yasetshenziswa: 1) ukuqhathanisa isithombe sobizo lobuthishela ngaphambi nangemuva kwesifundo,, kanye no-2) baqhathanisa isithombe sobizo lobuthishela sothisha ngaphambi nangemuva kwesifundo, kanye no 2) babheke futhi bachaza uhlelo lwezimpawu zokwakha isithombe sobizo lobuthishela njengoba othisha baye badlala indima kulesi sifundo.

Imiphumela evela kwizinhlolovo ezenziwe ngaphambi kokuba othisha bahambele isifundo se-*WhatsApp Messenger-based IBP*, ikhombise ukuthi iningi lothisha libe nesithombe sobizo esibi. Baye bafundela ubuthishela ngezizathu ezahlukahlukile, kodwa abakaze bazibona bangothisha futhi baye bacabanga ukuyeka inyuvesi uma ngabe kuvela amathuba kwimboni. Abakaze babe neziqu zokufundisa, kanti abazange bakholwe ukuthi ulwazi olunjalo kwakunesidingo sokuba nalo, kanti iningi lothisha lwalandela indlela izindlela ezencike kuthisha. Imiphumela evela ekubukeni izenzo zothisha ngesikhathi sesifundo se-*IBP* ikhombise ukuthi isifundo kancane kancane sinikeze othisha izimfundiso ezithile, kanti futhi nezinye izindlela zokufundisa. Uhlelo lwe-*WhatsApp Messenger* lunikeze inkundla ye-

inthanethi engenamngcele lapho othisha bebahlangana futhi baphakelane ngemibono nhlangothi zombili ngaphandle kwesidingo sokuhlangana endaweni ephathekayo. Ngemuva kwesifundo se-*IBP* abadlalindima baye babika ukuthi babone izithombe zobizo lwabo zizinhle kakhulu. Manje sebeyakwazi ukubaluleka kwendlela yephedagogi ekufundiseni, bazibona behambisane kahle kakhulu nobizo lobuthishela. Kanti abanye baze bacabanga ukuthola ezinye iziqu ezisemthethweni zobizo lobuthisha.

Amagama asemqoka: Iqembu labantu abanempokophelo eyodwa (CoP), ubuchwepheshe bezolwazi kanye nezokuxhumana (ICT), Uhlelo lokufundisa olwencike ekuphenyeni (IBP), Ubuchwepheshe bezokuxhumana obuqhutshwa ngomakhalekhukhwini, isithombe sobizo lobuthishela, othisha basenyuvesi abafundisa beKhemistri, uhlelo lwe-*WhatsApp Messenger*.

TSHOSOBANYO

Thuto e, e dirile dipatlisiso tsa kgonagalo tsa go dirisa WhattsApp Messenger jaaka sediriso sa go tlotlomatsa tlhaolo ya borutegi le potsiso theo ya thuto ya sekolo ya barutabana ba Yunibesithi ba thuto ya khemise, ka tlhabololo ya borutegi. Go dirisitswe pharataeme ya phetolo ya episitemoloji go kaela thuto e e tsaletseng botlhagiso jwa tlhago le tlhotlhomiso. Thutatsela ya patlisiso e e boleng e ne ya dirisiwa go tsamaisa thuto, le barutabana ba ba robongwe ba diyunibesithi tse di neng di na le maikemisetso a bosupi go tswa mo diyunibesithi tse tharo (ba bararo go tswa mo go nngwe le nngwe ya tsona). Didatha di ne di kgobokantswe ka seka-popego sa dipuisano, kelotlhokomelo ya batsayakarolo le tsepamiso ya setlhopha sa dipuisano, fa tshekatsheko ya datha e feditswe ka go dirisa tshekatsheko ya kgokagano ya thitokgang. Kelotlhoko ya maitshwaro e ne e na le tlhokomelo ka go se senole tshedimosetso ya batsayakarolo kgotsa tshedimosetso ka diyunibesthi tse e leng baemedi ba tsona. Thuto e ne e kaelwa ke metheo e mene ya tiori: tiori ya kopano, tiori ya phetogo ya thuto, tiori ya boleng jo bo solofetsweng le tiori ya thulaganyo. Potso e kgolo ya patlisiso e e kaelang thuto e ne e le: tlhaolo ya borutegi e gola jaang mo barutabaneng ba yunibesithi ba thuto ya Khemise fa ba ithuta thuto ka theo-potsiso ya petakoji (IBP) ka WhatsApp Messenger? Go thapilwe tlhagiso e e tlhagelelang gabedi **1)** go farologanya tlhaolo ya barutabana pele le morago ga khoso le 2) go ela tlhoko le go tlhalosa tshedimosetso ya tlhaolo ya borutegi jaaka barutabana ba batsayakarolo mo khosong.

Dipholo tsa tsamaiso ya potsotherisano e e neng e le teng pele ga go tsena khoso ya WhatsApp Messenger-based IBP, di bontsha gore ba bantsi ba na le tlhaolo ya borutegi jo bo sa siamang. Ba ne ba nna barutabana ka mabaka a a rileng a a sa tshwaneng fela ba sa ipone sentle jaaka barutabana, ka megopolo ya go tlogela Yunibesithi fa ditšhono tsa intasetari di tlhagelela. Ba ne ba sena boatlhodi jwa semmuso ba petakoji, mme ba ne ba sa dumele gore kitso e jaana e a tlhokagala, ka bone bontsi bo ne bo tsaletswe ditlhagiso tsa go tsepama mo borutabaneng. Dipholo tsa kelotlhoko ya batsayakarolo mo nakong ya khoso ya IBP di bontsha gore khoso e e neetse barutabana ditlwaelo tse di rileng tse di sa tsamaisaneng fela le IBP gape le ditlhagiso tse dingwe tsa borutabana. WhatsApp Messenger e kgona go abelana mo polatefomong e e bonolo ya inthanete mo barutabaneng ba ba tlhaeletsanang le go abelana dikakanyo kwa ntle ga tlhokego ya go kopana mo lefelong ka sebele. Morago ga khoso ya IBP batsayakarolo ba begile gore ba leba ditlhaolo tsa bone tsa borutegi ka letshwao la koketso. Jaanong ba lemogile botlhokwa jwa petakoji mo go ruteng, se se tlhagisiwa ka letshwao la koketso mo boruteging jwa go ruta, ba bangwe ba ntse ba akanya go nna le boatlhodi jwa semmuso ka mo petakoji.

Mafoko a konokono: Katiso ya baagi (CoP), thekenoloji ya tshedimosetso le tlhaeletsano (ICT), petakoji ya theo-potsiso (IBP), thekenoliji ya tsamaiso ya tlhaeletsano, tlhaolo ya borutegi, barutabana ba yunibesithi ba thuto ya khemise, WhatsApp Messenger.

LIST OF ABBREVIATIONS AND ACRONYMS

CK	Content Knowledge
CoP:	Community of Practice
IBP:	Inquiry-based pedagogy
ICT:	Information Communication Technology
PK:	Pedagogical Knowledge
PLC:	Professional Learning Communities
STEM:	Science, Technology, Engineering, and Math
TK:	Technological Knowledge
TPCK:	Technological Pedagogical Content Knowledge
TSE:	Teacher Self-Efficacy
UNISA:	University of South Africa
VoIP:	Voice over Internet Protocol

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CHAPTER 1

INTRODUCTION AND BACKGROUND OF THE STUDY

1.1 INTRODUCTION

This Chapter examines the need for professional development for university teachers. It also discusses how issues of professional development are being tackled by universities. In addition, the chapter highlight the challenges that are encountered in the current professional development efforts. The importance of inquiry-based pedagogy (IBP) as a teaching approach and how university teachers need to be equipped with IBP skills are also discussed. Furthermore, the chapter examines the how the advent of information communication technologies can transform the delivery of educational content especially through the use of WhatsApp messenger. The problem statement and the rationale are discussed to enable the readers to understand why the researcher undertook the study. Main research questions, sub research questions, purpose, aims and objectives are outlined as a guide to show what the researcher intended to achieve. A brief literature review is also presented in order to assist readers to gain an understanding of the existing research and debates relevant to the study. Also discussed are the theoretical underpinnings of the study as well as the research methodology, data collection and analysis used. The ethical issues concerning the study and measures taken to ensure the credibility of the study are also outlined. Key terms used in the study as well as the general structure of the study are also defined. At the end, a summary of the chapter is provided.

1.2 BACKGROUND

In the primary and secondary education sectors, pedagogical skills and related practices are considered essential. It is therefore mandatory for teachers in these sectors to acquire formal qualifications in pedagogy, which imparts such skills. However, in the higher education sector, pedagogy skills have not received the same attention, especially at a university level. Most teachers at universities possess a master's or doctoral degree in their academic fields (Chabaya, 2015), but no formal pedagogy training. Effectively this implies that universities are currently manned by academics.

Prioritising professional development in teaching skills for new university teachers is a recent phenomenon (Donnelly, 2016; James-Jacob, Xiong, Wang & Ye, 2015; Jeannin, 2016;

Veniger, 2016). This focus is due to the fact that universities face new realities in the ever-changing world of higher education where institutions now have to compete for students and issues of quality have become indispensable. Recent years have shown an increased expectation to professionalise teaching at higher education institutions (Bakah, Voogt & Pieters, 2012). This expectation signals a departure from past practices where university teachers only needed high qualifications in their academic fields to be able to teach. Professional qualifications in pedagogy are gaining popularity within universities, and many university administrators now encourage their teachers to acquire these skills. The aim is to enhance the quality of teaching through the professional capacity development of university teachers (Clarke, Hyde & Drennan, 2013). By acquiring professional qualifications, university teachers are equipped with the necessary skills required to properly play their role in the generation and transfer of knowledge.

The need for professional development in higher education cannot be overemphasised. Universities now face the need to provide professional training to their teachers. Of particular importance is the professional development of university teachers to improve their capacity to enhance learning for diverse student populations (Chabaya, 2015; Leibowitz, Bozaleck & Sipuka, 2014). Universities no longer only recruit students from specific localities. Their recruitment thrusts now transcend race, tribe, geographic location, and national borders. The result is that the student populations are so diverse in their backgrounds that teachers need to be better geared to meet their diverse expectations. In the past, teachers could anticipate the academic needs of the students because of their similarities. Today, the diverse backgrounds and entry qualifications of students mean that they do not enter university on equal footing. This greater level of student differentiation calls for professionally trained teachers who can employ the requisite teaching approaches that cater for such diversity. According to Mgijima (2014), the objective of professional development of university teachers is to ensure that teachers acquire and use specialist skills and knowledge to meet the new expectations placed on their profession. This development is possible through on-going training and socialisation about attitudes and expectations of the teaching profession. Without such training, university teachers tend to identify more with their academic qualifications than with their teaching duties.

The teaching of science in general, and chemistry in particular, is a specialist endeavour. The design of such teaching is for students who could be useful in diverse societal challenges and who must be able to cope with the ever-changing circumstances in their lives. There are a plethora of teaching methods suitable for different situations and topics, for example,

traditional direct teaching of chemistry promotes mastery of content but does little to enhance the development of scientific skills and attitudes (Shamsudin, Abdullah & Yaamat, 2013; Archer-Kuhn, 2013; Nybo & May, 2015). Teachers should have the professional skills to diagnose which methods are suitable in different teaching and learning contexts or situations. Teaching and learning contexts and situations are comprised of a variety of components. Teachers play a pivotal role in reading and responding to the requirements of each situation and should have the professional preparation to do so. This skilled response to context is possible if teachers possess the appropriate pedagogical knowledge and skills and then subsequently demonstrate the appropriate competencies in practice.

Inquiry-based pedagogy (IBP) is an approach that places the students' quest for knowledge at the centre of the learning process (Lazonder & Harmsen, 2016; Lehtinen, 2017; Nedungadi, Malini & Raman, 2015). In this approach, the students' thought processes, opinions, and observation are of great importance in learning. They are not passive recipients of knowledge but are actively involved in the creation of knowledge. They use their prior knowledge as a basis for new knowledge. Both faculty and students actively participate in the teaching and learning process, with students being encouraged to express their own opinions and ideas (Abdi, 2014; Friesen & Scot, 2013; Sever & Guven, 2014. Teachers can then direct the students to use their ideas to solve problems. Students, therefore, take ownership of the learning process while the teacher focusses on knowledge acquisition.

Teachers challenge, question, test, refine, and improve students' ideas and enable them to develop a deeper understanding of concepts (Ernst, Hodge & Yoshinobu, 2017; Kogan & Laursen, 2014). In order for teachers to do so, they must possess the requisite knowledge of specific methods and processes. In the context of this study, they must know IBP. Teachers should know what role each participant (e.g. students) plays if IBP is to succeed in enhancing scientific understanding among students. An example is that the teacher must diagnose students' prior knowledge of specific concepts in order to prescribe investigations with a view to finding solutions. In other words, teachers must guide the students as they go through the process of finding logical solutions to the problems (Arsal, 2017; Dibiase & McDonald, 2015; Lehtinen, 2017). The students need this guidance so that they do not lose focus. The result is a co-authored knowledge creation venture where teachers guide students to produce meaningful learning (Abdi, 2014; Friesen & Scott, 2013; Sever & Guven 2014). Researchers and teachers consider IBP a very effective approach in the teaching of science, technology, engineering and

math (STEM) subjects (Nedungadi et al., 2015). There are, however, many ways to communicate information when teaching using a particular teaching approach.

Information and Communication Technology (ICT) has provided a new way for communication among university teachers. The Internet provides for extensive social interaction through various social media. Social network sites allow users to create, share, and edit information (Rajesh & Michael, 2015; Seaman & Tinti-Kane, 2013; Griesemer, 2014). The key attribute of social media is that it enables mass socialisation of people by harnessing the power of the activities of a community of users rather than that of individual users (van Doorn & Eklund, 2013). WhatsApp Messenger is one social media platform that is becoming increasingly popular in the education sector, where teachers use these media for personal and professional growth. In the higher education sector, some institutions the world over are redesigning their learning environments to accommodate new pedagogical practices that incorporate social networks, such as WhatsApp Messenger (Johnson et al 2016). Universities generally organise the networks according to specific subject areas. Once available, teachers can use them as opportunities to both teach and learn. The increasing popularity of the WhatsApp Messenger platform in education necessitates the need to establish its role and suitability as a tool for the professional development of IBP in university teachers.

1.3 STATEMENT OF THE PROBLEM

The teaching of science in general and chemistry in particular, has received a lot of attention in recent years as universities strive to improve their quality of education. One teaching approach that is proving to be popular for teaching chemistry in higher education is inquiry. Inquiry-based teaching (IBT) is popular because it places the student at the centre of the learning process (Fine & Desmond, 2015; Kazempour & Sadler, 2015; Lehtinen, 2017). IBT enhances problem-solving skills (Nedungadi, Raman & MeGregor, 2013), makes learning more meaningful, promotes higher-order thinking, and enhances active knowledge construction (Buchanan, Harlan, Bruce & Edwards, 2016; Suhaili & Hayhood, 2017; Simmons & Ackerman, 2016).

Despite the evidence of IBT success, many university teachers have not embraced this approach fully in their teaching, especially in science teaching (Chabaya, 2015; Shava, 2015, James-Jacob et al., 2015). The argument most universities make about the minimal use of IBT is that their teachers do not have the relevant qualifications or pedagogical competencies to apply the approach, even though they are experts in their respective academic fields (Komba et al., 2013;

Suwaed & Rahouma, 2015; Shava, 2015). This lack of relevant pedagogical knowledge, IBT skills, and related science teaching methods negatively affects meaningful science teaching, and results in students graduating without the necessary competencies required in the workplace.

Current efforts to improve the situation by teaching pedagogy to university teachers have not yielded satisfactory outcomes (Kennedy, 2016; Murphy, 2014; Suwaed & Rahouma, 2015). Attempts have failed because they rely on rigid, traditional classroom-based training, which requires the teacher to sit in the classroom and take formal lessons in pedagogy. Teachers resist such arrangements and, because of not acquiring the necessary skills, continue to produce ill-prepared graduates with limited problem-solving skills (Shava, 2015). Some universities use professional development workshops but these are also not effective as they lack cohesiveness and do not inspire lasting pedagogical changes among university teachers (Chabaya, 2015; Murphy 2014). In light of the challenges cited, it is necessary to seek new, innovative, and flexible ways to teach pedagogy to develop the pedagogic knowledge and skills of university teachers without compromising the quality of teaching.

Developments in ICT have brought many changes to the way institutions approach content delivery (Barhoumi, 2016; Barhoumi & Rossi, 2013; Lu & Churchill, 2014). Institutions of higher education have been redesigning their teaching and learning systems to accommodate new pedagogical practices by incorporating social networks (Altinay, 2017; Amory, 2014). These developments have given rise to an increase in the use of mobile technology in teaching and learning in higher education institutions (Anastopoulou et al., 2012; Rambe & Chipunza, 2013).

The WhatsApp Messenger application has become one of the most flexible and convenient social media tools for teaching and learning in recent years because it allows for easy information sharing and communication (Guler, 2017; Magogwe & Ntereke, 2014). It is a cross-platform and instant messaging voice over Internet protocol (VoIP) service (Metz, 2016) with special features that make it useful for education. These features include the capability to make video calls and send text, audio, voice messages, pictures, videos, and documents. It is common for students and teachers to belong to one or more WhatsApp Messenger groups, driven by their common interests. The major debate is how effective this application can be in teaching IBP to chemistry teachers. This study investigated the feasibility of using WhatsApp

Messenger as a tool to enhance the professional identity and inquiry-based pedagogy through the professional development of university chemistry teachers.

1.4 RATIONALE OF THE STUDY

Universities are important institutions of knowledge production in society in any country (Cunningham & Link, 2015; Tijssen, Yegros & Winnink, 2016). They serve as centres for knowledge creation and knowledge transfer. At the centre of knowledge creation processes are the university teachers as they provide guidance and control over the generation and transfer of knowledge (Mofreh, Ghafar & Omar, 2013; McCabe & O'Connor, 2014). The current setup of most universities is such that university teachers do not possess professional qualifications in university teaching (Komba, Anangsye & Katabaro, 2013). As such, there is no shared vision about what pedagogical skills a university teacher should possess or how they should acquire them. The ever-changing nature of the knowledge society requires that universities reinvent themselves to remain relevant. That is, university teachers need to adjust and further develop themselves to be able to meet the current demands of the teaching world. For any intervention to succeed in the professional development of higher education teachers, it must be well organised and considered an acceptable intervention programme or process (Komba et al., 2013).

In addition to professional development, there exists a need to change the stereotypes or perceptions that university teachers have about themselves and the attitudes that they exhibit in practice (Chabaya, 2015; James-Jacob et al., 2015; Murphy, 2014). University teachers view themselves as experts in their academic fields. They are engineers, pharmacists, biochemists, medical doctors, amongst others, who are doing the work of teachers. Some of them teach because they have not found a job within their academic field and they use teaching as a temporary measure while they wait for opportunities elsewhere.

The perceptions university teachers have about themselves have a bearing on the quality of the educational service they provide (Burton, Boschmans & Hoelson, 2013). When teachers perceive teaching as their calling, they will engage in activities that improve their pedagogical practices. However, if they do not believe that they are really teachers then their approach to teaching will be negative, and students will not benefit as much as they could from their teaching. The challenge facing universities in their quest to improve quality in the provision of education is that university teachers with a scientific qualification are reluctant to engage in continuing professional development in areas of specialisation such as in pedagogy (Shava,

2015). The reluctance stems from the fact that most university teachers are experts in their respective academic fields, and they look down upon pedagogical and professional skills (Chabaya, 2015). However, research shows that the professional identity of teachers is dependent on their professional teaching knowledge (Izadinia, 2014).

When teachers acquire the requisite identity in the teaching field they are more likely to employ the appropriate approaches that enhance students' conceptual understanding. For university chemistry teachers it is envisaged that the acquisition of professional identity will simultaneously lead to the acquisition of IBP skills which have been proved to be very effective in enhancing students' conceptual understanding (Chabaya, 2015). It also helps in sharpening students' problem solving skills (Shava, 2015). Professional development courses tailor-made to equip teachers with such skill are therefore a necessity.

The advent of ICT presents university teachers with an informal platform for interaction. WhatsApp Messenger is one possible way of facilitating this interaction. WhatsApp Messenger enables teachers to collaborate, interact, and share ideas about pedagogical practices. This study investigated how these types of social media-enhanced interactions may help teachers acquire IBP and how they could shape the professional identity of university teachers.

1.5 MAIN RESEARCH QUESTION AND SUB-QUESTIONS

1.5.1 Main research question

The main research question is:

How does the professional identity of university teachers develop as they learn inquiry-based pedagogy through WhatsApp Messenger?

1.5.2 Research sub-questions

The researcher used the following sub-questions to address specific aspects of the main research question on a more in-depth and efficient scale:

Sub-question 1: How do university chemistry teachers perceive their professional identities?

The purpose of the first sub-question is to establish the baseline of current university teachers' pedagogy knowledge. This baseline knowledge informs the research about the teacher self-efficacy (TSE) of the university teachers. TSE refers to the beliefs as well as referent judgement on capabilities of teachers (Zee & Koomen, 2017). Studies have shown that teachers with a

positive sense of self-efficacy create a conducive environment that facilitates students' learning (Thoonen, Sleegers, Peetsma & Oort, 2011; Zee & Koomen, 2017). They also have a higher level of satisfaction and commitment to their profession, and have lower stress levels (Aloe, Amo & Shanahan, 2013; Collie, Shapka & Perry, 2012). TSE has its roots in social cognitive theory and locus of control (Zee & Koomen, 2017). The two theories emphasise human agency that suggests that humans are able to control actions that have an effect on their lives. To address this sub-question, interviews were conducted with university teachers who had no formal qualifications in pedagogy to establish their self-assessment of their teaching strategies or approaches. Their first responses were compared to their responses after embarking on an IBP course offered through the WhatsApp Messenger platform.

Sub-question 2: What are the experiences of university chemistry teachers as they use WhatsApp Messenger to interact in the process of learning about inquiry-based pedagogy?

The aim of the second sub-question is to establish human agency. Humans tend to engage in those functional behaviours that they expect will lead to a particular valuable outcome (Neff & Nagy, 2016). This is the notion that people can exercise control over their environment (Zee & Koomen, 2017). People have different perceptions about whether outcomes of any actions within a learning environment occur because of their own actions, the actions of others, or the influence of the environment itself. The person-environment interaction either reinforces or inhibits the individual's actions and influences how that individual may participate in future situations (Neff & Nagy, 2016). Those who believe the environment enhances their actions, may derive internal satisfaction and may more likely participate in future tasks. The analysis of the interactions between and among the participants (mostly through WhatsApp Messenger) will answer this question. Thus, the focus of this sub-question is on how the environment (WhatsApp group activities) enhanced or inhibited the interactions; and their effect on the acquisition (or lack thereof) of IBP.

Sub-question 3: How does the professional identity of university chemistry teachers change as they interact using WhatsApp?

The aim of the fourth question was to determine if any changes could occur in pedagogical practices of university teachers because of learning IBP through WhatsApp. Generally, changes in professional identity translate into changes in teacher self-efficacy, which leads to changes in professional practice (Zee & Koomen, 2017). Positive self-efficacy enhances the quality of

classroom practice (Gou et al., 2012). For this study, the researcher used interviews to gain insight into changes in the self-efficacy and pedagogical practices of university teachers.

Sub-question 4: How do the pedagogical practices of university chemistry teachers, change after learning inquiry-based pedagogy through WhatsApp Messenger?

The aim of the third sub-question was to establish how learning IBL through WhatsApp could facilitate transformative learning in university teachers. Transformative learning refers to how meaning perspectives, mind habits, and reference frames change because of a learning process (Mezirow, 2006). Emphasis was placed on the strengths and weaknesses of WhatsApp in effecting the professional identity change of the participating university teachers. The expectation was that transformative learning will lead to identity change (Illeris, 2014). All concepts change as the context changes. Identity is a concept that changes according to the interactions between individuals and their social environments. By investigating transformative learning in relation to identity change, it becomes possible to establish the social conditions appropriate for the transformation process (Illeris, 2014). Thus, the changes in professional identity that occurred to university teachers in this research were as a result of interactions occurring between and among participants within the WhatsApp Messenger context.

1.6 PURPOSE, AIMS AND OBJECTIVES OF THE STUDY

The purpose of the study was to investigate the feasibility of using WhatsApp Messenger as a tool to enhance the professional identity and inquiry-based pedagogy through the professional development of university chemistry teachers, after which recommendations would be made regarding its use for professional development. The general aim was to explore and describe the development of the professional identity of university teachers as they undertook a professional course in IBP through the WhatsApp Messenger platform.

The objectives of the study were to:

1. Establish the initial professional identities of university chemistry teachers without formal training in pedagogy and before engaging in the study;
2. Establish the experiences of university chemistry teachers as they use WhatsApp Messenger to interact in learning IBP;
3. Identify changes in the professional identity indicators of university chemistry teachers after learning pedagogy through WhatsApp Messenger; and

4. Identify changes in pedagogical practices of university chemistry teachers after learning inquiry-based pedagogy through WhatsApp messenger.

1.7 SIGNIFICANCE OF THE STUDY

This study is significant in that it establishes the applicability of using social media in the professional development of university teachers. The results of the study have the potential to inform university policy makers on how they can ride on the popularity of social media to develop their professional identity and their pedagogical skills. WhatsApp Messenger is one of the most popular social media platforms due to its low cost and simple operational procedures (Barhoumi, 2016; Magogwe & Ntereke, 2014). In addition, WhatsApp enhances connectivity and interaction between people of various backgrounds by eliminating the need to be in the same physical place at the same time (Gon & Raweka, 2017). Professional development teachers have faced challenges bringing university teachers into formal classroom settings to take pedagogy lessons (Chabaya, 2015; Margalef & Roblin, 2016). WhatsApp Messenger can facilitate interaction between university teachers. The results of this study will, therefore, have an enormous impact on approaches to professional development.

The results of the study have the potential to inform the Ministry of Higher Education and Technology Development policy makers on the need for university teacher professional development. Universities need new innovative ways to enhance the professional identity of their teachers. The results of the study have the potential to help universities alleviate the shortage of professionally competent university teachers who can effectively discharge their duties. This professional competency will lead to improved self-images which will improve university teachers' pedagogical practices and lead to better performance by university students. Research shows that the performance of students depends on their teachers' professional competence (Chabaya, 2015).

1.8 PRELIMINARY LITERATURE REVIEW.

This section of the study briefly introduces the literature review, which will be covered in more detail in chapter 2. The literature focuses on the concept of professional identity, the use of social media in education, and inquiry-based pedagogy.

1.8.1 Professional identity

Professional identity is the self that has been developed so that one is able to function fully and with enough legitimacy in a profession, and this identity continuously develops during the person's career (Barbour & Lammers, 2015; Khalid, 2014; Tan, Molen & Schmidt, 2015).

Because of the continual development, contextual issues within the profession play a significant part in the development of professional identity. Individuals' perceptions about themselves within a profession will, therefore, change when circumstances change within the profession. Developing an individual's professional identity should typically lead to a change in the way that he or she presents himself or herself to other people. (Van der Want et al., 2017; Weld, 2015).

Once an individual has acquired the professional identity of their profession, they will act and make decisions in a manner that is consistent with the profession (Neary, 2014; Weld, 2015). An individual becomes more conscious of their actions and their consequences on the profession; the positive professional conduct is reinforced, while the negative aspects fade away. Professional identity is a socially and culturally constructed concept that manifests in a person's life based on personal experiences and those of others (Cruess, Cruess, Boudreaus, Snell & Steinert, 2015). The interactions that take place between individuals within the same profession, shape their professional identity. Such interactions enable individuals to share their experiences and ideas as they go about their professional practice. Professional identity, therefore, is a product of an individual's active participation in related activities. As individuals interact and share experiences, they begin to understand how others perform their tasks, and this can cause them to adopt the positive aspects of other people's experiences and abandon the negative aspects.

Identity development occurs in an inter-subjective field. It is a continuous process where an individual interprets himself/herself as a certain type of person, and gains recognition as such within a certain context (Hatmaker, 2013). The individuals become professionally visible within their professional community by expressing themselves. This professional visibility will lead the professional to be recognised and acknowledged as such by those within and outside the profession. It is these communities that impose the norms and values into the individual and, as the individual attempts to conform to these norms and values, their identity takes shape.

Interpretation of one's professional identity is, to some extent, an argument that tries to justify and explain why an individual represents their profession in a specific way, that is, to explain their activity and values for the profession (Eatough & Tomkins, 2014; Haamer, Lepp & Reva, 2012). As individuals perform their professional duties, they are not only doing the work but are also being professional. Professional identity is an aspect of a person's self-concept, which develops in a social context as a result of the dialogue between an individual and their

environment (Meyer, Zapatka & Brienza, 2015). Change in the social context will lead to a change in professional identity. A person's identity can be described as the way an individual views himself or herself with respect to others in that profession; where an individual gets to know who they are and whether they understand their relationship with others. Such social spaces (contexts) provide an individual with an insight as to what choices exist in their fields. As the individual chooses or rejects the available choices, they will be affirming their affiliations and, as such, develop a professional identity.

1.8.2 The use of social media in education: the WhatsApp Messenger phenomenon

Social media platforms, such as WhatsApp Messenger, have gained acceptance as communication tools in education, and are now widely used in universities for learning purposes (Magogwe & Ntereke, 2014). WhatsApp Messenger is an instant messaging, Internet-based, cross-platform application for smartphones, personal computers, and tablets (Priyono, 2016). WhatsApp Messenger can be used to post images, text, video messages, and audio messages to other users whose devices are equipped with that application. Launched in 2010, by March 2020 WhatsApp Messenger had over 2 billion subscribers (Singh, 2020). WhatsApp Messenger has the following general benefits according to (Barhoumi, 2016):

- the instant messaging facilitates online interaction and collaboration;
- it is a free application which is not difficult to use;
- it has group functions which allow easy sharing of information; and
- it has end-to-end encryption which allows only members of a particular group to view and share information.

WhatsApp Messenger has been gaining popularity as a communication tool in universities (Gasaymeh, 2017). Most adult students use the application to stay connected with their peers and their teachers. There has been growing use of WhatsApp Messenger in transmitting instant texts messages for both social and academic purposes (Yin, 2016). This has led to a rapid transformation in the way people communicate both socially and in academic settings (Susilo, 2014). It is now possible to conduct online discussions between students and teachers.

As a mobile application, WhatsApp Messenger can shape individualised learning (Yin, 2016). It enables students to learn at their own pace and does not impose strict timetables or schedules on them. If used correctly, it increases the students' sense of belonging to a community and encourages collaboration. It allows participants to express themselves freely without the pressure that comes with making presentations in the traditional classroom. When compared to

the traditional classroom, WhatsApp messenger gives students the opportunity to discuss a topic with participants in various geographical locations at the same time (Gasaymeh, 2017).

1.8.3 Inquiry-based pedagogy

IBP has its roots in the discovery teaching movement of the 1960s (Kuhn & O'Hara, 2014). The approach came about as a response to traditional pedagogical methods, which included direct instruction and rote learning (Shamsudin et. al, 2013). The antecedents of IBP are found in constructivist learning theories. IBP is student-centred and enables students to participate in knowledge generation (Kotsari & Smyrnaiou, 2017; Kuhn & O'Hara, 2014; Maab & Artigue, 2013). The approach allows teachers to build on what students already know. This learning approach provokes the student to take charge of the learning process (Fine & Desmond, 2015). Teachers provoke students to answer questions and direct them to answer them through experiments and give a thorough evaluation of any possible solutions. They guide the students to use the newly acquired knowledge to widen their knowledge, make an analysis and formulate new hypotheses for further study. In this way, teachers help students understand learning as a human endeavour (Shamsudin et. al., 2013).

1.9 THEORETICAL UNDERPINNINGS OF THE STUDY

Because of the diversity of issues undertaken in this research, it was not possible to use just one theory to elucidate the topics. As a result, at least four theories are used to provide lenses through which the researcher could analyse the variables. These theories are the *connectivism theory*, the *expectancy-value theory*, the *transformative learning theory* and the *dual system theory*. The connectivism theory describes how learning occurs in the digital age (AlDahdouh, Osorio & Caires, 2015). Because of advances in technology, learning is no longer an individual venture but has become a network concept. The socialising power of technology has enhanced the opportunity for movement of information between and among individuals. Learning occurs not only within an individual but across networks (Bockurt, Honey-Church, Cames, Koutropoulos & Cornier, 2016). As such, the more connected an individual is, the more information they can access. In other words, an individual's digital connections are more important than their current state of knowledge because it is from those connections that new knowledge is obtained. As such, the digital connections among the university chemistry teachers, afforded by WhatsApp Messenger gave them an opportunity to exchange ideas and learn from each other.

The expectancy-value theory by Eccles et al. (1983) postulates that a task has four main values – attainment value, intrinsic value, utility value, and cost (Ibrahim, Aulls & Shore, 2017).

Attainment value refers to the importance an individual gives to an activity if they consider the activity to be consistent with their own self-image. An individual considers tasks to be important if they relate to the individual's identity or if they enable the individual to express those aspects about their 'self' that they consider to be important (Ibrahim et al., 2017). Intrinsic value refers to the enjoyment that one derives from participating in a task; utility value refers to how useful an individual views the task to be for their future plans; and cost refers to what an individual has to give up in order to perform a task (Wigfield, Tonks & Klauda, 2009). The perception that the individual has about their ability influence their how they perform their professional tasks. In the context of this study the value that the teachers gave to the activities and exchanges they had in the WhatsApp Messenger group had an influence in the development of their professional identities.

Transformative learning refers to the changes that occur in human beings' meaning perspectives as a result of encountering new experiences (Mezirow, 2006). An individual's meaning perspective is usually acquired sub-consciously during childhood as a result of socialisation. As a result of constant interaction with peers, mentors, and the environment, these meaning perspectives become embedded in an individual's psyche and become more permanent over time (Khabanyane, Maimane & Ramabenyane, 2014; Sharpe, 2016). Transformative learning tries to explain how the meaning that we attach to our experiences can be explained in terms of our expectations as determined by cultural assumptions. In this research, transformative learning is explained in terms of changes in professional identity that occurs in the teachers as they learn about IBP through WhatsApp Messenger. The researcher tried to understand the changes in meaning structures of the teachers as they undertook the course by observing the participation behaviours in the learning processes and by interviewing the participants.

While the transformative learning theory tries to explain changes in frames of references, these frames of reference are problematic to analyse as they assimilate uncritically and their corresponding meaning schema may develop outside conscious awareness (Dirkx, 2012) and may, therefore, be not rational all the time (Mezirow, 2006). As such, an additional theoretical lens – the dual systems theory – was used to conceptualise the interactions between the conscious and unconscious reasoning of teachers during transformation.

The dual systems theory posits that cognition is an interaction between unconscious (implicit and automatic) and conscious (explicit and controlled) processes (Kahneman, 2011). The

conscious processes, attitudes, and actions may be easily transformed by education and persuasion, whereas the unconscious processes and attitudes usually take longer to transform. In this case, it is presented as a cognitive psychology framework for the unconscious and conscious aspects of teaching practice (Hattie & Yates, 2014) and the effect of integrating digital technology on teacher practice (Blundell, 2017), especially on participants' beliefs, attitudes, and routines. In the context of this study the researcher used the dual systems theory to track the transformation of the processes, attitudes and actions of the teachers as they engaged in the WhatsApp Messenger-based IBP course.

1.10 RESEARCH PARADIGM

The researcher used the epistemological interpretive paradigm to guide this study. The epistemological interpretive paradigm is concerned with understanding the world through individuals' subjective experiences (Thahn & Thahn, 2015).

1.11 RESEARCH DESIGN

This study assumed a naturalistic, exploratory investigation. A naturalistic exploration is an approach to research that assumes that there are multiple realities (Creswell, 2014). It is an approach to understanding the social world in which the researcher observes, describes, and interprets the experiences and actions of specific people and groups in societal and cultural contexts (Salkind, 2015).

1.11.1 Qualitative research method

The qualitative research method was used for this study because the researcher was exploring abstract concepts and the meaning of social phenomena constructed by actors in their real-life contexts (Creswell, 2014). As the participants interacted through the WhatsApp Messenger platform, they explored new relationships (Taquette & Minayo, 2015). For this research, the researcher was studying a social phenomenon, which was embedded in an organisation. The qualitative research method is suitable when the researcher intends to construct knowledge through interpretive, naturalistic approaches (Dooly & Moore, 2017). This means that the researcher attempted to understand a social phenomenon by observing humans participating in a real-life setting. By observing university teachers interacting through WhatsApp messenger, the researcher was able to interpret and make sense of how they learnt IBP and how their professional identities were transformed during that same time. By using qualitative research, the researcher was able to place the research within the existing body of literature about the development of professional identity, which had mostly used qualitative research as a result of

the complexity of the topic (McElhinney, 2008). Qualitative research enabled the researcher to understand the complexity of individual experiences.

1.11.2 Case study

.A case study is used in qualitative research when a researcher intends to examine, in-depth, a particular subject and its related context (Creswell, 2014). This enables the researcher to follow a particular phenomenon from all possible angles and have an opportunity to listen to various explanations from participants. In this study, the case study was used to gain a full understanding of individuals' meanings and experiences before, during, and after they discussed IBP on the WhatsApp Messenger platform. Nine teachers from three different universities were defined as a single case, as they participated in the same discussion.

1.11.3 Population and sampling

The target population for this study was all university chemistry teachers without training in pedagogy. The accessible population for this study was 194 university teachers who taught chemistry at the three universities that were studied. Purposive sampling was used to select participants for this study. The researcher approached departmental heads of the participants who helped him to identify participants. Purposive sampling allowed the researcher to get information-rich participants, which, in turn, enabled the researcher to gain a deep understanding of the issues being investigated (Patton, 2002). Purposive sampling enriches the data collected and enables the researcher to uncover multiple realities (Guba & Lincoln, 1994) because the researcher targets those participants who are already assumed to have the required data. It is with this in mind that participants were purposefully sampled. Nine teachers from three universities in Zimbabwe took part in the study. These were university teachers without any prior training in pedagogy but were knowledgeable about using the WhatsApp Messenger platform. It was important to the study that the participants had no pedagogy training because prior training has an influence on the professional identity of a teacher (Komba et al., 2013). After purposive sampling of the first participant, the researcher used snowballing to identify the next participant. The first participant was requested to recruit another participant without prior training in pedagogy. To minimise the effects of bias associated with snowballing the researcher used participants from three different universities. The universities were also purposefully sampled – only those with departments offering chemistry courses were selected.

1.11.4 Data collection techniques

Data were collected mainly through semi-structured interviews, participant observations, and focus group discussions.

1.11.4.1 Semi-structured interviews

Semi-structured interviews were used in this research to understand the existing professional identities of the participants before they undertook a course in IBL through WhatsApp Messenger. The interviews were also used to establish participants' baseline knowledge in pedagogy as well as their views, attitudes, and beliefs about IBL before, during, and after they participated in the course. Semi-structured interviews allowed for in-depth probing by the researcher, while, at the same time, allowing the researcher to maintain the interview within the parameters set out by the study aims (Alshenqeeti, 2014). Three interviews were done with each of the participants. The course was conducted over a two-month period. As the interviews were being conducted, the researcher recorded the responses (with permission from participants) for the purpose of identifying common themes that would emerge from the data**.**

1.11.4.2 Participant observations

Participant observation was also used to collect data in this study. The researcher was able to observe participants by following the discussions and interactions that took place on the WhatsApp Messenger platform. Observations were conducted to help uncover any themes that may emerge during the process. Observation is the most appropriate method of collecting data when the researcher is more interested in the behaviour of the participants than their opinions (Silverman, 2013). By participating in the group, the researcher was able to gather information on those aspects of WhatsApp Messenger that either facilitated or hindered the development of professional identity. These observations were conducted over two months.

1.11.4.3 Focus group discussions

One focus group discussion was conducted to learn about the experiences of the university teachers after participating in the course. The advantage of focus group discussions is that the researcher can facilitate a high level of interactions between the participants in a short period of time (Kumar, 2012). The focus group discussion was used by the researcher to study attitude, opinions, and perceptions about the effectiveness of WhatsApp Messenger in professional identity development. The researcher used open discussions between himself and the group of participants. Through focus group discussions, the researcher asked questions that stimulated debate among the participants. Group discussions also give members the opportunity to correct and complement each other. Compared with other data collection techniques, focus group discussions are the least expensive (Creswell, 2014). The researcher recorded the focus group discussion. The data was transcribed, coded and analysed using the thematic networks approach.

1.11.5 Data analysis and interpretation

Data were collected and analysed simultaneously throughout the whole study. This means that the researcher attempted to attach meaning to data and interpret any events as they occurred during the study. Data were collected and continuously re-examined so as to deal with new issues that needed further collection and analysis (Creswell, 2014). Data analysis was based on the categorisation and coding approach. As the interviews and observations took place, recurring themes emerged and data were coded to enable the identification of salient theme and patterns.

The thematic networks analysis process (Attride-Stirling, 2001) was used to analyse data. Thematic networks analysis endeavours to expose themes emerging from text data. It clarifies procedures that can be employed as a researcher moves from text to interpretation. Thematic networks analysis presents data as a web-like network (Pokorny et al., 2018). It systemises extraction of data at three different levels: basic themes; organising themes and global themes (discussed in more detail in chapter 4).

Data analysis was done using records from WhatsApp Messenger conversations and interviews based on the tenets of the connectivism; transformative learning; dual systems; and expectancy-value theories. Data analysis was conducted simultaneously with data collection. Deductive thematic analysis was adopted in analysing data. This is because the research used a pre-determined context, being the WhatsApp Messenger context. The deductive approach is theory-driven, and analysis was limited to the pre-determined framework of the connectivism and expectancy-value theories, Transformative learning and dual systems theory. Emphasis was placed on pinpointing and recording patterns or themes that emerged from the data. These themes came from data that was closely linked to the relevant research questions and became categories of analysis.

1.11.6 Measures to ensure trustworthiness

Trustworthiness in research is a concept that speaks to whether a research and its findings can be trusted (Creswell, 2014). There several criteria that are used to ensure trustworthiness but the best known are the ones proposed Lincoln and Guba (1985). These are credibility, transferability, dependability, and confirmability. The trustworthiness of the study was ensured by following the measures of self-description, prolonged engagement, triangulation, member checking, and peer debriefing.

1.11.6.1 Self-description/reflexivity

Self-description is a process where the researcher tries to minimise the effects of their biases on the findings of the study by acknowledging these biases (Hadi & Closs, 2016). Self-reflection allows the researcher to discuss their own position in a study and how it influences their own interpretation of phenomena (O'Brien, Harris, Beckman, Reed & Cook, 2014). In this study, the researcher made notes and kept a reflective journal that clarified existing personal biases.

1.11.6.2 Prolonged engagement

Prolonged engagement involves spending sufficient time with participants to get full understanding about participants and their interactions (Noble & Smith, 2015). By spending enough time with the participants the researcher is able get a fuller understanding of the factors that influence the phenomena under study. In this study, the researcher interacted with the participants daily on the WhatsApp Messenger platform for the duration of the study.

1.11.6.3 Persistent observation

Persistent observation involves identifying and focusing on the most relevant elements of the study so as to gain a full understanding of the situation (Hadi & Closs, 2016). By focusing on the discussions about IBP that took place on the WhatsApp Messenger platform the researcher managed to observe the professional identity development of the university teachers.

1.11.6.4 Peer debriefing

Peer debriefing entails the researcher discussing their methodology, data analysis and interpretations with peers as the study is going on (Silverman, 2013). In this study, the peers were experienced qualitative researchers in the Technology Education Centre at the Harare Institute of Technology. Though they did not participate in the research, they assisted in providing additional perspectives and interpretations.

1.11.6.5 Member checking

Member checking is a process whereby the researcher returns to the participants after the study to discuss the interpretation of the data collected (Noble & Smith, 2015). This allows the researcher and participants to reach a common understanding of the interpretations of the data. In this study, the researcher revisited the participants after the study to allow them to verify the researcher's interpretations that were attached to their data.

1.11.7 Ethical considerations

Qualitative research involves contact with people and it is important to consider ethical issues in the conduct of the research (Silverman, 2013). In this study, the researcher observed the following ethical issues:

Ethical clearance – the researcher applied for ethical clearance from the Ethical Clearance Committee of the College of Education at the University of South Africa. The researcher also sought permission from the authorities of the universities where the participating taught. Permission was granted on condition that the names of the universities and the teachers remained anonymous.

Informed consent – all research participants and universities were informed about the purpose, method, and intended possible uses of the research. They were also informed about what their participation in the research entailed and any risk involved. This information was provided in a written format and signed for by the research participants.

Confidentiality – confidentiality was maintained by non-disclosure of the sources of data.

Voluntary participation – the participants were informed of their right to refuse to participate, as well as their right to withdraw from participation at any stage in the process. There was no coercion for participants to take part in the research.

Protection from harm – research participants were protected from any harm, and their interest and well-being were guaranteed.

Impartiality – the research was conducted in such a way that it ensured the professional integrity of its design, the generation and analysis of data, and the publication of results. Direct and indirect contributions of colleagues and collaborators were acknowledged.

Plagiarism – all ideas, works, writings, drawings, and images that were originated by sources other than the researcher, was referenced.

1.12 STRUCTURE OF THE STUDY

The study is presented in six chapters as shown in Table 1.

Table 1. The structure of the study

Chapter	Content	Brief description
1	Introduction and background	Chapter 1 includes the introduction; rationale of the study; statement of the problem; main and sub research questions; significance of the study; purpose and objectives of the study; preliminary literature review; theoretical underpinnings of the study; research methods and design; data analysis procedures; measures taken to ensure trustworthiness; ethical considerations; plan of study; and definition of terms.
2	ICT, pedagogy and professional development	Chapter 2 consists of a detailed literature review. It covers existing literature on the use of ICT in pedagogy; and ICT as facilitator and as a barrier of knowledge creation and dissemination. It looks at the use of social media in higher education with particular emphasis to the WhatsApp Messenger platform. The researcher further looks at the strategies, methods and tools used for the professional development of university teachers before exploring online professional learning communities. He then discusses some of the pedagogical tools and methods used in education, with particular emphasis on IBP in chemistry education. The chapter covers the concept of professional identity with particular emphasis on university teachers. Discussion then turns to the importance of professional identity; factors affecting

		professional identity development; and roles played by individuals in professional development. The chapter further covers the professional identity development process. Finally, the determination of professional identity development through the process of professional identification and professional identity construction is discussed.
3	Theoretical underpinnings of the study and research framework	Chapter 3 presents the theoretical underpinnings that guided the study, as well as the overall framework of the research. Several theories were used to guide the research process, namely: The connectivism theory, which illuminates how knowledge is created and transmitted in an online network of individuals. The transformative learning theory, which explained the changes that occur in an individual's meaning structures as a result of encountering life-changing experiences. The dual systems theory, which complimented the transformative learning theory in explaining the conscious and unconscious processes that lead to transformation. The expectancy-value theory which explains the role of motivation in influencing humans to meaningfully participate in certain activities.
4	Research methodology	Chapter 4 presents a detailed research methodology. This includes detailed descriptions of the qualitative research methodology; the case study design; population and sampling strategies

		used; instrumentation and data collection techniques; the data analysis process; measures to ensure trustworthiness; and ethical considerations taken in the conduct of the study.
5	Data management and research findings	Chapter 5 is a detailed presentation and analysis of the research findings. The universities at which the researchers teach are described in terms of their ICT infrastructure and teacher professional development policies. The biographical information of the teachers is also presented. The researcher gives a description of the thematic networks analysis process used in data analysis, and then presents a detailed description of themes that emerged from data supported by the relevant theories and views from authors.
6	Summary of findings, recommendations and conclusions	In chapter 6, a summary of each chapter is presented. This is followed by a summary of the research findings. Recommendations were also made based on the finding. The limitations of the study of the study were discussed. suggestions were made for further study and reflections based on the journey taken in this study

1.13 DEFINITION OF TERMS

Inquiry-based pedagogy – a teaching approach that puts the learner at the centre of the learning process by engaging them in hands-on activities that provide solutions to given problems (Arsal, 2017; El-Shaer & Gaber, 2014; Thaiposri & Wannapiroon, 2015). In this study, inquiry-based pedagogy is used to describe the teaching approaches that are used by

university teachers to enhance students' conceptual understanding of chemistry concepts by making them discover new knowledge through experimental work

Social media - modern networking platforms that allow for the interpenetration of people's private and public spheres (Barhoumi, 2016; Magogwe & Ntereke, 2014). Social media is used in this study to refer to internet-based communication applications that enable students and teachers to engage in group communication.

WhatsApp Messenger - an instant messaging, Internet-based, cross-platform application for smartphones, personal computers, and tablets (Barhoumi, 2016; Guler, 2017; Yin, 2016). In this study, WhatsApp Messenger is used to an online social media platform that is installed on mobile phones which enhances networking among groups of teachers and students

Professional identity - Professional identity is an aspect of a person's self-concept, which develops in a social context as a result of dialogue between an individual and their environment (Burton et al., 2013; Clarke et al., 2013; Green, 2015). In this study, professional identity refers to the views that university chemistry teachers have about themselves within the teaching profession.

Professional identity construction – this refers to the process by which an individual constructs a subjective perception of themself in their professional role (Caza & Creary, 2016). Professional identity construction is used in this study to describe the changes that occurred to teachers' views about themselves as they engaged in the WhatsApp-Messenger-based IBP course.

Online professional communities – These are Internet-based learning communities that are built around specific subject areas (Reeves, Karp, Mendez, Alemany & McDermott, 2015). In this study, online professional community used to describe the group of chemistry teachers who were discussing about IBP on the WhatsApp Messenger platform

ICT (Information communication technology) - refers to technologies that enable people to access information through telecommunications. These include the Internet, cellphones, telephones, and wireless networks (Duke, Harper & Johnson, 2013; Guler, 2017; Vanderhoven, Raes, Montrieux, Rotsaert & Schellens, 2015). In this study, the ICT describes the smartphones and software (WhatsApp Messenger) that were used by the teachers to share ideas as they discussed about IBP.

1.14 SUMMARY

This chapter introduces the study. It provides the rationale of carrying out the study. The research problem was presented and discussed. This was followed by stating the main research question which was intended to be answered by the research. For easier understanding of the main research question it was further divided into four sub-questions. The significance of the study was discussed followed by the purpose and objectives of the study. A preliminary review of literature relevant to the study was presented. The literature focused on the concept of professional identity, the use of social media in education IBP. This was followed by a discussion on the research method and design used in the study. The discussion focused on the case study design, population and sampling strategies used in the study and the instrumentation and data collection strategies. The data analysis procedure was discussed followed by the measures taken to ensure the credibility of the study and the ethical considerations taken in carrying out the study. An outline of how the study was structured was also given. The chapter ends with definition of key term used in the study. The next chapter focuses on the review of literature about ICT, pedagogy and professional development.

CHAPTER 2

ICT, PEDAGOGY AND PROFESSIONAL DEVELOPMENT

2.1 INTRODUCTION

In this chapter, a comprehensive literature review is presented. This was done to give the reader more insight in to the debates around the topic. In this chapter, the researcher identifies and explains the various roles that ICT plays, and the potential uses it may have in pedagogy. Discussions on the use of information communication technology in education with particular reference to social media, especially the WhatsApp Messenger phenomenon was discussed. The chapter also discusses the strategies, methods and tool used for professional development of university lecturers in order to transform their professional identities and to equip them with inquiry-based pedagogy skills. The concepts of professional identity development and inquiry-based pedagogy were also examined. A summary was given as a conclusion to the chapter.

2.2 INFORMATION AND COMMUNICATION TECHNOLOGY IN PEDAGOGY.

The advent of information and communication technology (ICT) has brought new ways of interaction to the education sector in general and into higher education in particular. Various social media platforms allow, in many different ways, for the creation, storage, dissemination, and management of information among university teachers, their students, and across universities and other institutions for knowledge creation activities. The Internet, as an essential part of ICT, has provided flexible ways for university teachers to disseminate and receive information. For example, WhatsApp Messenger, an ICT tool, has played a pivotal and convenient role of communicating ideas for knowledge creation, learning, and social interaction between students, teachers, and authorities across the higher education system.

At the heart of any successful exchange of information or communication are the tools and languages used. This researcher's view is that WhatsApp Messenger, an ICT tool, has many of the characteristics needed in a communication tool that can convey a teaching message in a way that most students would understand better. That is, WhatsApp Messenger would, in the context of this study, serve the role of communicating teachers' learning and professional development messages successfully and timeously. ICT, including WhatsApp Messenger, is adaptable to various strategies and methods of pedagogy. The current study explored the use

of WhatsApp Messenger in the development of university chemistry teachers' professional development. The exploration was conducted specifically on how teaching inquiry-based pedagogy (IBP) on the WhatsApp Messenger platform would impact university chemistry teachers' professional identity. Therefore, this literature review's foci is on the use of WhatsApp Messenger (ICT) as a communication tool, and inquiry- based pedagogy (IBP) as a strategy to enhance the development of professional identity among university chemistry teachers. Furthermore, the review locates and frames teachers' professional identity within three theories, namely connectivism, transformative learning, and expectancy-value.

Information and communication technologies emerged in the education system in the early 20th century (Rodriguez, Nussbaum & Dombrovskaia, 2013). Currently, ICT is an integral part of education because of its diverse usage in teaching and learning at various levels of education, especially at the university level. Universities worldwide use ICT to create, store, communicate, and manage information. In some instances, ICT has replaced the traditional 'chalk and talk' teaching methods. Traditional teaching tools such as the chalkboard have, in some instances, been replaced by modern gadgets such as digital interactive boards and students' smartphones. Computer devices have also gained popularity for their capacity to share information. Students can now watch lectures at home without having to be in the classroom physically.

For university teachers, the use of ICT has brought many opportunities as well as challenges. Teachers can now reach a diversity of students without the need to congregate them in a central location. A large quantity of information can be disseminated with minimum effort and at a low cost. The advent of the computer and Internet means teachers can now send and receive information from the students in real-time. The Internet also avails a large number of databases that teachers can refer students to for use in their studies. Furthermore, where teachers are adequately prepared to use ICT in their teaching, students can engage in higher-order thinking (Johnson et al, 2016). However, in most institutions teachers are reluctant and unable to use ICT in their teaching due to a lack of requisite skills, inadequate ICT infrastructure, and lack of proper planning by institutions (Molotsi, 2014). This teacher-reluctance shows that even though ICT offers many opportunities for teaching and learning, more still needs to be done to leverage the benefits of ICT in education. The somewhat haphazard way in which teachers apply ICT in teaching and learning calls for more concerted research into ICT integration in the education system. This research explores the social media aspect of ICT to determine its potential applicability in the professional development of university teachers.

2.2.1 Information and communication technology as facilitator and/or barrier of knowledge creation and dissemination

The use of ICT in education has brought many benefits to both teachers and their students. Researchers have shown that teaching using ICT improves engagement – when students learn using ICT, they develop an interest in learning (Lidström & Hemmingsson, 2014). Technology makes learning more fun and enjoyable as they learn age-old topics using new, innovative learning methods (Johnson et al, 2016). One example is that ICT provides for gamification functionality and allows students to engage in virtual field trips. ICT enhances active participation because it eliminates inhibitions associated with traditional classrooms (Rodriguez et al., 2013). The use of ICT in education improves knowledge retention (Hussain, Suleman, Din & Shafique, 2017). Students who engage in stimulating activities tend to have better knowledge retention than those who engage in less interesting activities (Ghavifekr et al., 2016). As such, the heightened interest associated with learning through ICT enables students to remember more of what they learn (Hussain et al., 2017).

Using ICT in education has been proven to facilitate collaboration among students (Ezekoka, 2014). ICT enables students to share knowledge with their peers through online collaborations. Various online forums can connect students from different institutions and enable them to share experiences. Learning in the modern world not only involves collaborating with others, but also problem solving, critical thinking, and learning modern ways of communicating (Johnson et al 2016). Both students and teachers learn lifelong skills when they use ICT in education (Johnson et al, 2016). Presentation skills and the ability to choose reliable Internet sources are just two of the skills sharpened through the use of ICT in learning. Apart from encouraging collaborative learning, ICT also improves individual learning skills (Hussain et al., 2017). ICT helps students determine their personal learning speeds, revisit difficult content, or skip particular concepts if need be (Ghavifekr et al., 2016). Students also have access to a wide range of information sources for their research.

ICT offers teachers extensive online teaching resources which they can use to enhance their teaching (Johnson et al, 2016). Teachers can use various computer applications to disseminate information. Virtual lesson plans, assessment and grading software, and online feedback save administrative time, which teachers can use to focus more attention on academically struggling students.

The discussion shows that ICT has impacted heavily on teaching and learning. The opportunities for ICT innovation to improve teaching and learning are unlimited. The variety

of modern software and applications available to the education sector can be adjusted or modified to suit particular educational situations. In the context of this study, social media (WhatsApp Messenger in particular) is being adapted from its traditional role as a social networking platform to an educational tool. The assumption is that teachers who engage in professional development using ICT will, over and above developing their professional identity, also use ICT in their teaching.

The major challenge in the integration of ICT in education is the limited technical support for schools, which results in limited use of ICT in teaching and learning (Molotsi, 2014). Some of the technical challenges include slow connectivity, network failure, incompatible software, and malfunctioning computers and accessories. Lack of ICT training for teachers is a significant challenge in most institutions (Alkahtani, 2017). The issue of training is complicated in that it must include training in the subject area, training in the use of computers, and training in pedagogy. This lack of a holistic training approach results in teachers not being confident enough to integrate ICT in their teaching practice.

Where teachers do have the confidence and competence to use ICT in teaching, it is sometimes a lack of time that prevents implementation (Ekberg & Gao, 2018; Mutanga, Nezandonyi & Bhukuvhani, 2018). Using ICT in teaching requires sufficient time for teachers to plan accordingly, visit various websites, and learn how to apply a variety of software. As such, teachers find it more convenient to revert to traditional teaching methods that do not exert extra work on them.

The integration of ICT in teaching and learning requires competences that most university teachers do not possess. The teachers are not very enthusiastic to learn about modern technologies that they can use for teaching and learning (Nicolopoulou & Gialamas, 2016). This is particularly a significant problem in developing countries where teachers simply lack the enthusiasm to learn how to integrate ICT in teaching. The situation is exacerbated by the lack of pedagogical skills on the part of university teachers of whom most do not believe that they are teachers and, as such, do not seek to acquire skills that enhance their instructional capabilities.

2.3 SOCIAL MEDIA IN HIGHER EDUCATION

Social media platforms have greatly transformed Internet use from being a one-way communicating tool to an interactive communication system (Altinay, 2017; Selwyn, 2012). Internet use is now a participatory and collective endeavour. Many higher education institutions

are finding it increasingly necessary to embed mobile educational technology in their pedagogical activities to maximise the benefits of social media (Altinay, 2017; Amory, 2014; Barhoumi 2016). Most of the characteristics of social media existed many years ago but the integration of the media in educational practices has only gained traction recently (Magogwe & Ntereke, 2014; Van Dijck, 2013). The only difference is that recently; social media has gained more widespread use. The changing nature of new university students has led to an increase in the use of social media in education.

Barhoumi (2016) argued that current university entrants are not only technologically savvy, but they tend to juggle their tasks digitally. Technologies associated with social media afford students with social autonomy, where they can choose to do what they want to do, when, as well as how to do it. Students are no longer passive consumers of teaching but participate in the design, development, and distribution of knowledge and products. This cohort of students was born into a world of connectivity (AlDahdouh et al., 2015) and hence teachers must resort to social media to connect with them.

Social media support knowledge construction that differs from the epistemological principles of formal education. The new culture of learning is based on collective exploration, interaction, innovation, and playful learning (Duta & Martinez-Rivera, 2015; Egizii, 2015). Social media support constructivist as well as social learning theories that are currently popular among educators (Egizii, 2015). Learning in the age of social media is linked to the idea of connectivism – the notion that learning depends on an individual's ability to link with information nodes and connect with information sources (Bockurt et al., 2016). Thus, for an individual to be knowledgeable, they ought to develop and maintain these connections.

The use of social media is not without its weaknesses. Using social media platforms presents a huge challenge in formal education systems. The fact that social media allow students to take part in knowledge generation puts proponents of social media at odds with those who believe that technology should only support education in its current form (Bockurt et al., 2016). Some educators believe that social media can disrupt the university completely while others believe that social media can strengthen higher education institutions. The current research, therefore, explores the affordances as well as the challenges posed by social media when used as a tool for the professional development of university teachers.

2.3.1 The WhatsApp Messenger phenomenon

WhatsApp Messenger is a communication application that users can download onto desktops, laptops, smartphones and tablets free of charge (Barhoumi, 2016; Anglano, 2014). It uses the Internet to transmit text messages, images, audios, and videos (Johnston et al., 2015). It can be used to communicate with other users who equip their devices with the application. Once installed users can create user profiles, which other WhatsApp users can see and access. The application has an invitation function that allows a user to invite other users for one-on-one or group interactions.

Launched in 2010, WhatsApp had over 1.6 billion subscribers by May 2016 (Barhoumi, 2016; Statista, 2016). Though its functions are similar to those of the traditional short message service (SMS), WhatsApp Messenger is Internet-based. As a result, the costs of using WhatsApp Messenger are much lower than those of SMS. It has replaced SMS as the communication tool of choice because of its capability to send large data files inexpensively and instantly (Eberechukwu & Queendarline, 2018). WhatsApp has the following general benefits according to Barhoumi (2016):

- Instant messaging facilitates online interaction and collaboration;
- It is a free application that is not difficult to use;
- It has group functions that allow easy sharing of information; and
- It has end-to-end encryption that allows only users who are approved members of a particular group to view and share group information.

WhatsApp also has enhanced features, such group chats and locations (Figure 1) that make it popular with users.

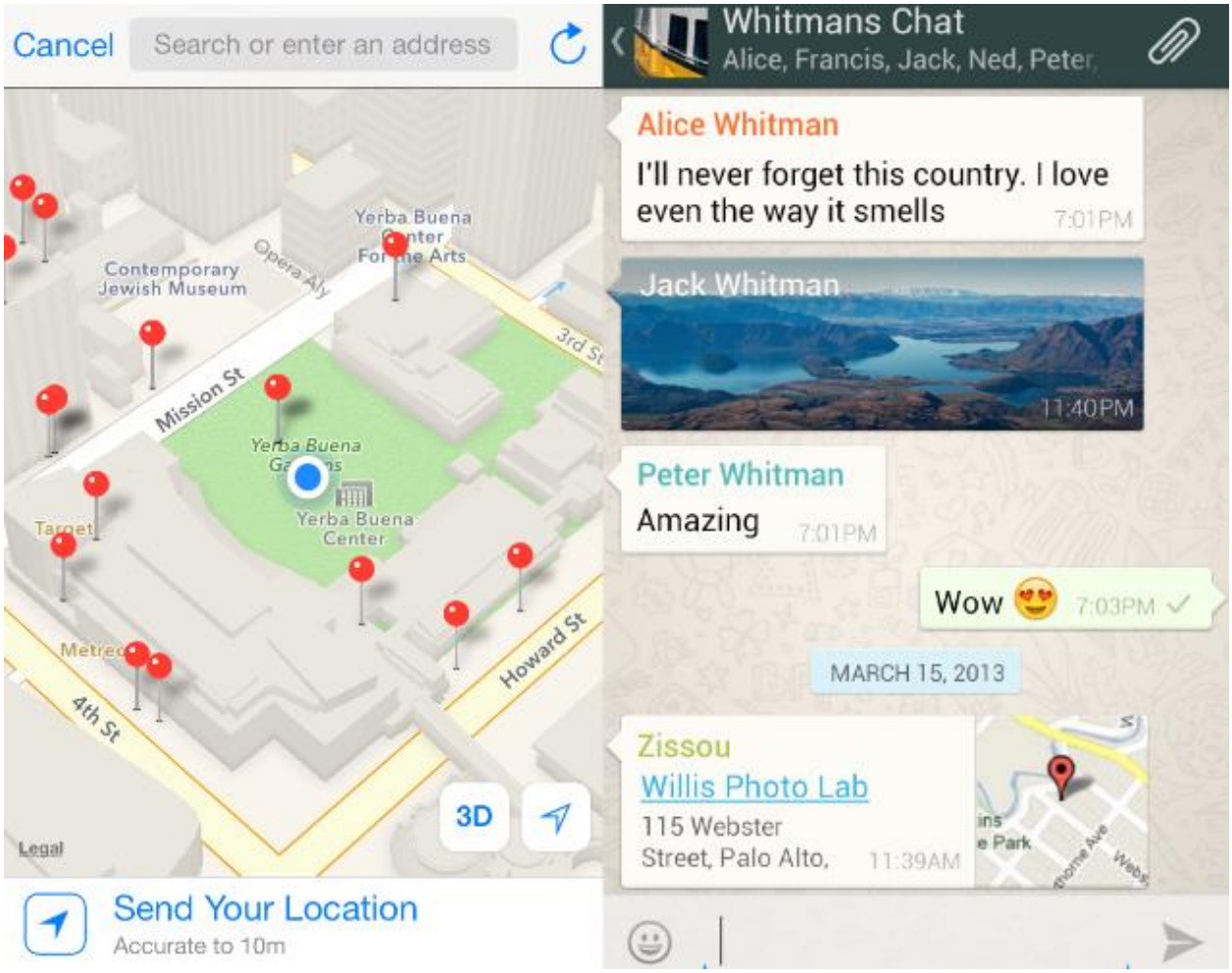

Figure 1. **A depiction of WhatsApp Messenger's location sharing and group chat.** Source: http://www.webwise.ie/parents/explainer-whatsapp

The location feature allows peers to share their geographical locations with other users in real-time. The group function allows users to form groups whose membership is pre-determined by the group administrator (Johnston et al., 2015). It is the group administrator's responsibility to add or remove members from the group. Anything sent to the group has end-to-end encryption meaning that only members of the group can access the messages (Barhoumi, 2016). The group function facilitates communication as a message only needs to be sent once and it immediately becomes visible and accessible to all group members once they are online.

Members of a group can discuss an issue by sharing text messages, voice messages (audios), images, and videos. Members can choose which specific messages they want to respond to (Vanderhoven et al., 2015), which helps to keep the discussion focused. A member can also delete any message sent by mistake, and it will be automatically removed from the conversation. Messages that are not deleted can be kept permanently on the users' devices, and

this enables group members to maintain a record of communication that can be used for future reference (Giordano et al., 2015). The WhatsApp group function was crucial to this research as the researcher was interested in the interactions that occurred as the study progressed.

There has been an increase in the use of WhatsApp as a communication tool in recent years. In April 2013, WhatsApp had 200 million active subscribers (Statista, 2016). This number increased to 700 million in January 2015, and by January 2016, the figure had risen to over 1 billion subscribers (Statista, 2016). This rapid growth makes WhatsApp Messenger one of the most popular communication platforms in the world (Giordano et al., 2015).

Using WhatsApp Messenger to communicate removes social hierarchies, which can become a barrier to face-to-face communication (Giordano et al., 2015; Johnston et al., 2015; Rambe & Bere, 2013). This provides shy or introverted individuals with a platform to express themselves without any barriers. WhatsApp Messenger enables users to criticise each other, evaluate each other, and advise each other anonymously. This anonymity enhances truthfulness and honesty (Vanderhoven et al., 2015).

2.3.2 Using WhatsApp Messenger in education

WhatsApp Messenger has gained acceptance as a communication tool in education (Rambe & Chipunza, 2013), mainly in universities (Nedungadi et al 2013). Most students and their teachers can afford personal computers and mobile communication devices. They can download the WhatsApp Messenger application and install it on their devices at the cost of data required for the download. There is no purchase fee and the application can be installed directly on desktops, laptops, smartphones, and tablets (Eberechukwu & Queendarline, 2018).

The use of WhatsApp in education is supported by the notion of connectivism which posits that learning is now dependent on an individual's ability to link with information nodes as well as connect with information sources (Bockurt et al., 2016). Most adult learners use it to stay connected with their peers as well as their teachers.

There has been growing use of WhatsApp Messenger to transmit instant texts messages for both social and academic purposes (Yin, 2016). This has led to a rapid transformation in the way people communicate in both social and in academic settings (Susilo, 2014). Nowadays, it is possible to conduct online discussions between students and teachers and teachers can create WhatsApp Messenger groups for easier communication with their students (Fischer, 2013).

Information can flow more easily between teachers and students without the need to be in the same physical place at the same time.

In their study on WhatsApp Messenger use in education, Etim, Udosen and Ema (2016) found that the application has a positive influence on academic knowledge sharing and academic performance. Iziyan and Mohammed (2016) established that the use of WhatsApp Messenger improves the English language proficiency among Malaysian university students. In their investigation into the use of WhatsApp Messenger as a pedagogical tool, Kumar, Lian, and Vasudevan (2016) established that it improved the performance of students at Kuala Lumpur University. Rambe and Chipunza (2013) conducted a study on student perceptions and the use of WhatsApp Messenger as an educational tool. The study established that students perceived the application to be effective as an educational tool. In a study on the extent to which students used WhatsApp Messenger as a learning tool, Yin (2016) concluded that the majority of students at Ipoh College were using the application and their experience was tremendous.

WhatsApp Messenger can shape individualised learning (Yin, 2016). It enables participants to learn at their own pace and does not impose strict timetables or schedules on learners. If used correctly, it increases the learner's sense of belonging to a community and encourages collaboration. It allows participants to express themselves freely without the pressure of making presentations in a traditional classroom. Compared to the traditional classroom, WhatsApp Messenger allows learners to have discussions with other participants in various geographical locations at the same time (Gasaymeh, 2017).

Research on the pedagogical use of WhatsApp Messenger in South African universities shows that it made communication between students and their teachers easier (Rambe & Bere, 2013). It provides an informal communication environment that allows easy sharing of information. The online communication eliminates the need for learners and their lecturers to be in the same room for learning to take place. It enhances cooperation and increases motivation to engage in academic activities (Rambe & Chipunza, 2013). In Spain, a study conducted among students learning the English language showed that students who studied in a WhatsApp Messenger group showed more enthusiasm to study the language than those who studied in a traditional classroom (Plana, Gimeno, Appel & Hopkins, 2013).

In addition to facilitating online communication between teachers and students, WhatsApp Messenger also enhances communication among the teachers themselves. Through WhatsApp Messenger groups, teachers can become part of online communities of practice where they can

discuss their teaching experiences. This enhanced interaction with other teachers has the potential to develop their professional identity (see Section 2.4.1) as they interact and share information with their peers.

2.4 PROFESSIONAL DEVELOPMENT OF UNIVERSITY TEACHERS: STRATEGIES, METHODS, AND TOOLS

University teachers need support and guidance in their teaching endeavours. Most university teachers enter teaching on the strength of their expertise in specific academic fields. Very few of these individuals possess the professional pedagogical skills that enable them to function effectively as teachers (Chabaya, 2015; Leavitt, Reynolds, Barnes, Schilpzand & Hannah, 2015). Their pedagogical skills are usually influenced by their own vocational experiences (Green, 2015). As such, university teachers who do not have formal pedagogical training, tend to teach the way they were taught when they were students. The goal of professional development of university teachers is to promote the acquisition of skills, attitudes, and values of the teaching profession (Bakah et al., 2012; Gonzalez & Skultety, 2018). Universities use different approaches to professional development. The primary approach universities use is the induction approach, presented mainly through workshops and seminars. These tend to be once-off, ad hoc, and unsystematic (Green, 2015; Jeannin, 2016). This study, therefore, sought to investigate the effectiveness of a longer-term, WhatsApp Messenger-based course in IBP.

Throughout their careers, university teachers will encounter the need to acquire new skills and hence require structures that support the continuous acquisition of new skills. Online communities of practice (such as those facilitated using WhatsApp) are an example of such a structure because the structure can exist for a significant amount of time and does not cease to exist after a particular session. Teacher change should not be only about the change of behaviour but entails continuous growth and development in their professional practice (Witworth & Chiu, 2015). Professional development enables university teachers to gain new skills, increase their effectiveness, and learn from the experiences of others to acquire a clear philosophy of teaching that is suitable for university teaching (Harnett, 2012; Leibowitz et al., 2014).

Witworth and Chiu (2015) identified the following characteristics of effective professional development:

Active learning. This is where a teacher observes other teachers and practises what they learn from them. They also receive feedback from others and engage in discussions.

Content focus. For a professional development programme to be effective, there has to be a strong component of content.

Coherence. This refers to the alignment of professional development with policies and standards.

Duration. The programme should be spread over a significant period so that it becomes effective. This is why workshops have been proven to be ineffective.

Collective participation. This is where teachers from similar fields discuss the curriculum as a single community of learners.

Teachers prefer professional development programmes that allow collaboration with other educators and the resultant learning communities (Al-Musawi, 2008; Smith, 2015). Research shows that collaboration has positive influences on both teaching and learning (Dogan, Pringlele & Mesa, 2015; Jones, Gadner, Robertson & Robert, 2013) This is because professional development shifts attention from teaching to learning and educators have their own experiences that they find worthwhile sharing with others (Gonzalez & Skultety, 2018). Within communities of practice, teachers can mentor and coach each other, which makes the professional development programme effective (Witworth & Chiu, 2015). The WhatsApp Messenger application provides an online platform where teachers can communicate with each other in a flexible way. It was, therefore, important that the study investigates whether the flexible communication environment offered by WhatsApp Messenger could be used for the professional development of university teachers.

In their study on the technological pedagogical content knowledge (TPCK) of teachers in an online professional learning community, Dogan et al. (2015) found that the more teachers collaborate, the better their TPCK develops. This means any medium that enhances teacher collaboration has the ability to enhance their knowledge. WhatsApp Messenger facilitates collaboration in online communities and therefore has the potential to improve teaching practice. Online professional learning communities (PLCs) have an indirect impact on student learning. In their meta-analysis of the relationship between PLCs and student performance, Lomos, Hofmen, and Bosker (2012) found that there was always a positive relationship between the two. Chapter

Teachers' experiences must be taken into consideration for professional development programmes to work (Chabaya, 2015; Komba et al., 2013). Developers of professional

development programmes for teachers should value the knowledge and experiences of participating teachers and build on their knowledge to improve teacher learning. Effective professional development programmes are those that intrinsically motivate teachers to participate in problem solving and continuous learning activities while paying specific attention to the needs of the teachers (Donnelly, 2016; Howson, 2012). Such programmes need to foster the link between the content knowledge and the pedagogical knowledge of the teachers. Programmes also need to acknowledge that teachers are adult learners and should, therefore, use adult learning methods that promote lifelong learning (Chabaya, 2015; Mgijima, 2014). Teachers can apply their experience in new learning situations. Any learning situations should, therefore, employ active learning strategies that enable teachers to engage with their peers as well as with their environment. WhatsApp Messenger facilitates the active participation of members of PLCs as it offers a flexible environment for individuals to share ideas.

2.4.1 Online professional learning communities

Research on mobile technologies indicates growth in PLCs over the past decade (Barhoumi, 2016; Lu & Churchill, 2014). These learning communities are established around specific subject areas and reach beyond national borders (Reeves et al., 2015). The major contributing factor to the growth of these online PLCs is the ease of use associated with technologies such as WhatsApp Messenger. In addition, the individuals' social presence in online communities is a pertinent influence on their participation in cooperative and collaborative learning. Mercier and Higgins (2013) found that students are motivated to take part in online collaborative learning activities. Lu and Churchill (2014) reported that online discussions using mobile communication technology improves students' social networking skills, enhances their self-esteem, and improves their academic performance. Online discussions also enhance joint participation, joint attention, and task-focused conversation (Higgins, Mercier, Burd & Joice-Gibbons, 2012). WhatsApp messenger has, therefore, transformed from being a mere social networking medium to being a formidable educational tool. With proper guidance and control, WhatsApp Messenger has the potential to revolutionise the way educational institutions plan and develop their curricula.

Online communities enhance interaction between students and teachers. The greater the interaction, the higher the satisfaction for both students and teachers (Reeves et al., 2015; Richmond & Manokore, 2012). WhatsApp enhances the interactions within online professional communities as it eliminates the rigidity associated with traditional learning practices. In the higher education sector, the integration of social media platforms has contributed to a change

in pedagogical practices. However, empirical research into the effectiveness of such platforms is still in its infancy (Allen & Seaman, 2016; Jaschik & Lederman, 2013). What is not in doubt is that social media enhance communication and interaction within online professional communities. This study, therefore, explores the effect of the enhanced interaction, facilitated by WhatsApp Messenger, on the professional identity development of university teachers.

2.4.2 Pedagogical methods and tools in education

Teachers face numerous challenges because they not only have to teach in a way that makes students understand the concepts, but also in a way that helps students use the knowledge to solve practical problems. Teachers must factor in numerous variables to find the right approach that caters for different students' needs, institutional resources, level of students' maturity, student workloads and environmental issues. The social constructivist learning theory (discussed in chapter 1) is one central philosophy that guides the teaching approaches used in the teaching of science. The philosophy's major argument is that students learn better when they interact with their peers than when they sit and listen to their teacher. The most common approaches that support social constructivism are problem-based learning (PBL), process-oriented guided inquiry learning (POGIL), and project-based learning (PjBL) (Kristen, Malinda, Monica & Kendra, 2017). These teaching and learning approaches place the student at the centre of the learning process and offer them the opportunity to discover and generate knowledge.

For teachers to be able to use these teaching methods, they need to be properly trained and socialised in their application. Information and communication technology (ICT) has provided many opportunities for teachers to learn outside the formal classroom setting. This study, therefore, aims to establish facts about the potential of IBP as a strategy to develop university chemistry teachers' professional identity through the use of WhatsApp Messenger.

2.4.3 Inquiry-based pedagogy use in education

Inquiry-based pedagogy (IBP) has its roots in the 1960's discovery instruction movement (Kazempour & Amirshokoohi, 2015; Kuhn & O'Hara, 2014; Suhaili, & Hayhood, 2017). IBP came about as a response to traditional pedagogical methods that included mainly direct instruction and rote learning (Shamsudin et. al., 2013; Ernst at al., 2017). Its antecedents are located in constructivist learning theories found in the works of Vygotsky, Piaget, Freire, and Dewey, among others (Kotsari & Smyrnaiou, 2017).

Inquiry-based pedagogy (IBP) methods are student-centred and enable students to participate in knowledge generation actively (Kotsari & Smyrnaiou, 2017; Kuhn & O'Hara, 2014; Maab & Artigue, 2013). In this approach to teaching, the teacher assumes the role of facilitator while the student's role is to discover new knowledge and methods to solve problems. IBP allows teachers to build on what students already know and, in this way, teachers help students understand learning as a human endeavour (Shamsudin et. al, 2013; Buchanan et al., 2016). It represents a departure from the traditional teaching methods where the teacher is supposedly the source of all knowledge. This learning approach provokes the learner to take charge of the learning process (Fine & Desmond, 2015; Friesen & Scot, 2013; Khan, 2012). The teacher assumes an advisory role where they guide the learners through the discovery process. The teacher provokes learners to answer questions and then directs them to find answers through experiments and give a thorough evaluation of any possible solutions. The teacher guides the learners to use their newly acquired knowledge to widen their knowledge base, make an analysis, and formulate new hypotheses for further study. This study, therefore, sought to determine if WhatsApp Messenger could be used to socialise teachers into inquiry-based practitioners.

In the context of IBP, the teacher assumes the role of a facilitator who guides the students in exploring questions and making decisions on what course of action to take. The teacher asks well-constructed, open-ended questions, which invites the students to think deeply and make further investigations instead of replying with a single correct or wrong answer (Abdi, 2014; Fine & Desmond, 2015). While the teacher's questions reflect the goals and objectives of the curriculum, they should also follow the student's own thinking so that the teacher is able to provide the student with the appropriate resources that can expand thinking. According to Hamlin and Wisneki (2012), open-ended questions cause students to engage in higher-order thinking. They are able to interact with other students, and this helps them to increase their comprehension (Calleja, 2016; Kogan & Laursen, 2014). However, for the teachers to be able to use IBP, they need to understand how it works first. Therefore, in this study, the researcher used WhatsApp Messenger, which is generally used as a social learning tool, to teach university teachers about IBP.

Despite a growing consensus towards the efficacy of IBP, research has found that its implementation poses many challenges to educators (Ramnarain & Hlatswayo, 2018). For example, in developing countries, many educators are not adequately trained in pedagogy, and they tend to teach the way they were taught while they still at school. While IBP appears easy

to use as a teaching approach, its implementation implies a lot of administrative changes (Dibiase & McDonald, 2015; Kotsari & Smyrnaiou, 2017). Teachers have to relinquish their traditional roles as knowledge imparters and students have to adjust to a new role as partners in knowledge generation.

Faculty at universities usually plan their teaching independently of each other and tend to be more interested in research than teaching as their promotion is linked to their research output. In addition, IBP imposes a 'core learner' tag on the teachers, which many of them find unacceptable. IBP also leads students to acquire false facts and unreasonable knowledge (Nybo & May, 2015; Sowey, 2013) because it can lead to the haphazard acquisition of knowledge if it is not done correctly (Silby, 2013). Students acquire knowledge through trial and error, which leads students to gain procedural knowledge at the expense of propositional knowledge (Sowey, 2013).

2.4.4 Inquiry-based pedagogy in chemistry education

Using IBP in chemistry allows teachers to build on what students already know and in this way, teachers help students understand chemistry as a human endeavour (Shamsudin et. al, 2013; Akhter, 2013; Lehtinen, 2017). This learning approach provokes the learner to take charge of the learning process (Archer-Kuhn, 2013; Fine & Desmond, 2015). The teacher guides the student as they perform experiments that are designed to answer questions. Studies have shown IBP enhances understanding when students are learning abstract concepts such as mass, volume, and density (Idleman, 2016; Simmons & Ackerman, 2016). As the students work through experiments, they can analyse information and use their observations as a basis on which to draw conclusions. This allows them to gain a better understanding of how or why things happen the way they do. The starting point in inquiry-based chemistry learning is a question or an observation (Lehtinen, 2017; McCabe & O'Connor, 2014). This is then followed by an experiment designed to solve the problem. As the students work on their experiments, the teacher facilitates learning by guiding the students and clarifying issues that arise during the process.

The teaching of chemistry requires teachers who are equipped with the right pedagogical competences if it is to empower students with problem-solving skills. Without these competencies, teachers will continue to produce graduates who have theoretical knowledge about chemistry but who cannot function in the real world of work. As discussed earlier in this chapter, the IBP approach places students at the centre of the learning process, allowing them

to sharpen their knowledge generation and problem-solving skills. It, therefore, follows that chemistry teachers need to be trained and socialised in IBP theories and practices. WhatsApp Messenger offers a platform for such socialisation without disrupting the teachers' work.

If teachers are to inculcate authentic practice of IBP, they must receive support to learn how to teach with methods that help students to construct knowledge. There is a strong correlation between teachers' conceptions about chemistry and the approaches that they use to teach it (Sever & Guven, 2014). Where teachers believe that the learning of chemistry is a process of inquiry, they are more likely to use IBP approaches which emphasise the development of chemistry process skills. Such teachers do not view chemistry as a set of facts that a student should memorise, but as a body of knowledge that still has a lot to be discovered. It is therefore essential that teachers are socialised into believing that chemistry teaching should be about guiding students to discover knowledge. Professional development for chemistry teachers in the context of IBP, therefore, aims to expand and improve teachers' beliefs so that they engage. In the context of this research, the professional development of university teachers entails socialising them in the theories and practices of IBP using WhatsApp Messenger, to determine whether this will lead to any change in their professional identity

Teacher training programmes that emphasise IPB help change the identity of teachers from being the "keepers of knowledge" to "facilitators of knowledge generation" (McKenna, 2013). Understanding this change in identity helps to predict the changes that occur in an individual teacher's classroom practices since the change in identity may be in conflict with the teacher's long-held belief about themselves. Such a situation can lead to a professional identity crisis which may leave the teacher confused or frustrated. A teacher may not appreciate the loss of their role as the authority and source of information.

While research on the professional development of high school teachers shows that IBP training leads to a shift in identity from instructor to facilitator, not much evidence exists to show whether the same applies to university teachers. The case of university teachers is complicated by their dual identities in that most of them are academic experts in fields such as engineering, medicine, pharmacy, biotechnology, who find themselves having to take the added role of teachers. Their professional development trajectory cannot, therefore, be expected to be the same as high school teachers. Besides this, the levels at which they teach and the performance objectives they set for their students, differs to those at a high school level.

As this research explores the professional identity development of university teachers, these contextual issues were taken into consideration

2.5 TEACHER IDENTITIES: SEARCHING FOR THE SENSE OF SELF

Teacher identity refers to the way a teacher views themselves in terms of the work they do, including who they are professionally, what they want to achieve, and are empowered to achieve as they continuously reflect on their experiences and practices (Owen, 2014; Vokatis & Zhang, 2016). Teacher identity is not static; teachers continuously reflect on their sense of self as they encounter new situations in their teaching practice. A teacher's identity is a reflection of his or her unique set of practices (Vokatis & Zhang, 2016), such as inquiry-based teaching. As such, there is an overlap or intertwining between teacher identity and teaching practice.

The professional identity of teachers emanates from the way they teach across various contexts where they develop holistic views of themselves in relation to their students, colleagues, and teaching circumstances (Meyer et al., 2015). Professional identity is thus constantly changing when teachers interpret and reinterpret themselves, view themselves, and get recognition for being a certain type of people in certain contexts. Identity, therefore, does not only seek to answer the question 'who am I now?', but also 'who am I going to be?' and 'how do I want people to view me'. To this end, teachers constantly explore who they are as professionals based on their experience and they seek new ways to define who they are as they encounter new educational contexts. Using WhatsApp Messenger in teaching is one such contemporary issue that teachers are encountering in their day to day teaching practice. It is, therefore, essential to determine using WhatsApp can be beneficial to the professional development of teachers.

Several contextual factors shape teacher identity. These include socio-cultural-historical factors, personal histories, institutional cultures, institutional history, and the views of other institutional stakeholders (Vokatis & Zhang, 2016). Therefore, as teachers reflect on who they are, they are conscious about how this sense of self fits into the broader context, which involves others. In the context of this study, the view and experiences of other teachers play a role in professional identity development. The affordances and challenges of the context in which such views and experiences are shared will help in shaping the development of professional identity development. For this study, the aim was to explore how the WhatsApp Messenger platform can be used as a medium for sharing such ideas and experiences.

Since contextual issues are important in shaping the development of professional identity of teachers, it is necessary to understand how teachers relate to their peers, their students, and their administrators. Social relations are crucial to identity development (Eatough & Tomkins, 2014; Shava, 2015), as an individual seeks to be recognised as a particular kind of person by those with whom he or she relates. The professional identity of a teacher, therefore, is a product of how he or she interacts with others from the same profession. Teacher identity is co-constructed through his or her interaction with others and it, in turn, shapes how he or she negotiates his or her roles amongst various stakeholders. For a teacher to be able to negotiate their role, there is need for them to have a voice through which their view can be heard. It was, therefore, the purpose of this study to find out how WhatsApp Messenger afforded the teacher a platform for his or her voice to be heard as he or developed his or her professional identity.

2.5.1 Chemistry teacher identities: The role of pedagogical beliefs

The pedagogical beliefs and practices of chemistry teachers are a key factor in shaping their identities. It is assumed that teachers' pedagogical beliefs play a critical role in determining their decision-making processes as they plan and implement educational activities (Mihaela & Alina-Oana, 2014). In general, teaching beliefs can be categorised into the following areas: beliefs about teaching (goals, methods, content), beliefs about assessment, beliefs about students and how they learn, and belief about professional development (Macugay & Bernado, 2013).

A study by Mihaela and Alina-Oana (2014) showed that many chemistry teachers view themselves as chemistry specialists rather than pedagogues. This identity means that the chemistry teachers are more concerned about the principles and concepts of chemistry than how they teach it. Such teachers require excellent knowledge of chemistry in order to be able to teach effectively. However, pedagogues are concerned with how students learn and how to make learning activities more interesting (Mihaela & Alina-Oana, 2014; Veniger, 2016). Chemistry teachers' own identities are influenced by the way they learnt while at university. Those who were taught using inquiry techniques tend to view teaching as a process that puts students at the centre of the teaching and learning process (Gormally, 2016; Shamsudin et. al, 2013). They view themselves as moderators or facilitators in knowledge creation. However, those who were taught using the traditional rote learning methods tend to think that they are the owners of knowledge.

Most university teachers did not encounter IBP during the time that they were at university and hence they tend to teach the way they were taught (Gormally, 2016; James-Jacob et al., 2015). This means that the majority of chemistry teachers at university tend to view themselves as the sources of knowledge and students as passive recipients of the information. Understanding teachers' beliefs is key to predicting their classroom behaviour. It is imperative that researchers and teachers of professional identity first understand teachers' beliefs before providing any professional interventions. It was, therefore, necessary for this current study to determine the teachers' views about themselves before they undertook the IBP course through WhatsApp Messenger. This helped determine what changes would be attributed to the intervention.

Educational institutions are increasingly leaning towards problem solving, inquiry-based pedagogy. It has, therefore, become important for research on teacher learning to focus on the identity of teachers with a view to impart inquiry-based pedagogical skills. In the case of chemistry teachers, new roles have emerged that define teachers as: designers, mentors, modellers, facilitators, and partners in the learning process (Vokatis & Zhang, 2016). The inquiry-based chemistry teacher is a co-learner who partners with students in the inquiry process, values their collaborative contributions, and fosters their agency (Mills, 2014). This study used the WhatsApp Messenger platform to impart IBP skills with a view to determine how the professional identities of the teachers would change.

Existing research has concentrated more on equipping chemistry teachers with the knowledge to integrate IBP in their teaching, than on focusing on the professional identity of teachers (Vokatis & Zhang, 2016). When teacher identity aligns with IBP, it enables teachers to consistently implement adaptive and responsive teaching methods (Mills, 2014). As such, in order to have a better understanding of chemistry teacher identity development aligned to IBP, this study explored the professional identity development of teachers involved in learning IBP using the WhatsApp Messenger platform. The aim was to investigate the suitability of WhatsApp Messenger as a tool for teachers to learn IBP and develop their professional identities.

2.5.2 Teacher professional identity

The rapid developments in the knowledge field mean that professionals are now being recognised and appreciated in many fields of educational endeavour (Sethi, Schofield, McAleer & Ajjawi, 2018). As a result, people no longer want to be only recognised as a professional, but also want act and behave like professionals. Apart from certificates and diplomas that

prepare graduates for future professions, many educational fields now have professional bodies that regulate the standards of service. Regulation protects clients from incompetent and careless service providers (Sethi et al., 2018) as specific minimum standards define the acceptable conduct and expectations of a professional.

Professional identity is, therefore, the *self* that has been developed to be able to function fully and with enough legitimacy in a profession, and it develops continually during the person's career (Barbour & Lammers, 2015; Burton et al., 2013; Khalid, 2014). Contextual issues within the profession play a massive part in the development of professional identity. The perceptions that individuals have about themselves within a profession will change as circumstances within the profession change. Professional identity development should typically lead to a change in the way individuals presents themselves to other people as well as to themselves (Van der Want et al., 2017; Weld, 2015). The extent of change is dependent on how an individual will respond to the demands and expectations of the profession. Rejection of these demands and expectations would lead to a negative professional identity, whereas acceptance would result in a positive self-image. Most university teachers would not have been exposed to these pedagogical demands and expectations because of their lack of professional training. The WhatsApp Messenger platform offers a flexible environment for teachers to learn pedagogy without disrupting their planned teaching activities.

A more positive self-image develops as a result of professional development, and this will typically lead to improved professional conduct. An acquired professional identity influences an individual to act and make decisions in a manner consistent with the profession (Weld, 2015). An individual becomes more conscious of his or her actions and their consequences to the profession. Those traits that promote positive professional conduct are reinforced, while the negative aspects fade away.

The professional identity concept is a socially and culturally constructed concept that manifests in a person's life due to personal experiences and other people's experiences (Cruess et al., 2015). The interactions that take place between individuals within the same profession shape their professional identity because they enable individuals to share their experiences and ideas as they go about their professional practice. Identity construction is an inclusive process where each individual participates in various social and cultural worlds that come about as a social construction (Wald et al., 2015). Professional identity, therefore, is a product of an individual's active participation in professional activities. As individuals interact and share experiences,

they get to understand how others perform their tasks, and this can lead them to adopt the positive aspects of other people's experience while abandoning the negative aspects. In the context of this study, the WhatsApp Messenger application afforded the teachers the opportunity to interact and actively participate in a professional development course.

The development of identity happens in an inter-subjective field as a continuous process wherein an individual interprets himself or herself as a particular type of person and gains recognition as such within a specific context (Hatmaker, 2013). The WhatsApp Messenger platform provides a unique context where the teachers participate at their own pace and physical location. In other words, WhatsApp Messenger can offer teachers professional visibility without necessarily enrolling in a classroom-based professional course. Individual becomes professionally visible within the professional community by expressing themselves. This professional visibility will lead the professional to be recognised and acknowledged as such by those within and outside the profession. In the context of this study, the teachers had the opportunity to participate in the course without leaving their own workstations. The WhatsApp Messenger app provided the platform for them to work as an online community.

An individual's professional identity is shaped by their participation in different professional communities (Barbour & Lammers, 2015; Cruess et al., 2015; Smith, Hayes & Shea, 2017). An individual's identity takes shape as they attempt to conform to the norms and values imposed by the community.

Interpretation of one's professional identity is to some extent an argument that seeks to justify and provide meaning to an individual's activity and values as they represent their profession (Cruess et al., 2015; Eatough & Tomkins, 2014). As individuals perform their professional duties, they are not only doing the work of professionals but are also being professional. Professional identity is an aspect of a person's self-concept, which develops in a social context as a result of the dialogue between an individual and his or her environment (Meyer et al., 2015). Change in context will lead to a change in professional identity. A person's identity can be compared to their relative position with respect to others, where they get to know who they are; and whether they understand their relationship with others. Such social spaces provide individuals with insights as to the choices that exist in various fields. As individuals chooses and rejects some choices, they will be affirming their affiliations and as such, develops professional identity.

2.5.3 Importance of professional identity

The way individuals perform their duties in any profession is influenced by their professional identity. Individuals with a positive professional view about themselves tend to perform their duties more effectively than those with negative views (Eatough & Tomkins, 2014). Professional identity raises self-esteem and confidence levels (Smith et al., 2017). As a cognitive function, professional identity affects individuals' attitude and commitment to work (Caza & Creary, 2016). Lack of positive professional identity is associated with poor performance.

Professional identity is an indication of the type of work that an individual does and therefore indicates what training an individual needs and the skills that they should possess (Caza & Creary, 2016). Such training and skills acquisition enables an individual to fit into the community of practitioners. Through interactions with others, individuals learn who they really are as professionals by seeing themselves through the eyes of others. This insight helps individuals understand what is expected of them. The way individuals view themselves is an important tool they can use to identify their purpose in life. As such, an individual's professional identity is an indicator of their professional self. Through professional identity construction, individuals can realise their individual purpose and meaning and define their contribution to society.

Apart from being process that develops meaning, professional identity formation is an indication of one's psychological well-being (Meyer et al., 2015). The role identities that are valued by an individual protect them from anxiety and depression because individuals use professional identities as a measure of their worth. The word 'professional' has traditionally been used to indicate high levels of training and competence and, therefore, the word provides individuals with valuable self-descriptions. This is why there are psychological benefits attached to being called a professional. Being associated with a prestigious profession boosts an individual's self-esteem and pride (Smith et al., 2017).

Professional identity controls the behaviour and conduct of individuals in the workplace. The norms and values of the profession work as a moral compass, which provides a boundary of what an individual may or may not do. These norms and values help to shape the behaviours of individuals both in the workplace and outside. Professional identity also helps with decision making (Eatough & Tomkins, 2014). Positive professional identity enhances success in the workplace (Meyer et al., 2015).

2.5.4 Factors affecting professional identity development

Professional identity formation is a result of professional socialisation (Cruess et al., 2015). Various factors play a crucial role in the socialisation process. Figure 2 presents some of the factors that shape the formation of professional identity. While all these factors influence professional identity formation, their level of influence is not the same. The most powerful factors in shaping professional identity formation are mentors, role models, and individual experience (Burford, 2012; Jarvis-Selinger, Pratt & Regehr, 2012; Wilson, Cowin, Johnson & Young, 2013). Their positioning in the centre box, depicts their importance (see Figure 2).

For this study, the WhatsApp Messenger platform provided the environment in which the teachers interacted among themselves as well as the facilitator as they learnt how to teach using IBP. The platform offered them the chance to share their experiences as they were being socialised into the norms and practices of IBP.

Although role models and mentors are critical in shaping identity, their impact differs from individual to individual depending on other contextual issues (Cruess et al., 2015). The reflection on experiences between an individual and their mentors and role models is important for socialisation (Monrouxe & Rees, 2015). Learning contexts that allow individuals a chance to share experiences with their mentors and role models, provide the type of environment that fosters the development of professional identity. In the context of this study, teachers were learning by sharing their experience in the WhatsApp Messenger group environment, and any change in professional development was attributed to their learning activities within the group.

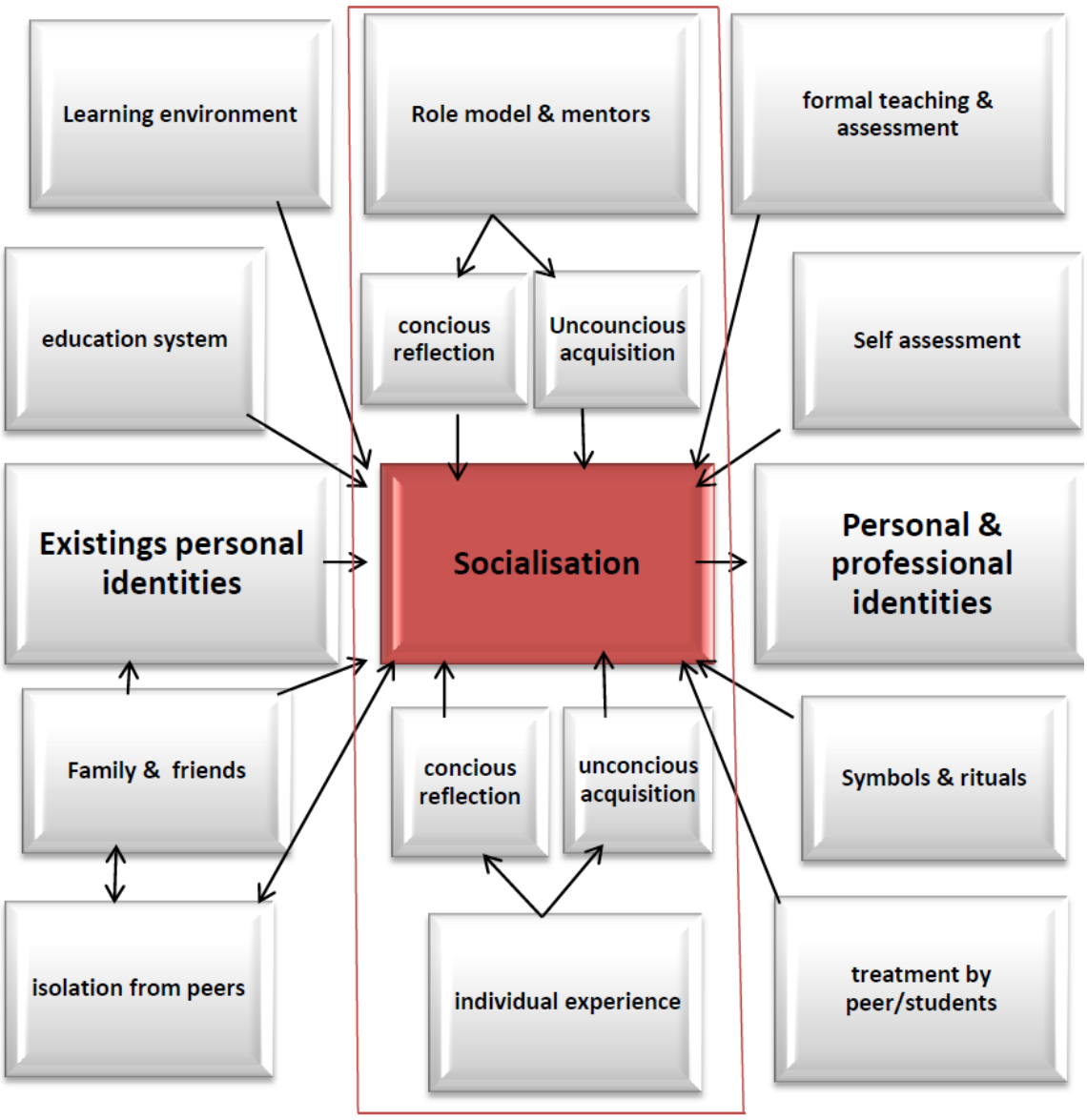

Figure 2. A presentation of factors affecting professional identity formation (Adapted from Cruess, et al., 2015).

When individuals are explicitly encouraged to reflect on their experiences, they participate actively in their own professional identity formation; this is strengthened when it happens as a group activity (Wilson et al., 2013). WhatsApp Messenger offers the type of communication context and platform for group interaction. The learning environment (see Figure 2) has a direct impact on socialisation. In the context of communities of practice, a learning environment that is welcoming and inclusionary, fosters the development of appropriate traits and behaviours consistent with the individual's profession (Benbassat, 2013). Conversely, if the environment is hostile, it impacts negatively on the individuals and hinders the development of expected norms and behaviours. As such, a successful professional development emerging from this

study would be attributed to the suitability of the WhatsApp Messenger platform to provide a conducive environment for the IBP.

2.5.5 Individuals' roles in professional identity development

The process of professional identity formation comes about as a result of professional socialisation (Cruess et al., 2015). The individual plays different roles in the socialisation process as their professional identity develops (see Figure 3). In the socialisation process, the environment plays a critical role in determining the outcome. An environment that offers individuals the opportunity to play their roles freely and without any hindrances would enhance the socialisation process. It was, therefore, the purpose of the researcher to determine whether or not the WhatsApp Messenger platform could provide an environment that allowed teachers to express themselves and perform different roles in the development of their professional identities.

The main goal in professional identity formation is to achieve competence and be recognised as competent by peers. As individual competence increases, individuals move from peripheral participation to full participation. The perceived competence will in turn be fed back into the socialisation process (Cruess et al., 2015) and strengthen the new sense of self, thereby assisting to define and stabilise the new identity of an individual. The strengthening of the new sense of self can only happen if the environment promotes the acquisition of the competences. If an individual fails to play the required role, or if the environment is not conducive to the acquisition of the necessary competences, then professional identity formation is be negatively affected.

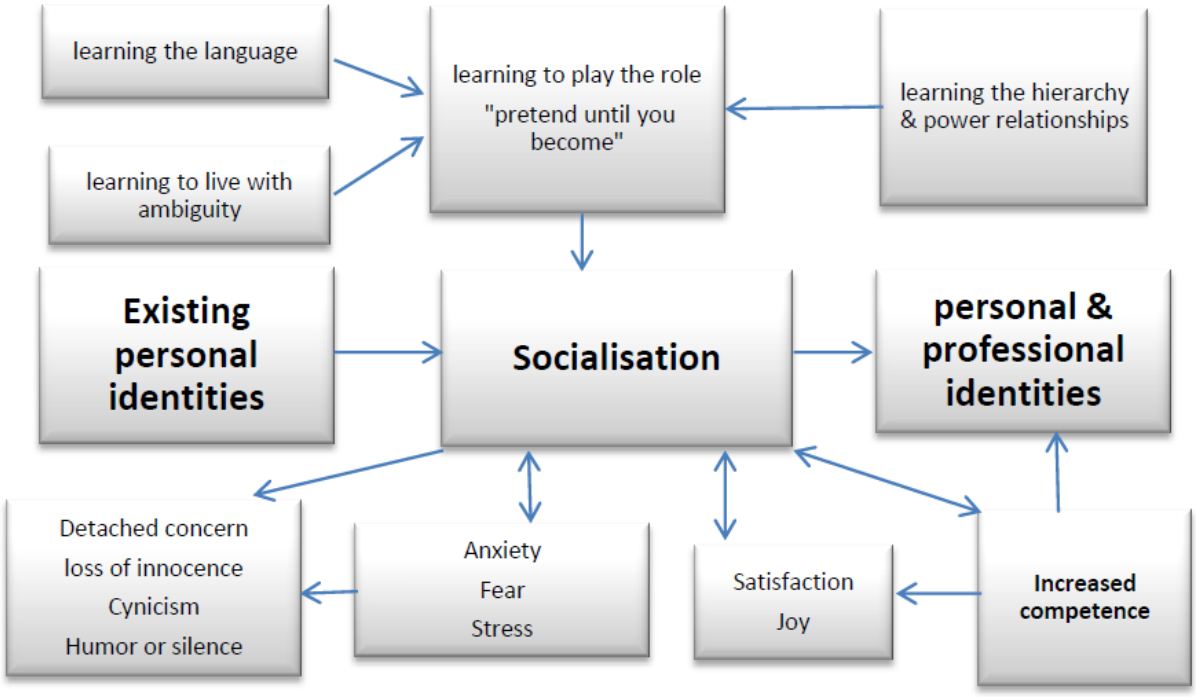

Figure 3. A schematic representation of individuals' roles and potential roles in the socialisation process (Adapted from Cruess, et al., 2015).

Undertaking a professional programme should result in individuals altering their existing identity (Frost & Regehr, 2013; Monrouxe, 2015). This change involves deconstructing aspects of their existing identities and assuming new ones. Individuals may not participate in the process if they are not prepared to change their image. This observation is consistent with the expectance value theory, which insinuates that an individual attaches value to activities that align to their self-image (Eccles et al., 1983; Ibrahim et al, 2017). In the context of this research, the continued participation of university teachers' in the online course would be influenced by the values they espouse to the interactions in the WhatsApp Messenger group.

Identity change entails acquiring new attitudes and values belonging to the current profession. Initially, individuals pretend and act as if they already know the norms of the profession, but they will eventually acquire them and become professionals (Jarvis-Selinger, Pratt & Gegehr, 2012. However, this process is not easy, and in some individuals, it can lead to confusion. Some individuals fail to deconstruct elements of their previous identities, and this can lead to identity dissonance (Monrouxe, 2015). The context under which individuals learns the norms and values of a profession, therefore, plays a crucial role in the whether or not they will assimilate or fail to assimilate such norms and values.

However, the satisfaction that comes with becoming a professional often leads to individuals overcoming the stress and confusion that come with such dissonance (Frost & Regehr, 2013). The levels of stress or satisfaction that could be caused by the socialisation process, could impact the new identity. The socialising context, therefore, plays a significant role in identity development. If the environment causes stress and humiliation, it can prevent identity formation, but if it facilitates constructive feedback, it can have a positive effect (Benbassat, 2013). It was, therefore, necessary to investigate the various aspects of WhatsApp Messenger to determine whether it provided the necessary environment to promote the professional identity formation of the university teachers.

Professional identity itself is not a fixed concept but is determined by contextual issues (Barbour & Lammers, 2015). As such, an individual can develop multiple identities depending on the context and roles. The work of university teachers is characterised by a multiplicity of roles, including being a teacher, researcher, community service provider, policy analyst, critic, and editor. This blurred space among the multiple roles often leads to identity dissonance, and teacher educators have to exercise control in shaping teacher identities (Loughran, 2014). For this research, the purpose was to inculcate the theories and practice of IBP. The researcher was, therefore, focused on the development of teachers as inquiry-based educators.

2.5.6 The professional identity formation process

Becoming a professional represents a transition from doing the work of a professional to be being a professional (Dutton, Roberts & Bednar, 2013; Wald et al, 2015). This transition means that professionals immerse themselves deeply in the ethos of their work. It means that a professional teacher will engage in conduct that is consistent with the norms of the profession, both inside and outside the classroom. In the classroom, this implies applying all the methods, theories, and practices of education that enhance student understanding and mastery of content. Outside the classroom, it involves engaging in conduct that preserves the reputation of the teaching profession.

Professional identity formation is an active, dynamic constructive, and developmental process (Holden, Buck & Luk, 2015; Mofreh et al., 2013) that leads to the deepening of an individual's commitment to the values and ethos of a profession. Thus, for academic experts, the process of professional identity formation represents a transition from being a mere expert in the academic field to being a professional in the specific sector in which one practises his or her expertise. In the case of this study, this transition would occur when an individual has acquired

the norms and values of the teaching profession. In this study, such norms and values were taught through the WhatsApp Messenger through IBP.

Professional identity formation is a transformative journey that leads to the development of internal standards that functions as an internal compass that regulates the work of a professional (Criger & Godfrey, 2014; Wald et al, 2015). It represents the acquisition of a frame of reference in as far as the conduct of a professional. Through professional identity formation, an individual integrates knowledge behaviours, skills, and norms of a profession with his personal identity and principal values (Holden et al., 2015). Cruess, et al. (2015) argued that professional identity formation is socially constructed as it integrates personal identity and professional self. Their schematic representation of professional identity formation incorporates aspects of the social learning theory, communities of practice, and situated learning (see Figure 4).

The social interactions that take place between individuals facilitate learning. A community of practice (CoP) is the product of the activities of individuals who wish to share knowledge and skills in a specific knowledge area. If the learning occurs within a specified domain, it is called situated learning (Al-Senaidi & Gawande, 2013. As a result of the learning process, individuals progress from legitimate peripheral participation, in the CoP to full participation. Legitimate peripheral participation is when newcomers engage in simple and low-risk activities of the community (Criger & Godfrey, 2014). These activities are nevertheless crucial in the attainment of community goals. Through these peripheral engagements, the novices learn norms, values, and expectations of the community (Holden et al., 2015). Gradually the novices will acquire the recognised mastery level and engage in full participation where the tasks conform to the functionality of the community.

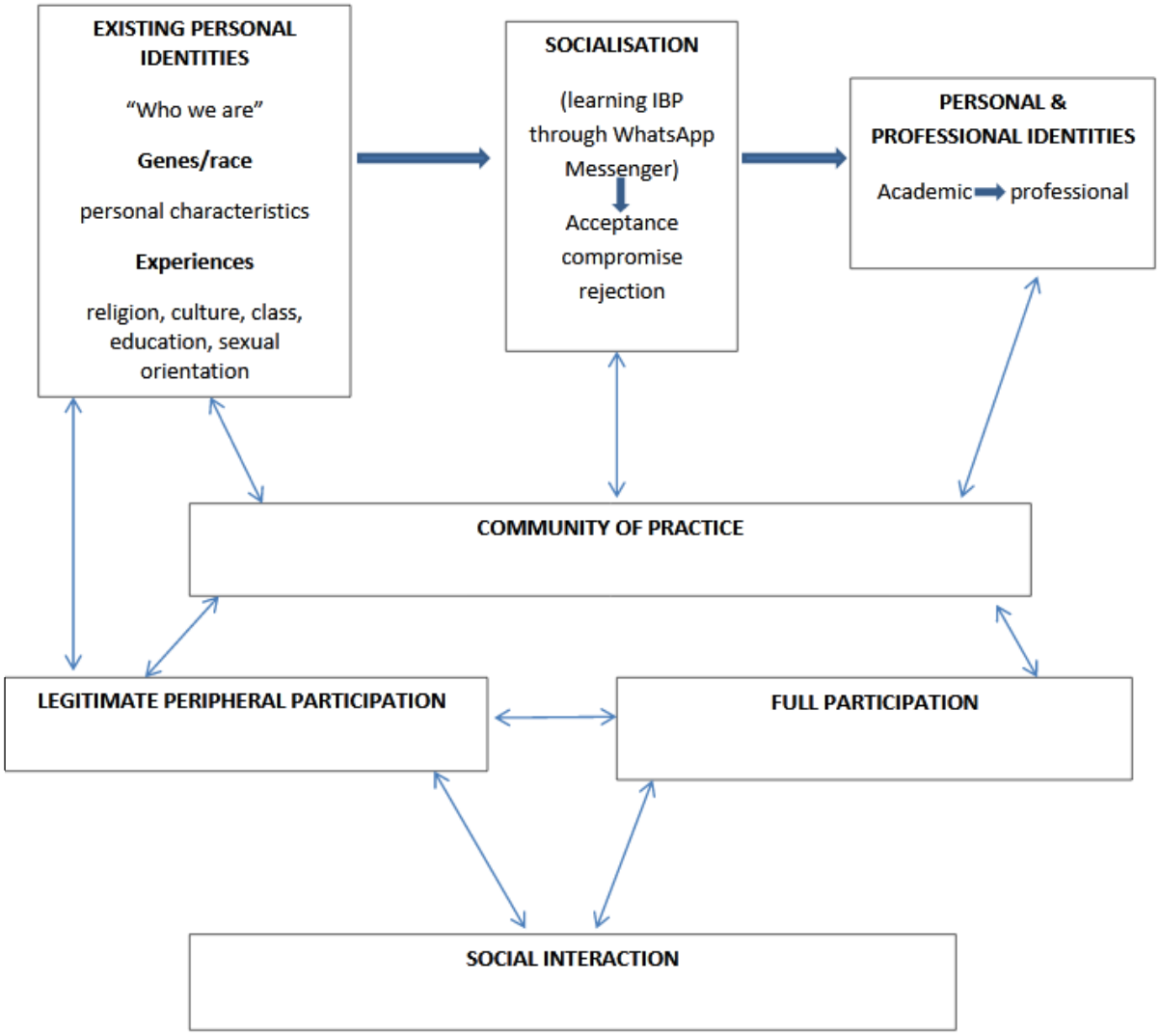

Figure 4 A schematic representation of professional identity formation **(**Adapted from Cruess, et al., 2015).

As the newcomers interact with others, they eventually acquire the skills and confidence to engage in higher-risk activities. The purpose in this study was, therefore, to determine whether the interactions that took place in the WhatsApp group gave individual teachers a chance to acquire the theories and skills of IBP and how it would change their professional identity and practices.

The WhatsApp Messenger platform offered the teachers an environment for learning. The researcher anticipated that if the learning that occurred within the group was meaningful, that teachers would transform from being only chemistry experts to individuals who could teach chemistry in a way that improves the problem-solving skills of their students. This transition occurred as a result of the social interactions that took place in the CoP.

The participation level of individuals affects the rate at which they transform from legitimate peripheral participation to full participation. Consequently, environments that facilitate the ease of participation enable quicker and easier transition. Those environments that restrict participation slow down the transition or hinder the transition altogether. Where the community consists of novices and experts, it is the experts who confer legitimacy to the novices and direct their access to various practices and experiences of the community (Holden et al., 2015). The newcomers determine their own place within the community by observing the experts' activities and behaviours. With an expert operating as the group administrator in a WhatsApp Messenger community, it was possible to socialise the group members towards the desired professional identities.

On the other hand, if the environment separates the newcomers from the activities of experts, their growth is stunted, and the latter will not be able to evaluate themselves to determine where their effort level fits in the community. In other words, they may not be able to acquire the identity compatible with the community (Benbassat, 2013; McArthur, Dailey &Villagran, 2016). Since joining the community is voluntary, individuals who fail to acquire the requisite norms and values may decide to exit the CoP (Criger & Godfrey, 2014). The WhatsApp platform has a function that allows individuals to exit the group at will, and members were free to exit at any time. Exit notifications gave the researcher the chance to follow up on the exiting individual to determine their reasons for leaving the group.

The transition from legitimate peripheral participation to full participation takes place in stages. It starts by observing and imitating experts, then proceeds to engaging in simple activities, and finally taking part in more complex tasks (Cruess et al., 2015). Figure 5 shows how the deepening competence level of individuals from the time they enter into a CoP.

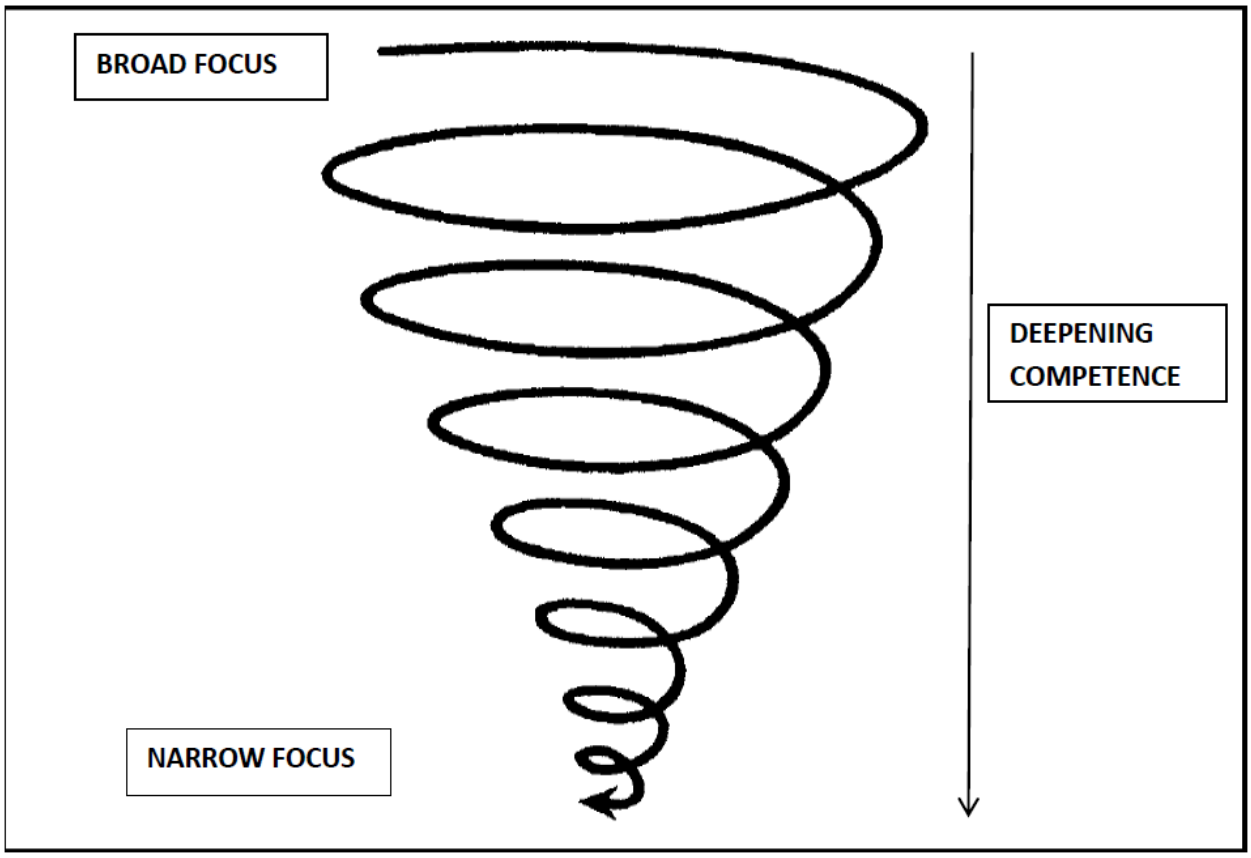

Figure 5 The structure of the spiral of deepening competency (Adapted from (Floding and Sweir, 2011).

Participation is still peripheral at the top of the spiral, which represents entry into the community. The individual has not yet mastered the norms and ethos of the community. Participation is still trial and error, and the focus is broad. However, with time, the individual moves deeper into the community. As this happens, the individual becomes more focused and, through reflection and practice, his or her competence becomes deeper. The depth depicted in Figure 5 represents an individual's ability to perform differently in a unique situation. For university teachers, this transition entailed transforming from an academic (doing) into a professional teacher (being). An essential part of the CoP is a sense of belonging. As the individual attains professional identity, they eventually start to exert significant social influence on other community members as the professional norms start to manifest in the individual (Holden et al., 2015; Leavitt et al., 2015).

2.5.7 Determination of professional identity development

This study incorporated both professional identification and professional identity constructions to help fully explore the professional identity development of university teachers.

2.5.7.1 Professional identification

Identification refers to how people relate to the professional group that they are associated with (Caza & Creary, 2016; McAthur, Dailey & Villagran, 2016). Professional identity becomes a reference point in terms of their goals and their self-sense. Professional identification, therefore, reflects the extent to which individuals describe themselves in terms of their work and the characteristics customarily assigned to people who do that same work (Kim & Shin, 2018; Salvatore, Numerato & Fattore, 2018). People who positively identify with their profession tend to have self-defining beliefs about the profession and will closely associate with the professional group (Gelech, Bayly & Desjardins, 2017; Ivanova & Scara-Mincana, 2016; Noble-Carr, Barker & Woodman, 2017). In the case of this study, it was important to determine how university teachers viewed themselves as teachers before and after undertaking a course in IBP. A comparison of these views would be used to determine any changes in professional identity.

Positive identification is generally linked to positive outcomes (Gelech et al., 2017). When the professional values are internalised, they become self-defining values. In addition, positive identification acts as a booster for self-esteem. Higher levels of professional identification lead to professional satisfaction. This study focused on the core indicators of professional identity, which were identified by Noi, Kwok and Goh (2016). These core indicators are teaching beliefs, professional competence, professional socialisation, and career progression. Each is described in detail below.

Teaching beliefs – Teaching beliefs refer to the personal frameworks educational practitioners use to express how they view themselves as educators (Green, 2015). The way educators perceive themselves is influenced by their personal beliefs as educators. These perceptions about their professional 'self' play a critical role in how they teach, their professional growth, and how they adapt to educational change (Fitzmaurice, 2013). Teaching beliefs, as an indicator of professional identity, is continuously transformed through experience (Noi et al., 2016). This means that how a teacher teaches, and how he or she responds to the changes in teaching contexts, is shaped by the changes in self-concept, which is a critical indicator of professional identity development. The experience of learning IBP through WhatsApp and the interactions between the university teachers as they shared their teaching experiences was important in shaping the development of professional identity in this study.

Professional competence – Educators are considered to be professionally competent when they have a good understanding of the subject that they teach as well as the pedagogical knowledge about student learning (Green, 2015: Izadinia, 2014). At a university level, the teachers are mainly highly qualified academics whose mastery of content is not doubted. However, their lack of training in pedagogy raises questions about their pedagogical competences.

University teachers' professional competences can be viewed in terms of their practice (what they do) and how they perform their professional duties (who they are) (Izadinia, 2014). In his study on the relationship between identity, knowledge and teaching practice, Andrzejewsk (2009) suggested that professional identity is a combination of the educator's content knowledge (CK) and pedagogical knowledge (PK). These two knowledge forms are collectively known as pedagogical content knowledge (PCK) and are key elements of professional identity (Green 2015). In this digital age, it is also essential for an educator to know about technology that is used in teaching. This technology knowledge (TK) together with the knowledge of pedagogy and content are collectively known as Technological Pedagogical Content Knowledge (TPCK) (Aqib, Budiarto & Wijayanti, 2018).

Professional socialisation – Professional socialisation is a process of acquiring skills, attitudes, and behaviours that enables one to perform their professional functions (Perez, 2016; Roucaud, 2016). In the teaching profession, this also includes learning the norms and values that are essential to the profession (Richards, Eberline & Templin, 2016). Many scholars believe that participation of educators in professional learning communities is essential in the identity development process (Clarke et al., 2013; Neto, Iza & da Silva, 2017). According to Loughran (2014), identity is a product (an outcome of influences on the educator) as well as process (continuous interaction in teacher development). From this perspective, professional identity is a label that is shaped by prior constructs of self, present context, social positioning, and meaning systems that intertwine as the teacher reacts to present context (Izadinia, 2014). Thus, professional identity development is a continuous process of integrating the personal and professional aspects of being an educator.

Professional identity development essentially occurs within interpersonal communication and depends on the broader perceptions and understanding of the professional community (Etelapelto, Vahasantanen, Hokka & Paloniemi, 2013). Professional identity development is thus the concept of self and the relationships that result from practical professional activities, sense of belonging as well as the learning experiences.

Socialisation plays a very important role in professional identity development. Socialisation has been defined as a process through which an individual acquires the knowledge and skills necessary to perform his or her professional role (Neto et al., 2017). In the context of this study, professional socialisation refers to the process through which university teachers acquire the IBP skills that will enable them to improve their teaching skills and their views about the teaching profession. Through interaction and sharing experiences with other teachers, they would acquire those attributes that define a teacher. Through socialisation, individuals acquire identification to their profession as they learn about the norms, values, attitudes, and behaviours that are expected in their new profession (Havnes & Smeby, 2014). This means that university teachers transform from being just academics into teachers.

The socialisation process is influenced by many factors including knowledge and practical skills, subject-related theories, reflective knowledge, critical analysis of experiences, and intuition (Neto et al., 2017). The programmed activities of institutions also play a critical role in socialisation and eventual professional identity (Braun, Moussa, Dafri & Stranjancevic, 2018). These activities include formal and informal educational activities. Scholars of professional identity formation have found that professionals undergo long periods of sustained socialisation before they identify with the professional group (Perez, 2016). In the context of this study, the WhatsApp Messenger platform provided a platform for continuous interaction between the university teachers.

In certain circumstances, the informal or hidden curriculum has a stronger socialising effect than the planned (Braun et al., 2018). This is important to note in this study as the WhatsApp platform provides an informal channel of communication with the potential to enhance the hidden curriculum (Richards et al., 2016). However, some professions make use of more robust socialising methods than others, with the result that some professionals develop stronger identities than others.

The more robust methods involve stripping individuals of their current identity perspective to facilitate the accommodation of the new (Neto et al., 2017). Other socialising methods, however, are less forceful, and these usually lead to weaker identification with the profession. It has also been established that the selection criteria used to enrol into a profession has a bearing on an individual's level of identification with the profession (Braun et al., 2018). In the case of this study, it is imperative to associate the strength of the professional identity development with the ability of WhatsApp Messenger to provide a suitable platform for the

learning of IBP. WhatsApp's ability to deliver content and facilitate interaction between the teachers in terms of the connectivism theory (enunciated later), as well as the teachers' willingness to learn new things are important in the professional identity development of the teachers.

Career progression – In any profession, it is normal for individuals to advance their knowledge to enable them to take on new and bigger challenges. Career progression refers to the various levels and positions that an educator goes through in their teaching career (Muchanje, Njuguna, Kalai & Bironga, 2016). Institutions usually assign posts to teachers based on their abilities and professional achievements. It is important that individuals have pre-determined goals and ambitions about what they need to become in their profession. When teachers have a clear career pathway that they want to follow, they are motivated to set career objectives, and strive to achieve them (Noi et al., 2016). The career ladder acts as a motivating factor that encourages the educators to improve their professional images and status (Straw, 2017). Having a clear career pathway indicates that an educator identifies positively with the profession and organisation, and this is a crucial indicator of professional identity (Lee & Nie, 2014). For this study, the aim was to find out how WhatsApp Messenger could facilitate professional identity development. It is therefore important to understand how learning IBP through WhatsApp Messenger could facilitate the university teachers to define their carrier pathways.

2.5.7.2 Professional identity construction

While professional identification is concerned with an individual's level of oneness with the profession and how this affects professional conduct, professional identity construction is concerned with how the individual constructs a subjective perception about themselves with regards to their professional roles (Caza & Creary, 2016). Scholars of identity construction argue that professionals do not acquire identity passively but are active participants in its construction (Salvatore et al., 2018). As a result, socialisation is a negotiated adaptation to an individual's professional environment rather than a unilateral conformity process (Caza & Creary, 2016). Understanding professional identity using the professional identity construction approach recognises the critical role that human agency plays in the process of identity formation. In this approach, therefore, research on professional identity is focused on the conscious cognitive and behavioural actions that an individual engages in during professional identity formation (Wald, 2015).

Professional identity construction is an identity transformation process that leads to a new identity within a specific profession (Wong & Trollope-Kumar, 2014). This process takes places through the conscious efforts of individuals as they interact with their social context (Viktoria & Joynes, 2018). Individuals engage in mental and physical activities that prompt them to experiment with temporary selves. These temporary selves are provisional identities that act as a bridge between their current and future self-concepts as they take on new roles.

During the temporary self, an individual may encounter situations that are contrary to their existing self-views. In response to this, the individual can engage in enrichment, patch up, or splinting actions as they construct their identity (Gupta, Shaheen & Reddy, 2018). Enrichment occurs when an individual's basic tenets remain the same, but their understanding of the expectations of the profession deepens (Salvatore et al., 2018). Patching occurs when an individual draws on one identity to deduce understanding of another identity (for example, drawing on one's identity as an engineer to improve understanding as a university teacher). Splinting occurs when an individual makes use of prior identity to strengthen a weaker identity (for example, assuming the identity of an engineering student instead of a university teacher) (Cameron & Sprietzer, 2012).

Peers play an important role in identity construction even though the peer role carries less weight than the individual's role (Fitzmaurice, 2013; Wong & Trollope-Kumar, 2014). For example, peers can act as role models who provide essential feedback to the individual (Burgess & Nestel, 2014; Burgess, Roberts, Black & Mellis, 2013). Peer feedback helps to provide social validation to the identity construction process. Senior members of the profession can give vital feedback, which helps individuals try out the provisional self, and later progress to their new identity (Caza & Creary, 2014; Karm, 2015). Validation through work feedback and role models is essential for self-assessment and the construction of identity (Wong & Trollope-Kumar, 2014)

2.6 SUMMARY

The purpose of this chapter was to discuss literature relevant to the study. Since the study is about the professional development of university chemistry teachers, the literature review focused on previous studies that addressed topics that were relevant to specific aspects of the study. The chapter addressed the use of ICT in education in general, and its use in chemistry education in particular. Specific issues addressed in this chapter are the affordances as well as the challenges encountered in integrating ICT in education. The literature review further

focused on social media use in communication and how these platforms have been reconfigured to be an educational tool. The discussion then moved on to the topic of professional identity development as a product of professional socialisation with a particular focus on indicators of professional identity formation as well as the process of professional identity construction. Inquiry-based pedagogy (IBP) was also discussed as a tool for professional development as it is at the centre of this study. The next chapter looks at the theoretical underpinnings of the study.

CHAPTER 3

THEORETICAL UNDERPINNINGS AND RESEARCH FRAMEWORK

3.1 INTRODUCTION

In this chapter, the researcher discusses the theoretical underpinning of the study as well as the overall research framework. Because of the nature of the variables which were under study, it was not feasible for the researcher to use only one theory. This study was, therefore conducted through the lens of the connectivism theory, the transformative learning theory, the dual systems theory, and the expectancy-value theory.

3.2 CONNECTIVISM THEORY

Connectivism theory caters for and explains learning in the digital age (AlDahdouh et al., 2015). According to the connectivism theory, learning is a network concept that is influenced by technology and socialisation. The socialising power of technology has enhanced the movement of information between and among individuals. Learning now occurs, not only individually but across networks (Bockurt et al., 2016). In other words, learning is no longer an individual activity but a shared endeavour among individuals with common interests.

What an individual knows not only depends on their capacity to learn but also on how networked the individual is. Personal networks enable individuals to acquire diverse opinions about certain phenomena (Duke et al., 2013). It is impossible for individuals to experience everything personally, so the interactions within these networks help them share their experiences and enhance their knowledge by hearing the experiences of other members of the network. In addition, individuals cannot know everything about specific situations because of the magnitude of knowledge that exists. The ability to tap into a knowledge network instantly helps individuals access relevant information with ease.

Siemens (2005) suggested that knowledge is distributed through connections across networks, and that learning requires the ability to construct the networks as well as traverse them. The advent of technology has changed the way people form networks. With WhatsApp Messenger, individuals can connect with a large number of people from diverse backgrounds. The traditional networking barriers no longer apply as people can interact with whomever they wish. Apart from physical barriers, such as geographical location, the cost-barrier associated

with traditional networking is greatly diminished through the use of platforms such as the WhatsApp Messenger.

Connectivism recognises knowledge creation as a shared responsibility. The knowledge emanates when members of the network interact and share their experiences (Garcia & Fereirra, 2014). A network comprises of two or more nodes that are joined together by connections or relationships (see Figure 6).

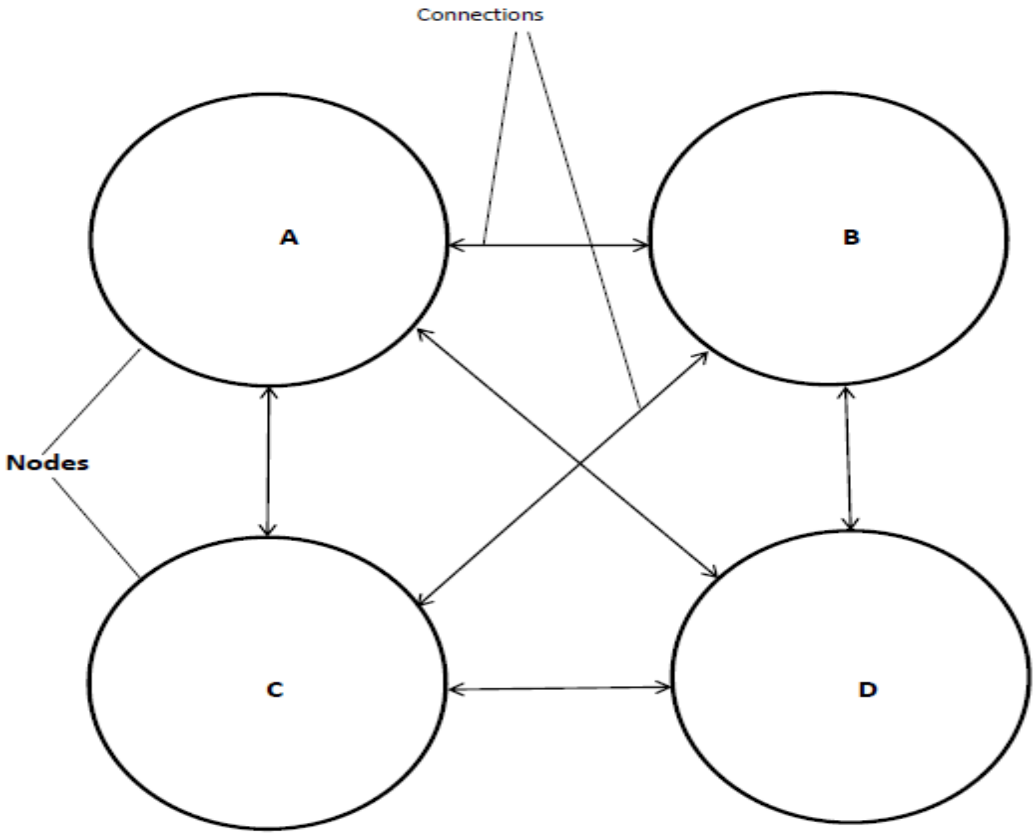

***Figure 6*:** An example of a network (Adapted from AlDahdouh et al., 2015)

The node represents any object that can be connected, such as ideas and sources of information (Ozturk, 2015). Six relationships connect the four nodes (A, B, C, D). The nodes vary in strength and size according to the amount of information and the number of people that navigate a particular node (AlDahdouh et al., 2015). The nodes can exist in one of three different levels: neural, conceptual, and external (AlDahdouh et al., 2015). The neural level is beyond the scope of this study and thus will not be discussed. At the conceptual level, the network comprises of nodes of ideas joined together by conceptual links such as similarity or positive correlation. At the external level, a network is made up of nodes of people,

programmes, books, and databases connected by the Internet, intranet and direct contact (AlDahdouh, et al., 2015; Wang, Anderson & Cheng, 2018).

In simple terms, connectivism is networked social learning (Duke at al., 2013). Connectivism reflects the rapid changes that take place in society as a result of technology. Society is becoming more complex, and individuals are becoming more socially connected due to technological advancements (Ozturk, 2015). WhatsApp Messenger has played an enormous role in connecting people from diverse backgrounds. Through WhatsApp Messenger, one can communicate and share ideas with people in different parts of the world without the need to meet in the same geographic location.

Arrays of disconnected ideas are now networked to produce specific information sets, and knowledge is derived from diverse opinions (AlDahdouh et al., 2015; Anastopoulou et al., 2012; Goldie, 2016). Select individuals no longer have control over information, but collaboration of ideas is the new reality. The requirement is now to discover the connections between sources of information and to sustain those connections so that learning can continue to take place (Duke et al., 2013). There is a need to rapidly alter the older views about learning as an individualistic endeavour and create a new way of thinking that views learning as a collaborative effort.

In the context of learning, the constant change in knowledge not only occurs in the students but also outside the student in components such as databases and specialised sources of information (Kizito, 2016). The connections that students have to outside knowledge is more important than their current state of knowledge and opinions (AlDahdouh et al., 2015). The individual is the first port of call for connectivism. An individual's knowledge is compared to a system of networks that feeds into an organisation, which will, in turn, supply knowledge back to the system (Goldie, 2016). Their access to the system sustains the knowledge growth cycle of the individual. The learner remains up to date in their knowledge through the established connections. Any established social network is driven by a common goal, and this helps to maintain a well-organised knowledge flow (Duke et al., 2013). This research explores how WhatsApp Messenger facilitates meaningful connections between university teachers as they learn inquiry-based pedagogy.

3.2.1 Connectivism and WhatsApp Messenger

The connectivist learning theory is supported by the concept of using blogs in learning (Chatti, Amine & Quix, 2015). Blog learning requires digital learning tools that connect students.

WhatsApp Messenger is one such tool that facilitates blog learning. Learning in blogs offers individuals opportunities for online collaboration and communication (Duke et al., 2013). Collective blogs allow for active interaction and continuity in interaction, which is essential for education. WhatsApp Messenger affords individuals the chance to connect to learning communities and hence supports the connectivist learning theory, which posits that individuals learn faster when they are connected to such communities (Boitshwalero, 2011; Garcia, Brown & Elbeltagi, 2013). While it is evident that WhatsApp supports the connectivist learning theory by connecting individuals, it is still important to consider the extent to which students accept blog use in learning and how compatible the blogs are with their learning needs. Figure 7 shows the relationship between teachers, the facilitator, and external expert within a blogging environment.

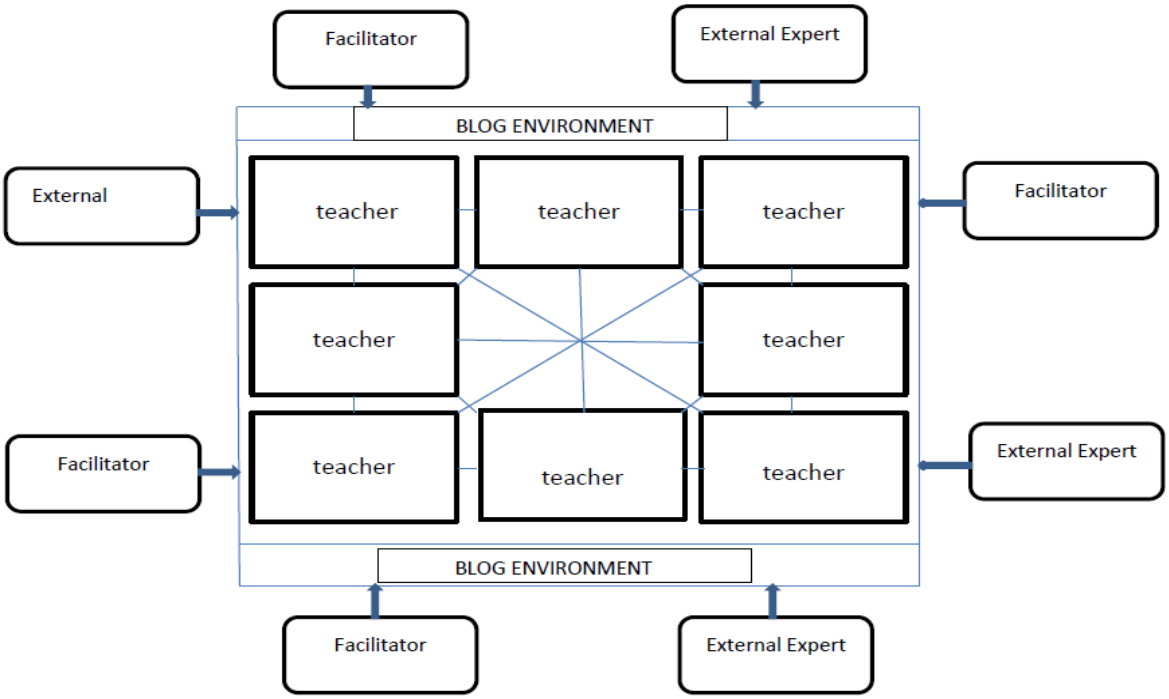

Figure 7. A presentation of the Connectivist educational blog **(**Adapted from Garcia, et al, 2013).

In this model, the students are connected to each other within a corporate blogging environment. This corporate environment allows them to view and comment on each other's posts, which allows the unlimited exchange of ideas among the students. The teachers and external experts are depicted as observers outside the blogging environment. However, the blogging environment allows them full access to participate as facilitators or moderators

(Garcia, Elbetagi & Brown, 2013). It should be noted that while the participants in the blog seem to have fixed roles, these roles can change over time. The number of participants is also not fixed and can increase or decrease as new member join or exit the blogging environment.

The growth in Internet-based connections has enabled individuals and communities to share information on a wide range of topics. This increase in social networks has led to many educators embracing this new way of knowledge creation and sharing in their teaching. Knowledge is no longer categorised and hierarchical but has shifted to networks and ecologies (AlDahdouh et al., 2015). Knowledge is now meant to explain human existence as well as warrant some action (Duke et al., 2013). The view of knowledge as a network concept has changed how people experience it, in other words, concepts now appear as mind maps or networks, and not the traditional linear progression of ideas (Duke et al., 2013; Wang et al., 2018). These rapid changes in the way knowledge is viewed have put educational institutions under pressure to change their pedagogical approaches to ones that embrace technology.

Siemens (2005) proposed the following principles about connectivism:

- Learning and knowledge are found in a diversity of opinions;
- Learning involves connecting information sources or nodes;
- Non-human appliances may be sources of learning;
- The capacity to gain more knowledge is more important than the current knowledge;
- Continual learning is facilitated by maintaining connections;
- It is important to identify connections between ideas concepts and fields;
- Connectivist learning is concerned about current knowledge; and
- Reality changes and it is, therefore, important to make the right decision about new information.

The connectivism theory places emphasis on the networks and the connections between the nodes. In this study, the individual university teachers represented the nodes, which are the information sources. The researcher tracked the flow of information between the nodes as well the formation or breakup of the connections between and among the nodes. Tracking allowed the researcher to gain an understanding of how WhatsApp Messenger was a tool to facilitate or impede the connections. The researcher also sought to understand the change that occurred in the nodes as a result of the interactions.

3.3 TRANSFORMATIVE LEARNING THEORY

Transformative learning is a term initially coined by Mezirow (2006). It refers to the changes that take place in individuals' meaning perspectives, mind habits, and reference frames. It has its roots in the women's liberation movements of the 1970s and was first used to describe the development of consciousness as a result of the oppressive nature of society towards women. The transformative learning concept recognises learning as a process that occurs at the cognitive, emotional, and social levels. It also places importance on the situatedness of learning (Fleming, 2018; Hoggan, 2016). In the context of this study, transformative learning represents the change in meaning perspectives of university teachers as they undergo professional development.

The assumption is that transformation occurs if the teachers find learning IBP to be meaningful and if the WhatsApp Messenger platform is conducive for learning. Transformative learning is considered to be an important academic issue in teaching and learning. It offers an explanation of the transformation in meaning structures, which occurs in learning in two domains, these being, *instrumental* learning and *communicative* learning (Illeris, 2014). Instrumental learning is concerned with learning that occurs through task-oriented problem solving and determining cause-effect relationships. Communicative learning, on the other hand, focuses on understanding what other people communicate in terms of values, perceptions, feelings, ideals, norms, and related concepts (Ochoa, Cabrera, Quinozez, Castillo & Gonzalez, 2016).

Transformative learning explains how the meaning that we attach to our experiences changes as we encounter unique contexts. In this research, transformative learning is explained in terms of changes that occurs in professional identity of the teachers as they learn about IBP through WhatsApp Messenger. By both observing the participation behaviours in the learning processes and interviewing the participants, the researcher endeavoured to understand the changes in meaning structures of the teachers as they undertook the course.

An individual's meaning perspective is usually acquired sub-consciously as a result of socialisation. These meaning perspectives become embedded in an individual's psyche and become more permanent as a result of constant interaction with peers, mentors, and the environment (Khabanyane et al., 2014; Sharpe, 2016). The meaning perspectives provide meaning to an individual about his or her world. They constrain an individual's view of the world and act as a reference point with which an individual will try to interpret any new experiences. The new experience in this study would be the WhatsApp Messenger-based IBP

course. As the teachers discussed on the WhatsApp Messenger platform, it was the researcher's interest to determine how these discussions would change the way the teachers view themselves within the teaching profession.

When a new experience is compatible with this reference point, it can be assimilated into the meaning structures and helps to expand the meaning perspectives. However, if the experience is radically different from the meaning perspectives, it can either be rejected completely, or can lead to a transformation of the meaning perspectives to accommodate the new experiences. This new meaning perspective results in the formation of new meaning structures and a shift in world view. According to Mezirow (2006), the perspectives of the transformation process occurs in ten phases:

- A dilemma of disorientation;
- Self-examination accompanied by guilt and shame;
- Critical evaluation of assumptions;
- Recognising that one's disorientation has also been experienced by others and that others have also undergone the same change;
- Searching for new roles, relationships, and activities;
- Deciding on what action to take;
- Acquiring new skills and knowledge to deal with a new plan of action;
- Embarking on a trial run of new roles;
- Consolidating self-confidence and competence in new roles; and
- Re-orienting one's life in accordance with new meaning perspective.

Three common themes are central to the transformative learning theory. These are experience, critical reflection, and rational discourse (Khabanyane et al., 2014). An individual's experience is the starting point in the transformative process. Experience is a socially constructed phenomenon. Individuals can deconstruct and act upon their experiences. Learning experiences provide a common platform for individuals to reflect and discuss. The meanings that they attach to these experiences can be reflected upon.

The teacher may interfere with the discussions to disrupt their world view and engage students in critical thinking. By disrupting the world view of students, the instructor creates uncertainty and ambiguity in their previously held beliefs and doubts about their previous interpretations of their experiences. This disruption helps students accommodate new interpretations of reality.

In the context of this research, the experience of the teachers as they learnt IBP through WhatsApp Messenger disrupted the way they thought about themselves as teachers and their approach to teaching chemistry. A successful learning process would mean that the teachers would be expected to view chemistry teaching as an inquiry-based process and change their traditional view about chemistry teaching.

Critical reflection is the distinguishing feature of adult learning. It is only in adulthood that individuals realise the existence of half-truths that they could have assimilated as conventional wisdom (Alem, 2019). Critical reflection is being able to question the validity of assumptions and beliefs informed by previous assumptions (Khabanyane, et al, 2014). Critical reflection often results from the conflict that erupts between an individual's thoughts, feelings, and actions. As the teachers learnt IBP through WhatsApp Messenger, they underwent an internal reflection and began to question their own initial beliefs about teaching the subject. If they found the learning process to be useful, they would begin to try the new teaching methodology (namely, IBP). If they found the methodology to be effective, they would try it out and eventually they would adopt it as a new teaching approach. This transformative learning process would lead to a change in professional identity.

Rational discourse represents the medium that facilitates the process of transformation. Unlike everyday discussions, rational discourse occurs when we allocate reasons to the meaning, appropriateness, and truthfulness or authenticity of an assertion or when the credibility of the individual making an assertion is doubtful. In transformative learning, discourse is based on the following assumptions:

- Something is rational only if it can create conditions that facilitate understanding with another;
- Objectivity drives rationality;
- Every action or statement is subject to questioning and discussion;
- It is by weighing evidence and supporting arguments that an understanding can be reached; and
- The most important aim is to reach an understanding among individuals.

It is within the rational discourse that critical reflection and experience play out. An individual's experience is reflected upon, and previous assumptions are challenged, leading to the transformation of meaning schemes and perspectives. The transformation of perspectives

provides a mirror into adult learning by focusing on the changes that occur in an individual's paradigm. It explains how adults develop and increase their capacity to adapt to new realities (Illeris, 2014). Adult development leads to a more inclusive and accommodative individual who is capable of reflecting on experience and integrate it into a new meaning perspective. The transformation of meaning perspectives is generally a consequence of the transformative learning process.

Transformative learning views adult learning as the interaction that occurs between new experiences and the current frames of reference, the mind's habits, and viewpoints (Mezirow, 2006). Any inconsistency between these aspects can lead to a disorienting dilemma – a discomfort of being unable to belong (Prestridge & de Aldama, 2016). Exploring a disorienting dilemma can become the basis of transformative learning. This exploration involves analysing reference frames, mind habits, assumptions, and viewpoints. However, frames of reference are problematic to analyse as they assimilate uncritically and their corresponding meaning schema may develop outside of conscious awareness (Dirkx, 2012) and may, therefore, be not rational all the time (Mezirow, 2006). As such, an additional theoretical lens, the dual systems theory, was used to conceptualise the interactions between the conscious and unconscious reasoning of teachers during transformation.

3.4 DUAL SYSTEMS THEORY

The dual systems theory posits that cognition is an interaction between the unconscious (implicit and automatic) and conscious (explicit and controlled) processes (Kahneman, 2011). The conscious processes, attitudes, and actions may be easily transformed by education and persuasion, whereas the unconscious processes and attitudes usually take longer to transform. In this case, the dual systems theory is presented as a cognitive psychology framework for the unconscious and conscious aspects of teaching practice (Hattie & Yates, 2014) and the effect of integrating digital technology on teacher practice (Blundell, 2017), especially on their beliefs, attitudes, and routines. The unconscious processes are described as System 1, and the conscious processes are described as System 2 (Kahneman, 2011) (see Figure 8).

The dual systems theory allows us to conceptualise how the transformative integration of digital communication technology in the professional development of teachers can lead to a change in their professional identities as well as challenge their established teaching practices. The new experiences of an online professional development community leads to the development System 1-based actions and heuristics, which can become the new default

processes (routines) and reduces the need to activate System 2 processes that require more effort. Environmental cues, ideas from other participants, and individual perceptions can trigger routines that can be enacted efficiently and unconsciously with little input from System 2. When individuals can execute these new habits as a routine without referring to System 2 processes, then it can be concluded that transformative learning has occurred. In this case, the dual systems theory assisted in conceptualising changes that occurred in teacher routines as a result of their participation in the WhatsApp Messenger-based IBP course.

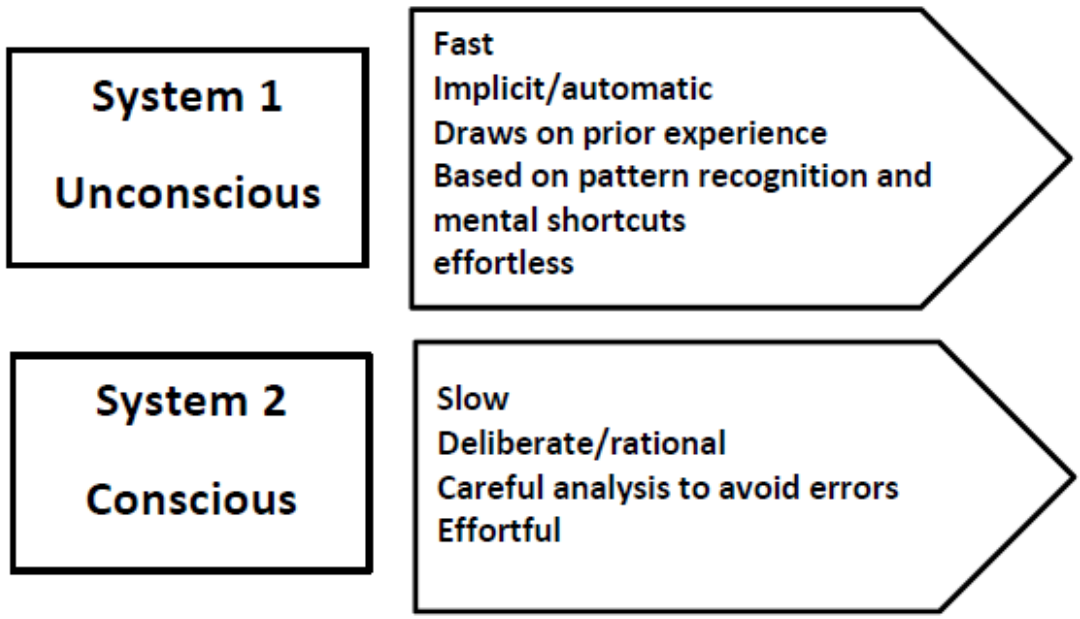

Figure 8. A depiction of the dual systems theory process (Adapted from. Kahneman, 2012).

3.5 EXPECTANCY-VALUE THEORY

The expectancy-value theory of Eccles et al. (1983) was also used in this study. It postulates that a task has four main values – attainment value, intrinsic value, utility value, and cost (Ibrahim et al., 2017). Attainment value refers to the importance an individual gives to an activity if they views the activity to be consistent with their existing self-image. Individuals consider tasks to be important if they relate to their identity or if they enable them to express those aspects about their self that they consider to be important (Ibrahim et al., 2017). Intrinsic value refers to the enjoyment that one derives from participating in a task. Utility value refers to how an individual views the usefulness of a task for their future plans. Cost refers to what an individual has to give up in order to perform a task (Wigfield et al., 2009). The self-

perception that individuals have about their ability and the task value that they have, influences their activities and achievement-related behaviours. This study, therefore, started by analysing the self-beliefs and efficacy of the university teachers, how they participated in the IBL course, and how this changed their professional identities.

3.6 FRAMEWORK FOR PROFESSIONAL IDENTITY CHANGE OF UNIVERSITY TEACHERS

Bearing in mind the tenets of the connectivism theory, transformative learning theory, and the expectancy-value theory, it can be assumed that professional identity development of university teachers must go through three stages, namely pre-socialisation, formal socialisation, and outcome. This is depicted in figure 9.

Within these stages are a series of elements. Pre-socialisation consists of prior socialisation and anticipatory socialisation. The formal socialisation phase consists of content and structure, and the practice (outcome) after socialisation consists of practice setting and situational adaptation (Crisogen, 2015, Cruess et al., 2015).

The pre-socialisation stage refers to the time before and when an individual is admitted into a formal social group (Dimitriadou, Lavdaniti & Pizirtzidou, 2013). Within this stage are elements of prior socialisation and anticipatory socialisation. Prior socialisation refers to the primary or childhood socialisation and how these affect an individual's worldview. Anticipatory socialisation describes how an individual chooses to align with a particular reference group and adopts that group's values and attitudes (Frones, 2016, van Kleef, 2016).

As shown in Figure 9, these two elements are not independent of each other. The experiences of primary socialisation have an impact on the choice of the anticipatory socialisation of the individual. In the context of this study, pre-socialisation refers to the period before the university teachers underwent training in inquiry pedagogy. Their views about themselves were influenced by how they were previously socialised as teachers as well as how they interacted with other university teachers.

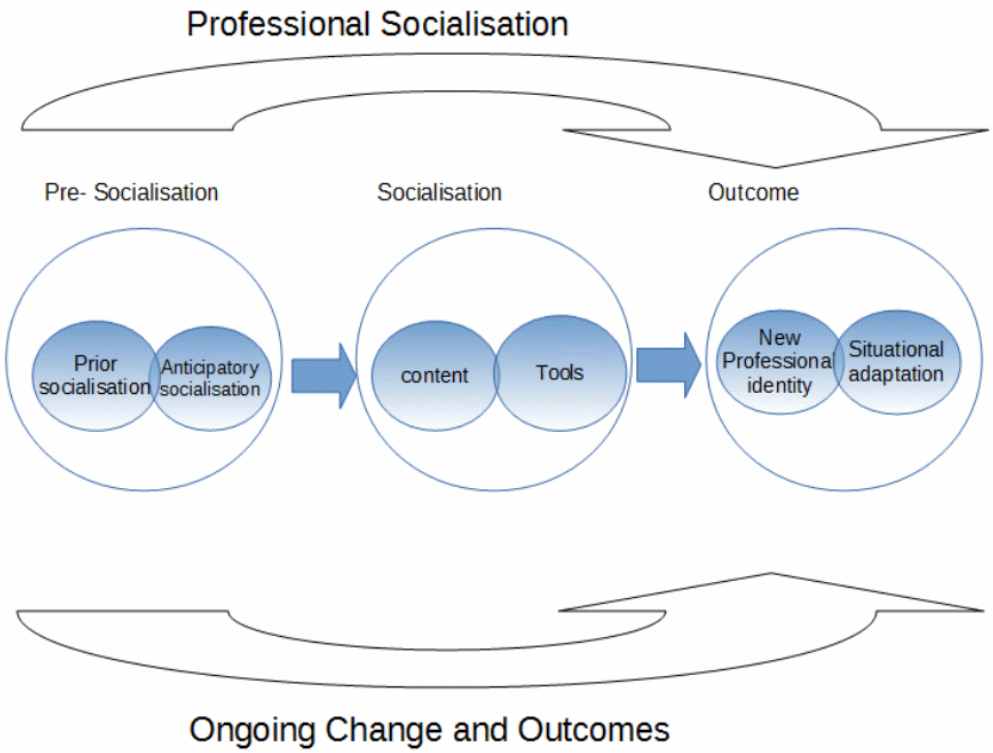

Figure 9: A schematic presentation of the conceptual framework for professional identity development of university teachers (Adapted from Miller, 2010)

The formal socialisation stage is the stage during which an individual is engaged in activities that have defined parameters or boundaries (Cruess et al., 2015). The elements of content and structure are important at this stage (Dimitriadou et al., 2013). Content refers to the technical skills, knowledge, as well as the values, attitudes, and norms that are acquired ring the programme. The structure refers to the contextual influence of a particular programme. It includes the recruitment criteria of instructors, facilitators, participants, as well as the curriculum design, and interpersonal relationships (Miller, 2010). In this study, the socialisation stage was the period during which the teachers were interacting through WhatsApp Messenger as they learnt about inquiry-based pedagogy. The relationship between formal socialisation and professional identity development is bi-directional. The way an individual engages in a social learning process has a bearing on his professional self-identity.

The outcome stage is the stage that comes after the social learning process and it continues until retirement. This stage has elements of practice settings, and situational adaptation. How an individual has been socialised affects how he or she relates to the setting in which he

practises as a professional (Miller, 2010). Additionally, how an individual adapts to a situation is determined by how they were professionally socialised. Certain aspects of professional socialisation can change to meet the demands of the new situation. Thus, the relationship between socialisation and practice after socialisation is also bi-directional. The practice after socialisation in this study refers to the pedagogical practices as well as the new professional identities of the teachers after learning IBP using the WhatsApp Messenger platform.

3.7 IMPLICATIONS OF THE THEORETICAL UNDERPINNINGS

The four theories acted as lenses through which this study was conducted. The connectivism theory emphasises the knowledge creation processes that occur when individuals are connected in an online community of practice (CoP). Each individual or group of individuals acts as a node that creates and disseminates knowledge throughout the network of individuals by using the connections that exist between and among individuals. As such, an individual's connections are more important than his or her own state of knowing. Knowledge itself exists within the network, and the more an individual is connected, the more they are likely to acquire new knowledge.

The transformative learning theory, on the other hand, helped to describe the changes that occurred to the meaning perspectives of the participants as a result of their participation in the WhatsApp Messenger-based IBP course. To prove that the knowledge created in the networks was worthwhile; it had to transform the way participants viewed themselves as teachers after participating in the course. Where the connectivism theory helped to cast light about how knowledge is generated in the online CoP, the transformative learning theory helped to explain how this knowledge transformed the professional identities of the teachers.

The dual systems theory was used to compliment the transformative learning theory by describing how the unconscious and conscious cognitive processes interacted in the professional development of the university teachers. It helped to explain the disruption of routines in teaching practices as a result of integrating digital technology in the professional development of the teachers.

The expectancy-value theory was used to explain the value that the teachers attached to the activities that they engaged in as they were learning IBP. Such value was significant in determining whether the teachers developed a positive identity or not. Where individuals do not see value in activities that they are engage in, the outcome will be negative. Tasks that allow individuals to express their abilities and self-efficacies are essential in helping the

individual develop and express their own professional identities. The next chapter focuses on the methodology used in the study.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 INTRODUCTION

The outcome of any research process depends on the robustness of the research methodology. It is the desire of every researcher to deliver results that are valid and reliable. This chapter is a discussion of the research methodology used for this study. The researcher starts by discussing research paradigms and how they guide the conduct of research. Furthermore, the researcher discusses the research design and research methods. The population of the study was also presented. The researcher also discussed various sampling methods used and justified the sampling methods for this particular study. Data collection and analysis procedures are also presented in the chapter. The chapter ends with a presentation of the measures taken to ensure trustworthiness and the ethical considerations observed in this study.

4.2 RESEARCH PARADIGM

Research paradigms refer to the general framework or viewpoints. They define how one looks at life and are grounded in sets of assumptions about the nature of reality (Creswell, 2014). They can be characterized by how someone responds to three basic questions: ontological, epistemological and methodological questions (Creswell, 2014).

Ontological – what is reality?

Epistemological – how do you know something?

Methodological – how do you go about finding it out?

Researchers can ground their studies in any number of paradigms. No paradigm is right or wrong, they can be merely more or less useful in particular situations. Each of them shape the type of theory created for general understanding. According to Phoenix *et. al*. (2013) the major paradigms can be grouped into two major orientations - positivism oriented and interpretivist oriented. Table 2 shows a summary of the description of the major paradigms

Table 2: Description of the major paradigm orientations (Phoenix et al, 2013)

	Positivism-oriented		**Interpretivist-oriented**	
	Positivism	Post-positivism	Interpretivism	Constructivism
Ontology: What is reality?	Naïve realism. Objective reality.	Critical realism. Reality is imperfectly apprehendable.	Subject and object are dependent. The real essence of the object cannot be known. Reality is constructed	
Epistemology: How do you know?	Dualism researcher-research. Replicable findings are "true". Reality can be explained.	Dualism is not possible. Replicated findings are "probably" true. Impossible to fully explain reality	Knowledge is interpreted. Reality can be understood	
Methodologies: How do you find it out?	Experimental, deductive. Mainly quantitative. Relationship cause-effect. Statistical analysis.	Experimental. Mainly quantitative methods, manipulative. Scientific Community plays an important role of validation. Statistical analysis. Probability sampling.	Interpretation. Mainly qualitative methods. Purposive and multipurpose sampling.	Mainly qualitative methods. Purposive and multipurpose sampling. Stakeholders' involvement.

Goodness or quality criteria	Rigorous data produced through scientific method.	Statistical confidence level and objectivity in data produced.	Inter-subjective agreement and reasoning reached through dialogue, shared conversation and construction.

The researcher used the epistemological interpretive paradigm to guide this study. The epistemological interpretive paradigm is concerned with understanding the world through individuals' subjective experiences (Thahn & Thahn, 2015). Researchers who use the interpretive paradigm believe that reality is constructed through individuals' subjective experiences of the external world (Creswell, 2014). In the interpretive tradition, no answer is correct or wrong. As such interpretivists attempt to base their perception of reality from an in-depth examination of a phenomenon. Because interpretive researchers believe that social reality is embedded within social settings and are and difficult to abstract, they interpret the reality though a "sense-making" process (Wright, O'Brien, Nimmon, Law & Mylopoulos, 2016).

Researchers who use the interpretive paradigm rely on participants' views and perceptions about a certain phenomenon (Creswell, 2014). As such, this researcher was interested in the chemistry teachers' views and perceptions about their professional identities before, during and after participating in the WhatsApp Messenger-base IBP course. These views and perceptions could only be understood through direct interaction with the teachers before they undertook the course, during the course and after the course.

4.3 RESEARCH DESIGN

A research design is referring to the overall strategy utilized to carry out research (Babbie & Mouton, 2012; Creswell, 2014). It defines the exact pathway that a researcher takes as he/she attempts to answer established research questions. It details the procedures taken to collect, interpret, analyse and discuss data. The methodologies and methods used in a research design depended on the researcher's viewpoint in terms of the nature of knowledge and reality (Wright, O'Brien, Nimmon, Law & Mylopoulos, 2016). The research design is usually shaped by the researcher's disciplinary area.

This study assumed a naturalistic, exploratory investigation. A naturalistic exploration is an approach to research that assumes that there are multiple realities (Creswell, 2014). It is an approach to understanding the social world in which the researcher observes, describes, and interprets the experiences and actions of specific people and groups in societal and cultural contexts (Salkind, 2015). In this study the researcher investigated the experiences of university teachers as they learnt IBP through WhatsApp Messenger. Particular focus was on the use of WhatsApp Messenger to facilitate teachers' learning of inquiry-based pedagogy. The general aim of the study was to explore and describe the development of a professional identity of university teachers as they undertook a professional course in IBP through the WhatsApp Messenger platform.

4.3.1 Qualitative research method

Qualitative research relies on data obtained by the researcher from first-hand observation, interviews, questionnaires, focus groups, participant-observation, recordings made in natural settings, documents, and artefacts (Tobi & Hilde, 2018). The data are generally non-numerical. Qualitative methods include ethnography, grounded theory, discourse analysis and interpretative phenomenological analysis. The nature of the study made aspects of these approaches relevant to the study.

4.3.1.1 Ethnography

Ethnography involves the examination of the behaviour of the participants in a given social situation and understanding the group members' own interpretation of such behaviour (Dooly & Moore, 2017). Ethnography relies heavily on participant observation - with the researcher participating in the setting or with the people being studied (Silverman, 2013), at least in some marginal role, and seeking to document, in detail, patterns of social interaction and the perspectives of participants, and to understand these in their local contexts.

4.3.1.2 Grounded theory

Grounded theory involves the construction of hypotheses and theories through the collecting and analysis of data (Taquette & Minayo, 2015). A study conducted using the grounded theory usually starts with a question and as the researcher collects and analyses the data, concepts and ideas become apparent (Creswell, 2014). In other words, ideas and concepts emerge from the data.

4.3.1.3 Discourse analysis

Discourse analysis is an approach used in the analysis of written, vocal, or sign language or any significant semiotic event (Silverman, 2013). The objectives of discourse analysis

(discourse, writing, conversation, communicative event) are variously defined in terms of coherent sequences of sentences, propositions, and speech (Thahn & Thahn, 2015). Unlike many traditional linguistics, discourse analysts do not only study language use 'beyond the sentence boundary' but also prefer to analyse 'naturally occurring' language use, not invented examples.

4.3.1.4 Phenomenology

A phenomenological study describes the meaning of the participants' lived experiences (Creswell, 2014). Its focus is in answering the 'what is it' question rather than questions of frequency or magnitude such as 'how much' and 'how many (Silverman, 2013). The task is to investigate and describe all phenomena including human experiences in the way these appear.

4.3.1.5 Case study

A case study is a qualitative research approach that involves an in-depth examination of a particular subject and its related contextual conditions (Cresswell, 2014). Using case study designs is a way for a researcher to easily follow a particular event, action, or phenomenon and examine these from all possible angles. Case studies allow researchers to listen to different explanations from participants while also observing the real context of the phenomenon (Simataa, 2015). The method enables the researcher to contextualise participants' viewpoints in relation to the observed reality. A researcher's personal reflections are also included as a data source and are taken into consideration during data interpretation; unlike the quantitative research which excludes a researcher's interpretations (Silverman, 2013). According to Creswell (2014), a case study design affords a rich, descriptive, and flexible inquiry into the meanings that have been constructed by the participants.

The primary aim of this study was to understand the individual meanings and experiences of participating teachers. It was, therefore, crucial that the researcher was able to get as close as possible to the participants. The researcher joined the WhatsApp Messenger group created for the university teachers. Membership enabled the researcher to engage the teachers and gain insight into the meanings that they ascribed to their experiences. Distancing oneself from participants is not useful in any study about human behaviour since meaning is influenced by prior knowledge, experiences, and beliefs (Taquette & Minayo, 2015). When a researcher applies a case study, they must collect data, reflect on it, and analyse it throughout the research process. This process allows the researcher to modify meanings and theories as new realities may unfold during the study. Interviews and observations are two examples of research

instruments used to employ a case study method (Leedy & Ormrod, 2005). In light thereof, the researcher used semi-structured interviews, focus group discussions and participant observations to collect data.

An important point of clarity is that, even though participants were from three different universities, the entire WhatsApp Messenger group was treated as a single case since all participants were part of a single online CoP. Even though individual responses were relevant, this research centred around how WhatsApp Messenger facilitated the interactions between the teachers as a ring-fenced group. The collective development of the group was, therefore, more important to the study than their individual transformations; although individual contexts could affect individual transformation. In choosing to study this collective development, the researcher was guided by the connectivism theory (explained in detail in Chapter 2), which provides the study's overarching theoretical framework. The theory emphasises that networks of individuals are crucial in the learning process (Siemens, 2005). As such, the network of teachers in this research was considered as a single case. Teachers were chosen from three universities to minimise the influence of pre-existing relationships, which may have been the case if teachers were all from the same university.

4.3.2 Justification of the use of qualitative research

The qualitative research method was used for this study as the researcher aimed to explore abstract concepts and the meaning of social phenomena constructed by actors in their real-life contexts (Creswell, 2014). Qualitative research is suitable when the intent is to construct knowledge through interpretive, naturalistic approaches (Dooly & Moore, 2017). This means that the researcher set out to understand a social phenomenon by observing humans participating in a real-life situation. As the participants interacted on the WhatsApp Messenger platform, they were exploring new social and professional relationships (Taquette & Minayo, 2015) and the researcher used the opportunity to study a social phenomenon that was unfolding in the online CoP. By observing university teachers interacting through WhatsApp Messenger, the researcher was able to interpret and make sense of the IBP learning process and the transformation and formation of professional identities. The existing body of literature on the development of professional identity also mostly uses qualitative research because of the complexity of the topic (McElhinney, 2008).

The qualitative approach enabled the researcher to understand the complexity of individual experiences. It further helped the researcher uncover subjective meanings that were grounded

in data. These meanings helped reflect the diversity of the issues under study (Creswell, 2014). The researcher embraced the variances in the participants' experiences and pursued the exceptional cases as a means to elaborate theory and deepen understanding of the issues under investigation.

4.3.3 Population

A research population is generally a large collection of individuals or objects that are the main focus of a scientific query (Guba & Lincoln, 1994; Seaman, 2013). Whilst research is done to make conclusions about the population, it is often impossible to carry out research on the whole population. This is the reason, researchers usually carry out research on a sample of the population. A research population is usually composed of individuals with defined, similar characteristics (Creswell, 2014). A research population can be categorised into two types – target population (the entire group of interest to the researcher) and the accessible population (the group to which the researcher can apply their investigations) (Asiamah, Mensah & Oteng-Abayie, 2017). It is from the accessible population that a researcher can draw his or her sample. For this study the target population was the entire group of university chemistry teachers in Zimbabwe whose number could not be determined due to the inability to access some research sites. The accessible population for this study was 194 university teachers who taught chemistry at the three universities that were studied.

4.3.4 Sampling

Sampling is a process of selecting a unit or units from the study so that a researcher can study them. In qualitative research, researchers typically make sampling choices that enable them to deepen understanding of whatever phenomenon it is that they are studying. Sampling can be classified into two categories – probability sampling and non-probability sampling.

4.3.4.1 Probability sampling

Probability sampling is a technique where a sample is obtained using a method based on the theory of probability. The basic principle in probability is that every individual has a known and equal chance of being selected (Seaman, 2013). The probability sampling methods include simple random sampling, stratified random sampling, random cluster sampling and systematic sampling

Simple random sampling – as the name suggests, this is a completely random method of selecting a sample. For example, numbers can be assigned to individuals and then picked randomly, using an electronic system.

Stratified random sampling – in this method the researcher divides a large population into smaller groups in such a way that their characteristics do not overlap (Dooly & Moore, 2017). For example, groups can be divided in terms of sex, age or ethnicity. Selection will then be done from each group. This ensures that each group is represented in the sample.

Random cluster sampling – this is a method of randomly selecting a sample from participants that are spread out geographically (Creswell, 2014). For example, if the research intends to select a sample from the whole country he or she can randomly select the areas (such as cities or villages) and randomly select paricipants from those areas.

Systematic sampling – this is done when the 'nth' individual is selected (Seaman, 2013). For example the researcher can decide to choose the 10^{th} person. In this type of sampling wach individual has an equal chance of being selecte

4.3.4.2 Nonprobability sampling

Nonprobability sampling techniques are those where the probability of a person being selected is unknown. Usually non-probability sampling is used in qualitative research projects, where the researcher's goal is in-depth, idiographic understanding rather than more general, nomothetic understanding (Creswell, 2014). There are several methods used in non-probability sampling. These include purposive sampling, snowball sampling, quota sampling and convenience sampling.

Purposive sampling – this is a sampling method where the researcher targets only those individuals that he thinks can provide him with necessary data (Guba & Lincoln, 1994). In other words, purposive sampling is used to select individuals who meet a certain predetermined criteria.

Snowball sampling – this is a sampling technique used when the researcher knows one or two potential participants and approaches them to recruit other participants (Seaman, 2013). Snowball sampling is usually used when a researcher wants to study a group whose characteristics or behaviours have some sort of stigma.

Quota sampling – this technique is applied in both qualitative and quantitative research (Dooly & Moore, 2017). When using this technique, the researcher selects certain characteristics that are relevant to the study and for which some variations exist. The researcher then creates sub-groups based on these characteristics and selects individuals from these sub-groups (Creswell, 2014).

Convenience sampling – this is a strategy in which the researcher targets only those individuals whom he or she has easy access and whom he or she believes can supply him with

the necessary information (Seaman, 2013). This method has the advantage of convenience to the researcher but it is difficult to generalise findings to larger populations.

Purposive sampling was used on this study. Purposive sampling allows a researcher to choose information-rich participants who will enable the researcher to gain a deep understanding of the issues being investigated (Patton, 2002). Purposive sampling enriches the data collected and enables the researcher to uncover multiple realities (Guba & Lincoln, 1994) because only participants who are believed to have the required data, are targeted for the study. In the context of the current study, the assumption was that the teachers who had no prior training in pedagogy had certain views and attitudes that defined their professional identity. Prior training in pedagogy influences the professional identity of a teacher (Komba et al., 2013). It was necessary for the researcher to collect these views before enrolling participants in a pedagogy course and to determine how these views would change after the course. It was with this in mind that participants were purposefully sampled.

Nine teachers from three universities took part in the study. Three teachers were selected from each university. This was done to ensure that the biases that could arise from having teachers from one university was minimised. Nine teachers were considered enough as the study used a case study approach. The researcher was aiming to get a deeper understanding of the case. All of them were university teachers without any prior pedagogy training and all knew how to use the WhatsApp Messenger platform. After purposive sampling of the first participant, the researcher used snowballing to identify the next participant. This snowballing involved requesting that participant to recruit another participant who met the necessary criteria. All nine teachers undertook a participatory course in inquiry-based chemistry pedagogy. This course was conducted using WhatsApp Messenger and ran for eight weeks. The teachers interacted and shared their experiences on the WhatsApp Messenger platform.

4.3.5 Data collection strategies and techniques

Data for the current study was collected through semi-structured interviews, observations, and focus group discussions.

4.3.5.1 Interviews

Interviews are discussions in research used to solicit information from participant (Alshenqeeti, 2014). Interviews are commonly used in survey designs and in exploratory and descriptive studies (Seaman, 2013). There are three types of interviews – unstructured, structured and semi-structured interviews.

Unstructured interviews – in conducting unstructured interviews the researcher does not have any specific guideline, restrictions, or pre-determine questions. The interviewer asks the interviewee a few broad questions to open up debate before probing with further questions to elicit clarifications (Easwaramoorthy & Zarinpoush, 2016). Interviews are useful when there is not much information about the topic

Structured interviews - In conducting a structured interview, the interviewer asks a set of standard, predetermined questions about a particular or topics, in a specific order (Alshenqeeti, 2014). The interviewee will be expected to select their answers from a list of pre-determined responses.

Semi-structured interviews – in semi structured interviews, the researcher asks a set of pre-determined questions, with the respondents expected to answer in their own way (Creswell, 2014). An interview guide is used as a check-list to ensure that the respondents give information related to the topic. Semi-structured interviews are used when the interviewer already has an overview of the topic (Creswell, 2014). Semi-structured interviews allow for in-depth probing by the researcher, while simultaneously allowing the researcher to maintain the interview within the parameters set out in the study aims (Alshenqeeti, 2014).

In this study, the researcher used semi-structured interviews. This is because the researcher already had some overview of the topic. Open-ended questions were prepared before the interviews (see Appendices 7, 8, and 9). The semi-structured interviews used objective questions to maintain data credibility. The open-ended questions allowed the researcher to be flexible and gather in-depth data because interviewees where given a chance to explain and elaborate on particular issues.

The flexible nature of semi-structured interviews enables the researcher to get more information by prompting or encouraging the interviewee to clarify issues (Seaman, 2013). This allowed the researcher to elicit hidden meanings from the participants' answers. The interviews were planned to take an average of one hour for each participant. Barclay (2018) conferred some recommendations for carrying out semi-structured interviews (see Table 3).

Table 3. Hints on conducting semi-structured interviews

Before the interview	The interviewer should familiarise themselves with the interview guide. They should prepare verbal and written information about the study and the required interview consent. For this study, the researcher prepared an interview guide, which was given to a colleague for comments and suggestions. Consent was sought from the teachers. Interview appointments were made with the teachers.
Setting	The interviewer should consider the interview settings and make it as comfortable and quiet as possible. They should establish rapport with the interviewee. In this study, five teachers were interviewed in their offices after they expressed their preference to conduct their interviews in that setting. Three of the interviews were conducted in this researcher's office. One of the participants preferred to be interviewed outdoors while basking in the sun.
Collecting data	The interviewer should consider the best way to capture the interviewees' responses during the interview. Either the interviewer uses recording equipment, or someone should take notes for them. In this study, this researcher recorded six of the interviews using a Samsung J2 tablet. The other three teachers were not comfortable being audio recorded, so the researcher engaged a colleague, who was a seasoned researcher to take written notes of the proceedings.
The interviewer's role	The interviewer should start the interview by giving a brief explanation of the study and seek consent from the interviewee. They should also: introduce the topic; keep to the agreed schedule; take note of non-verbal cues and body language; prompt the interviewee; and capture key points.

	The researcher used these recommendations to make sure that as much information was gathered from the teachers as possible.
After the interview	The interviewer should consider debriefing the interviewee. In the context of this study, the researcher explained to the teachers that the information that they had provided was very useful for the study, that it would be analysed, and that the thesis would be availed to them on completion.

The reason for carrying out the semi-structured interviews was to uncover the university teachers' self-efficacies (TSE) before they undertook the IBP course through WhatsApp. The researcher prepared the interview schedules using the guidelines on the core professional identity indicators identified by Noi et al. (2016). These core indicators are teaching beliefs, professional competence, professional socialisation, and career progression. The interviews helped answer research Sub-question 1: How do university chemistry teachers perceive their professional identities? A second wave of interviews using the same indicators, was conducted after the teachers had participated in the WhatsApp-based IBP. These interviews were to determine the changes that could have occurred to the professional identity perceived by teachers. These interviews lasted on average 90 minutes. The semi-structured interviews further assisted in addressing research Sub-question 3: How does the professional identity of university chemistry teachers change as they interact through WhatsApp?

Interviews were also used to establish participants' baseline knowledge in pedagogy, as well as their views, attitude, and beliefs about IBP before, during, and after they participated in the course. The course was conducted over an eight-week period. The researcher recorded the responses to all the interviews for the purpose of identifying common themes that were emerging from the data.

4.3.5.2 Observations

Observation is a qualitative research technique in which the researcher observes participants engaging in certain activities in their natural settings (Mackellar, 2013). In fact, observation is regarded as the basis of everyday social life for most people. People always watch, evaluate and draw conclusions made on human interactions. In qualitative research there are three types of observation that can be used to collect data – participant observation, non-participant observation and indirect observation (Creswell, 2014).

Participant observation – this type of technique involves the researcher directly taking part in the activities of the group that he is researching on (Creswell, 2014). Participant observation has its roots in traditional ethnographic studies, where the researcher's objective is to learn about the perspectives of the populations under study (Silverman, 2013). This type of observation enables the researcher to collect data about the group's social practices – what they do and how they do it – in their natural context.

Non-participant observation – this is a research technique where the researcher tries to understand the interactions that take place among group of people without getting involved in their activities (Alshenqeeti, 2014). By standing away from the group of participants the researcher prevents his own biases to influence the interactions. This technique may seem not to give a researcher a full understanding of the interactions, but the researcher can adjust his or her role depending on the needs of specific cases. It has strong advantages if on is observing issues such as rallies, religious gatherings.

Indirect observation – in its broad sense, indirect observation is a technique that gives a researcher a chance to get information about situations that he or she has no direct access to (Silverman, 2013). The researcher can use rich sources of information such as video recording of past events, looking at archaeological remains of human behaviour or written materials.

In this study the researcher used participant Information generated from participant observation helped answer research Sub-question 2: What are the experiences of university chemistry teachers as they use WhatsApp Messenger to interact in the process of learning about inquiry-based pedagogy? To maintain the credibility of the participant observation, the researcher acted as a facilitator, initiating discussions, and gave the teachers tasks to research on. These gave the teachers opportunities to interact by asking each other questions, critiquing each other, and commenting on each other's suggestions. The researcher needed always to avoid having the final say in the discussions. While embedded in the WhatsApp Messenger group, the researcher had to make careful, objective notes of the discussions, capturing all accounts and observations.

According to Mackellar (2013), the informal conversations and interaction that occur among the members of the community under study, also act as vital elements of participant observation. As such, the researcher made notes on these observations and interactions in as much detail as possible as they constituted an important component of the data. This enabled the researcher to better understand the relationships, behaviours, experiences, and conversations that occurred in the group. As a qualitative researcher, the researcher presumed

that there would be multiple perspectives within the online CoP of university teachers. The researcher was interested in knowing what multiple perspectives were and understanding the interplay between them.

It is important to highlight the complexity of observing in an online community as it can be argued that there is nothing to observe. It is different from face to face observations where the researcher might be able deduce meaning from such phenomena as body language and tone of voice. In the context of this study, participant observation entailed interpretation of participant communication styles in their written texts in the WhatsApp Messenger group. Of particular concern to the researcher was the issue of human agency in the construction of professional identity. The researcher interpreted human agency in terms of promptness of response, frequency of participation, the content of the responses, and resourcefulness of individual participants. The observation was performed by following and making inferences on the discussions and interactions that took place on the WhatsApp Messenger platform. These observations were used to uncover any themes that emerged during the process.

Participant observation enabled the researcher to appreciate those aspects of WhatsApp Messenger that facilitated or hindered the learning of IBP and professional identity development. Observation is the most appropriate method to collect data when the research is more interested in the behaviour of the participants than in their opinions. (Silverman, 2013).

4.3.5.3 Focus group discussions

A focus group discussion (FDG) is when a researcher interviews a group of people with similar backgrounds in a discussion setting (Nyumba, Wilson, Derrick & Mukherjee, 2017). The FDG technique assumes that the group processes in play during the group discussion, help clarify shared knowledge within the group. This type of clarity is challenging to obtain when interviewing an individual (Silverman, 2013; Moore, McKee & McLoughlin, 2015). In this study, the researcher conducted a focus group with six of the teachers after they undertook the WhatsApp Messenger-based IBP course. The purpose of the FGD was to gather additional information that could have missed from the interviews and participant observation. The researcher wanted to include all the participants, but the remaining three could not attend the FDG due to work commitments. The discussion was 90 minutes. The discussions were recorded using a J2 Samsung smartphone.

The researcher assumed the role of a moderator as the participants discussed their experiences about learning IBP through WhatsApp Messenger. The researcher used the FGD to study

attitudes, opinions, and perceptions about the effectiveness of WhatsApp Messenger in the acquisition of IBP. Open discussions were held between the group of participants and the researcher. This open discussion allowed the researcher to obtain more information about how the WhatsApp Messenger-based IBP course was able to transform the professional identities of the participants. The open format allowed participants to describe the strengths and weaknesses of the WhatsApp Messenger platform as a tool for professional development.

Kumar (2012) stated that the advantage of focus group discussions is that the researcher can facilitate a high level of interactions between the participants in a short period. By asking questions that stimulated debate, the researcher was able to get the participants to reveal more information about how they viewed themselves as teachers before and after the WhatsApp Messenger-based IBP course. The group members also corrected and complement each other during the discussions.

4.3.5.4 Activities used to collect data

The following section describes the actual activities used to collect data for this study. For the purpose of clarity, the research objectives were linked to the research question. This made it easier for the researcher to justify the actual methods that were used to collect data. Data were collected primarily through semi-structured interviews, participant observations, and focus group discussions. Table 4 shows the activities used to collect data.

Table 4. Activities to collect data

Research sub-question	**Objective**	**Data collection activity**	**Time of activity**
How do university chemistry teachers perceive their professional identities?	Establish the initial professional identities of university chemistry teachers without formal training in pedagogy; before engaging in the study.	Semi-structured interviews	Before IBP course

What are the experiences of university chemistry teachers as they use WhatsApp Messenger to interact in the process of learning about inquiry-based pedagogy?	Establish the experiences of university chemistry teachers as they use WhatsApp Messenger to interact in learning IBP.	Participant observations Semi-structured interviews	During the IBP course
How does the professional identity of university chemistry teachers change as they interact through WhatsApp?	Identify any changes in the professional identity indicators of university chemistry teachers after learning pedagogy through WhatsApp messenger.	Observations Interviews Focus group discussions	During the course
How do the pedagogical practices of university teachers change because of learning inquiry-based pedagogy through WhatsApp Messenger?	Identify any changes in pedagogical practices of university chemistry teachers after learning IBP through WhatsApp messenger.	Interviews	After the course

4.3.6 Phases of data collection

Data were collected in five phases.

4.3.6.1 Phase 1: Determining the initial professional identity of university teachers

The first research sub-question required an understanding of the professional identity of the teachers before they completed the course in IBP. Therefore, pre-course interviews were conducted with the teachers to record their views and perceptions about themselves as teachers. These interview questions (see Appendix 7) focused on the core indicators of professional identity, which were identified by Noi et al. (2016). These core indicators are teaching beliefs, professional competence, professional socialisation, and career progression. It was necessary to determine the initial professional identity of each participant in order to compare with their

professional identities after the course. This comparison would help the researcher determine the effects of the WhatsApp Messenger-based IBP course on professional identity development.

4.3.6.2 Phase 2: Intervention

The intervention phase was further divided into five steps.

Step 1: Setting up an online community of practice - The second phase of data gathering was the intervention phase. The university teachers were drafted into a central WhatsApp Messenger group where they interacted and discussed IBP. In setting up the online CoP, the researcher was guided by the connectivism theory, which recognises knowledge creation as a shared responsibility. The knowledge emanates from the experiences and interactions that take place within the network (Garcia & Fereirra, 2014). The network is made up of connected nodes, where the nodes can be individuals, a group of individuals, fields, or systems (AlDahdouh et al., 2015). Knowledge flows through a network of humans and non-human artefacts. For this research, the initial nodes were the individual teachers, as shown in Figure 10.

The network was set up in such a way that there were no hierarchies within the group and teachers participated on an equal basis. The researcher did not impose any participation rules but informed the participants to keep their contributions focused on discussions about IBP. The participants were also informed that the role of the researcher was to facilitate discussions about the topic and not to provide answers to the discussion. The researcher facilitated discussions by giving the teachers areas to research. After their research, the teachers were asked to report their findings on the WhatsApp Messenger platform. The researcher would then ask them to comment and discuss their findings.

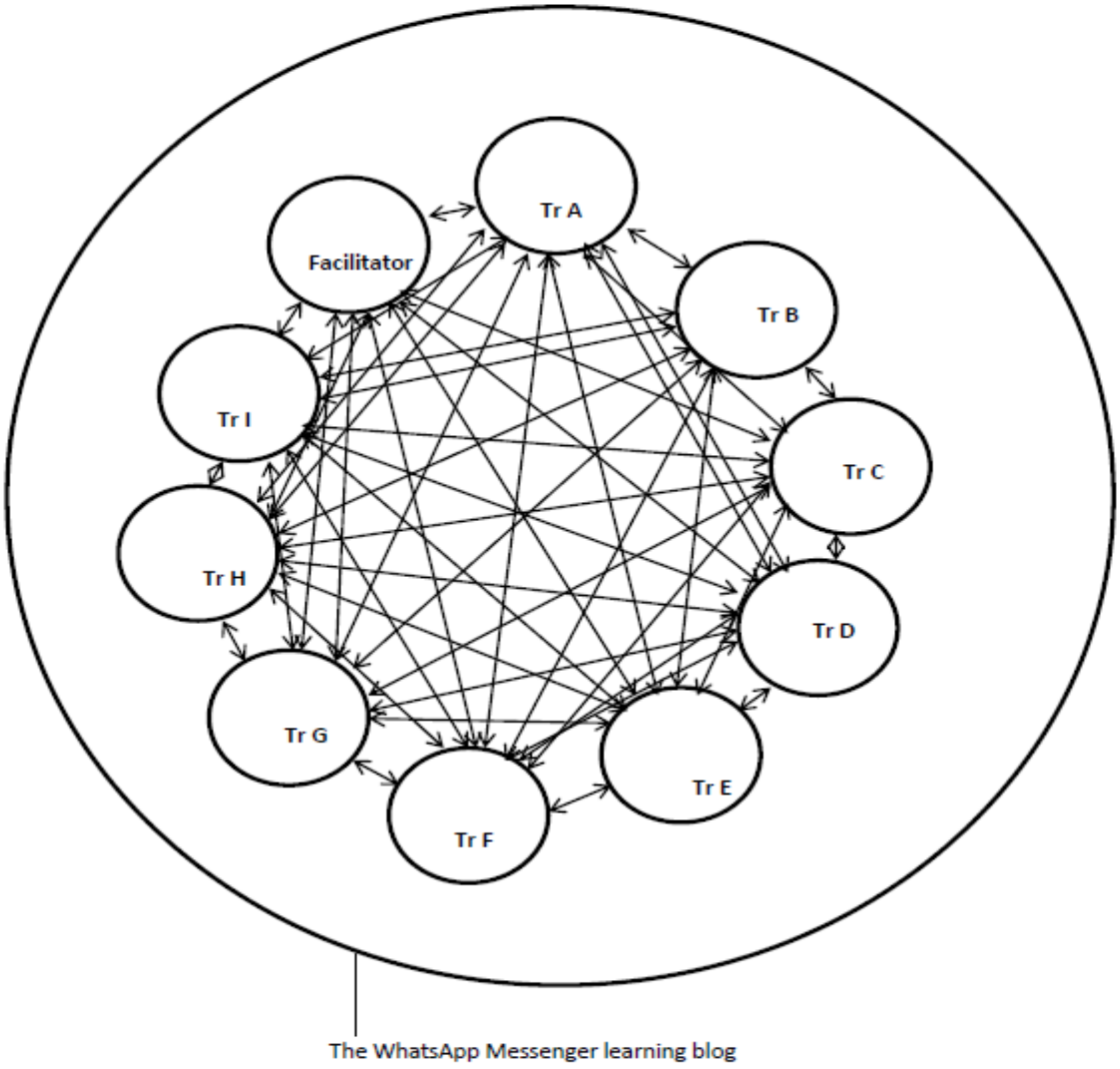

Figure 10: A depiction of the online network of individual teachers.

After the formation on the WhatsApp Messenger-based online community, the teachers were told that the objectives of the course were to:

- Demonstrate an understanding of the philosophy behind IBP;
- Analyse elements of the IBP instructional model;
- Discuss strategies and tools for implementing IBP;
- Demonstrate an understanding of the benefits and weaknesses of IBP; and
- Develop learning guides to use when implementing IBP in the chemistry classroom.

In line with the above-stated objective, the teachers went through several steps in the course.

Step 2*: *discussion on the philosophical foundations of IBP– The teachers were asked to research the constructivism philosophy, which forms the basis of the IBP approach. Understanding the philosophical underpinning of a teaching approach inspires reasoning about why the approach is used, and makes it possible for the teacher to have clear, relevant, deep, accurate, and consistent knowledge about the approach (Ekanem & Ekefre, 2014). It was therefore crucial for the teachers to understand the roots of IBP before studying its elements.

***Step 3: analysis of elements of the IBP model* –** In Step 3, the researcher explained the elements of the IBP concept to the participants and asked them to read and discuss their personal understanding about the instructional model. All the participants were asked to research as much as possible on the topic. The researcher intentionally did not specify the concepts to be read so as not to structure or limit the amount of knowledge to be created within the network. The intention was to activate all the nodes in the network to generate as much knowledge as possible at the same time. This is because, according to the connectivism theory, the facilitator is only supposed to initiate the learning context and allow students to construct their own knowledge through their network connections (Siemens, 2005). It is assumed that learning occurs automatically as a result of the flow of knowledge throughout the network.

Step 4: Discussion on strategies and tool for implementing IBP - In Step 4, participants were asked to research more about the topic. They were not referred to any particular search engines as the researcher wanted them to use their own discretion. The researcher also did not want to limit the knowledge generation capacity of the network. Participants were asked to research and discuss strategies and tools that could be used to implement IBP. This incited the participants to have more discussions on the topic with minimum intervention from the researcher. While the interactions were happening, the researcher was observing and making notes. This enabled the researcher to notice the changes that were occurring in the teachers' understanding and appreciation of IBP, and changes in their own professional identities. The researcher sought clarification from participants when any unusual behaviour was noted. This was to gain a fuller understanding of the individuals' identity construction process.

Step 5: Discussion on the benefits and weaknesses of IBP – The teachers were asked to read up on and discuss the benefits and weaknesses of IBP. The researcher asked each participant to post brief explanations on what they understood to be the benefits and weaknesses of IBP to teaching and learning. All nine teachers managed to express their views. After they posted their explanations, they were asked to discuss the implications of these benefits.

Step 5: Group work activities **-** After noticing that the teachers had developed a better appreciation about IBP, the researcher sub-divided the teachers into three groups. The teachers were grouped according to their universities, as shown below:

Group 1: Teacher A, B, and C;

Group 2: Teacher D, E, and F; and

Group 3: Teacher G, H, and I.

By grouping participants according to their universities, the researcher intended to determine any contextual issues that could affect group productivity and study their effect on professional identity development. Three WhatsApp Messenger groups were created, and each group was asked to work together online. Even though the researcher was part of the network, the researcher deliberately chose not to participate in the discussions to enable teachers to work independently from the researcher's facilitation. The reason was to determine whether or not the absence of a facilitator would affect group productivity. At this stage, the researcher was more interested in the product of participant interactions than in the process itself. Each group acted as a node in the network, as shown in Figure 11.

Each group was tasked to produce a lesson guide for a topic of their choice. The lesson guides were to describe how they would use the IBP approach to teach the topic. These lesson guides were uploaded onto to the central WhatsApp Messenger platform so that they could be viewed by the broader group (Appendices 12, 13, and 14). The teachers were asked to analyse the lesson guides vis-à-vis the elements of IPB that had been discussed during the course. The teachers were able to analyse and critique the lesson guides on the WhatsApp Messenger platform. They made comments and suggestions on how members could improve the lesson guides.

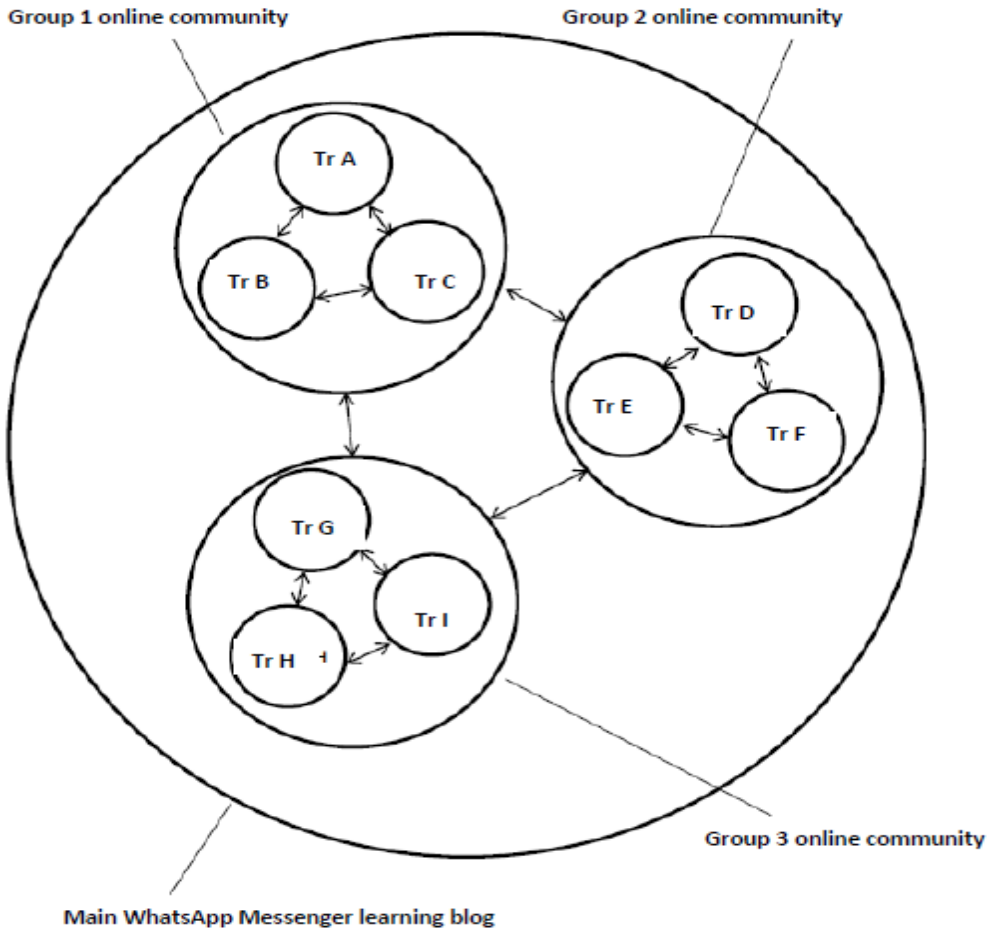

Figure 11: A depiction of the online network of groups of teachers

4.3.6.3 Phase 3: Post-intervention interviews

After being satisfied that the teachers had developed an understanding of the IBP concept, the teachers were interviewed again. The purpose of the second set of interviews was to gauge if any changes had occurred to teachers' professional identities as a result of their participation in the WhatsApp-based IBP course. The interview questions are appended as Appendix 8. The interviews were tailored to identify any changes to the professional identity indicators discussed in Phase 1.

4.3.6.4 Phase 4: Focus group discussion

A focus group discussion was conducted with the teachers after the second wave of interviews. The purpose of the FGD was to tie up loose ends in the data that had been collected from the interviews and participant observations. The focus group questions are appended as Appendix 9.

4.3.7 The data analysis process

Data were analysed using the thematic networks analysis process. This is a process that endeavours to expose themes emerging from text data. It clarifies procedures that can be employed as a researcher moves from text to interpretation. Thematic networks analysis presents data as a web-like network (Pokorny et al., 2018). It systemises extraction of data at three different levels: basic themes; organising themes; and global themes as shown on figure 12.

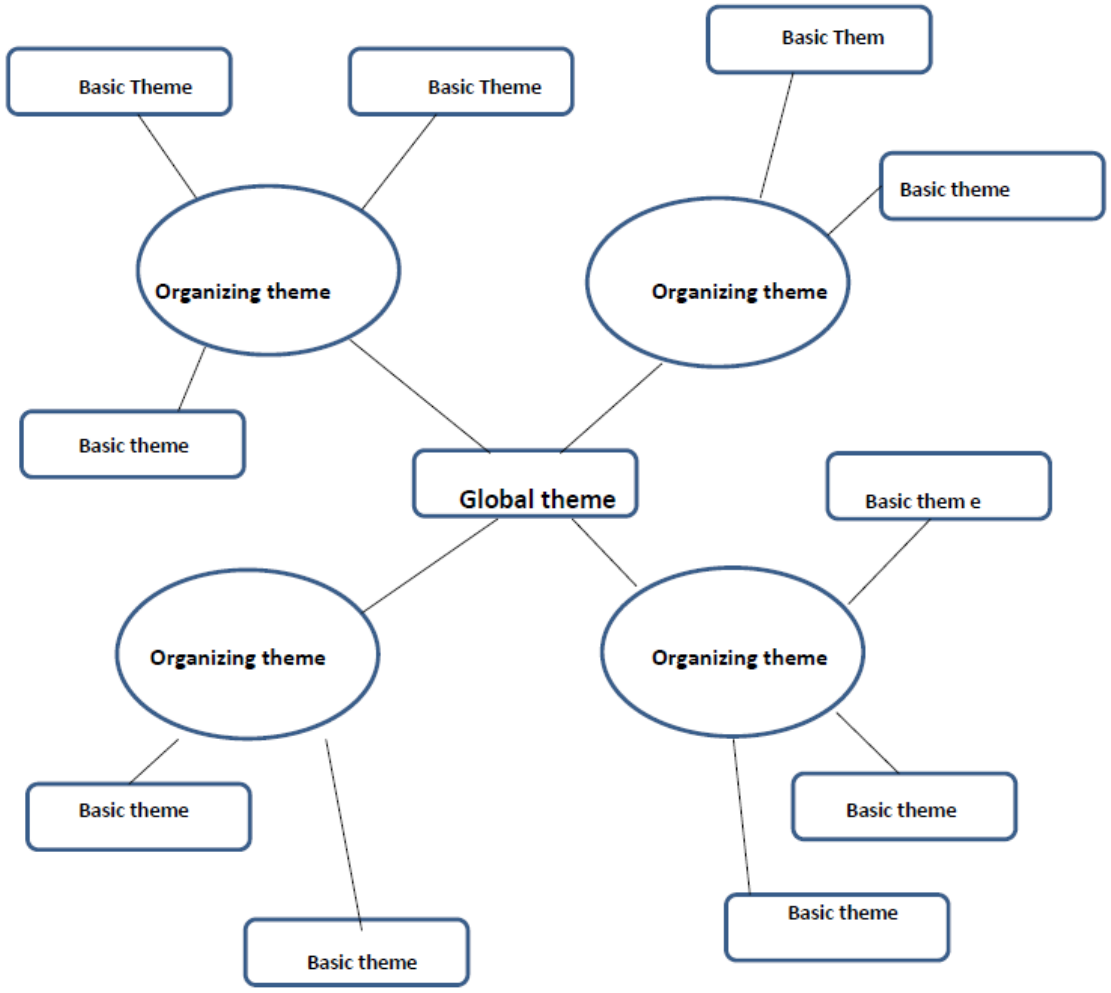

Figure 12: A presentation of an example of a thematic networks structure (Adapted from Attride-Stirling, 2001)

Basic Theme. A basic theme refers to the lowest order theme that can be extracted from the textual data. It is usually a statement that is anchored on a central idea. On its own, a basic theme usually does not express much about the whole text and must be considered next to the other basic themes (Attride-Stirling, 2001). For this study, abbreviations were used to denote basic themes. For example, when analysing the reasons why the participants became university

teachers, the codes RfT1, RfT2, RfT3, and so forth, (RfT being an abbreviation for *reason for teaching)*. The basic themes were then grouped to produce organising themes.

Organising Theme. An organising theme is composed of several basic themes that speak to the same issue (Pokorny et al., 2018). Such a theme summarises the main assumptions of a cluster of related themes. It is more abstract and reveals more about what is happening in the text than a basic theme. Organising themes play two roles during analysis, these being to group main ideas from the basic themes, and to dissect the main assumptions of a broader (Global) theme that emerges from the whole text. For example, after grouping the RfTs, it was shown that most of the teachers had not initially planned to be teachers, but entered the field when they had not found employment in their preferred occupations. Thus, the organising theme was: No initial plan to be a teacher.

Global theme: The global themes are super-ordinate themes that cover all the main metaphors that are found in the whole data (Attride-Stirling, 2001). They are comprised of a group of organising themes and present an assertion of the argument on a particular issue. In the analysis, they are the overall themes that summarise and give meaning to the lower order themes that emerged from the data. They tell the reader the meaning of the whole text. Nine global themes emerged from the analysis of the data, and these will be discussed in Chapter 5.

A thematic network starts with the basic theme and proceeds through the organising theme to the global theme (Ja'fari, Taslimi, Faghihi & Sheikhzade, 2011; Attride-Stirling, 2001). After deriving a cluster of basic themes, they are categorised according to the story they are telling to represent an organising theme. The organising themes are interpreted according to their basic themes and are grouped together to depict a super-ordinate Global Theme. Figure 12 shows the structure of a thematic network structure.

Thematic networks are depicted as web-like network structures to show that there are no hierarchies within the themes and to emphasise the interconnectedness through the whole network. The networks are not an analysis themselves but act as organising principles and tools in the interpretation of the text.

4.4 MEASURES TO ENSURE TRUSTWORTHINESS

Trustworthiness refers to the extent to which a research process and it results can be trusted (Noble & Smith, 2015). Good, qualitative research should produce results that are trustworthy. For their research to be accepted as trustworthy, researchers must demonstrate that data

collection and analysis is done in a precise, exhaustive and consistent manner. Babbie and Mouton (2012) proposed the following notions of trustworthiness: (a) credibility, (b) transferability, (c) dependability, and (d) confirmability. Each is described below.

4.4.1 Credibility

Credibility is a function of actions taken by the researcher in the field. According to Creswell (2014), credibility is enhanced by the following measures:

4.4.1.1 Prolonged engagement

Prolonged engagement involves devoting enough time with participants in order to gain enough understanding about the participants' interactions and to test misinformation brought about by distortion in either self or participants (Noble & Smith, 2015). Prolonged engagement enables the researcher to be aware of multiple influences and contextual factors that influence the phenomena under investigation. In this study, the researcher was a member of the participants' WhatsApp group. The researcher interacted with the teacher-members on a daily basis and sought clarification on peculiar issues raised by group members. Members were assured of the confidentiality of the process. This enabled them to give a thick description of their experiences.

4.4.1.2 Persistent observation

Persistent observation refers to identifying and focusing on the characteristics and elements that are most relevant to the study (Creswell, 2014) so that a researcher has an in-depth understanding of the situation under study. In this research, the researcher observed, identified, and assessed the crucial aspects about WhatsApp Messenger usage that led to the development of the professional identity of the participants. The researcher asked probing questions in order to obtain in-depth information from the participants. These questions were asked using the WhatsApp platform.

4.4.1.3 Triangulation

Triangulation is a research technique used to enrich the findings of qualitative research (Creswell, 2014). It involves the use of multiple data collection methods to shed a different light on a topic (Hadi & Closs, 2016). Each data collection method produces additional perspectives on the phenomenon under investigation (Rothbauer, 2008). The multiple perspectives enhance the credibility, accuracy, and validity of the research findings because, by employing several strategies to investigate a single phenomenon, the researcher ameliorates the weaknesses associated with every single method. This helps to confirm the accuracy of participants' responses.

In the context of this study, the researcher employed three data collection procedures, namely, interviews participant observations, and focus group discussions. The aim was to get a variety of perspectives concerning the development of professional identities of university teachers as they engaged in discussions about IBP on the WhatsApp Messenger platform. The convergence of these data collection methods provided a vivid picture of what transpired in the study.

4.4.1.4 Peer briefing

Peer briefing is an analytic triangulation (Brazinha & Fernandez-Llmos, 2014) method, where a researcher discussed their methodology, data analysis, and interpretation with their peers throughout the entire research process. The peers would not be directly involved in the research but would be skilled and experienced qualitative researchers (Hadi & Closs, 2016).

In this research, the researcher consistently briefed colleagues in the Teaching and Learning Centre at the Harare Institute of Technology in order to gain additional perspectives and interpretations. The study methodology and findings were also presented at a research and innovation workshop that was hosted at the Harare Institute of Technology.

4.4.1.5 Member checking

Member checking involves the researcher returning to the participants to discuss the interpretation of the data collected (Noble & Smith, 2015). This gives the participants the opportunity to correct errors in the data as well as challenge the interpretations. The researcher revisited the participants after the study to allow them to verify the interpretations that the researcher attached to their data. Most of the participants agreed with the interpretations that were made from the data. In the few, insignificant, instances where misinterpretation were made the researcher made the necessary adjustments

4.4.1.6 Self-description/reflexivity

Self-description is a process where a researcher acknowledges their bias and ensures that this bias will not affect the results of the study (Hadi & Closs, 2016). Through self-reflection, researchers discuss their own positions within the study or how it may reflect their personal beliefs or prior training (O'Brien, Harris, Beckman, Reed & Cook, 2014). While acknowledging the researcher's relation to the research process, reflectivity ensures that the research process follows standardised procedures. An understanding of the researcher's personal views, values, biases, and attitudes is useful in developing a deeper insight into the research (Patnaik, 2013) because it ensures that the focus stays on the research and the participants and not on the researcher themselves.

Reflexivity acknowledges the researcher's role in the creation of knowledge (Hadi & Closs, 2016). In the context of this research, the researcher was not an "outsider" or mere observer but played an active role in the professional identity development of the university teachers. To facilitate the process of self-examination and introspection, the researcher kept a reflective journal. After every interview, the researcher would spend time thinking about the observation and tried to give his own interpretation before subjecting these observations to a structured analysis. This helped the researcher to take note of his own attitudes and views about the meaning of individual participants' responses. This self-disclosure brought about some discomfort and hesitation as the researcher's intention was to elicit information rather than providing it. However, this helped the researcher have a better appreciation of the subjectivity of qualitative research.

4.4.2 Transferability

Transferability refers to the extent to which research findings can be applied in different settings (Silverman, 2013). It is important to note that the primary aim of qualitative research is not to generalise results. However, using three different universities as different contexts, the researcher attempted to find out if the results from the different contexts would be the same. The readers can use their own discretion to find out whether the knowledge generated in the research can be transferrable. The research instruments that were used in this research are attached as appendices at the end of this thesis. These can be used by readers for reference or for carrying out similar research in different settings.

4.4.3 Dependability

Dependability is a measure of research's consistency and repeatability (Creswell, 2014). Researchers strive to verify whether their findings are a true reflection of their raw data. They need to ensure that when they give someone their raw data, he or she will come out with similar findings. This ensures that nothing is missed in the research. It also ensures that the researcher was not sloppy in the final report. In this study, the researcher asked a senior research colleague to conduct an inquiry audit on the study. The senior colleague examined the data collection process, the data, and the results of the study and was satisfied with the work.

4.4.4 Confirmability

Confirmability relates to the degree to which study findings are informed by the research process rather than the researcher's biases (Babbie & Mouton, 2012). There has to be evidence that the research was indeed conducted. In the context of this research, the researcher requested a senior colleague to conduct an audit trail to verify the field notes, original transcripts, and

WhatsApp conversations. The colleague also checked all the chapters before they were submitted to the supervisors.

4.5 ETHICAL CONSIDERATIONS

Qualitative research inevitably involves contact with people and ethical issues always arise (Silverman, 2013). It was thus important that this research dealt with ethical issues. The following ethical considerations were observed.

4.5.1 Ethical clearance

The researcher applied for ethical clearance from the Ethical Clearance Committee of the University of South Africa. The acquired ethical clearance certificate is appended at the end of this thesis (Appendix 1). The researcher also wrote to the registrars of the universities at which the participating lecturers were faculty members, seeking permission to conduct research. There is no national authority that guides the conduct of research at universities in Zimbabwe. Permission was granted on the understanding that the identities of the universities would remain anonymous. To honour the confidentiality agreement, the letters of approval could not be appended to this thesis.

4.5.2 Informed consent

Before engaging a participant in a study, it is necessary for the researcher to get the consent of the participant (Creswell, 2014). Informed consent is a legal and ethical requirement in all research that involve human participants (Nijhawan et al., 2014). The researcher should give the participants enough information about the research and the implications of participating in the research. The participant should voluntarily agree that they understand all aspects of the study and agree to take part after studying (Manti, & Licari, 2018). For most research, it is necessary that the researcher obtains this consent in writing. For this research, participants were informed about the purpose, method, and intended potential uses of the research. They were also told what their participation in the research entailed and any risk (if any) was involved. This information was given to participants in writing. Each participant has to sign to acknowledge receipt.

4.5.3 Confidentiality

Confidentiality in research entails the protection of participants and their information (Surmiak, 2018). Researchers are always expected to keep the identity of their participants confidential. It could be argued that researchers cannot keep the research findings confidential since they have to be disseminated and published. What the researcher can do is to protect the identity of

the participants. Several methods can be used to do this. According to Creswell (2014) confidentiality of data can include the following:

- Ensuring the confidentiality of information and data: making sure that data is separated from identifiable participants and securing the code that links information to participants;
- Making sure that people who can access the information (e.g., the research team, the data transcriber, and any others) will maintain the anonymity of participants;
- Disseminating information that arises from an individual in such a way that people cannot easily identify the individual;
- Making sure that what an individual says in an interview is not disclosed and
- Ensuring that places and individuals are kept anonymous.

In the context of this study, the data and its sources will remain confidential unless participants have consented to disclosure. The participants were promised that their identities would be kept confidential, and the researcher will not breach this commitment. Their names will not be disclosed but instead codes, in the form alphabets, were used to refer to specific individuals.

4.5.4 Voluntary participation

When carrying out research, it is necessary to ensure that respondents participate voluntarily. It is unethical to induce, coerce, or entice participants (Silverman, 2013). It is important that the researchers inform their participants that they are not being forced to participate. Those who are unwilling, have the right not to participate. They should be informed that there are no consequences for those who choose not to participate. Participants should also be told of their right to withdraw from the research at any stage (Creswell, 2014). In the context of this study, the participants were informed, in written form, of their right to refuse or withdraw participation at any stage in the process. There was no coercion for subjects to participate in the research.

4.6 SUMMARY

This chapter described the research paradigm, research design and methodology used in this study. The qualitative research approach was described with a specific focus on the case study that was used in the study. The chapter articulated on the population and sampling method, as well as the data collection and data analysis procedures. The measures taken to ensure the trustworthiness of the research findings were also explained, as well as the ethical consideration for the study. This chapter, therefore, described the journey that the researcher followed to

answer the research questions. The next chapter focuses on data management and research findings

CHAPTER 5

DATA MANAGEMENT AND RESEARCH FINDINGS

5.1 INTRODUCTION

In this chapter, the researcher presents a descriptive account of the findings of the research conducted with nine teachers who teach chemistry courses at three universities in Zimbabwe. The discussion is based on the results of analysis of data from semi-structured interviews, participant observations, and focus group discussions (as discussed in Chapter 4). Data processing and management presents the research findings. When presenting the research findings, the researcher will be "selling" or persuading the reader of the research outcomes in terms of the research questions (Bavdekar, 2015). Data management in qualitative research involves extracting meaning from bulky information. Because of the mass of information, a series of steps are taken to reduce the raw data into categories and hierarchies so as to make sense of the meanings contained in the data. A thematic network approach (Attride-Stirling, 2001) was used in this study to be able to achieve this. The thematic networks analysis endeavours to expose themes emerging from text data and clarify procedures that can be employed as a researcher moves from text to interpretation.

Thus the Chapter is divided into three sections for the purpose. The three sections are the research settings; biographic information of the participants; and the analysis, interpretation and discussion of the findings. The first section describes the research settings. Research settings play a significant role in influencing the findings of a study. The three settings (i.e. Universities) from which the university teachers were sampled, have different thrusts in terms of their visions and missions. They also have different mandates that affect the approach to professional development and ICT use in education. These variable settings assisted in gaining an understanding of participants' approaches to the use of ICT in professional development. The second section discusses the biographical information of the participants. The participants' qualifications, experience, and prior knowledge informed their responses to issues they encountered in the study. The last section deals with the analysis, interpretation, and discussion of the findings.

5.2 RESEARCH SETTINGS

The participants were sampled from three different universities in Zimbabwe. All of the teachers taught chemistry courses. They all had no prior training in pedagogy.

5.2.1 Description of university settings

In this study, the three universities are identified as University **A, B**, and **C** respectively.

University **A** was based in Harare, the capital city of Zimbabwe. It was a public university whose teaching focus was on science, technology, and engineering programmes. While the university had adequate computers and other teaching technologies, it had not fully integrated ICT into its pedagogical practices. A few of the university teachers used the Moodle learning management system (as can be seen at www.moodle.org) for pedagogical purposes. The majority used whiteboards for teaching. The type of technology used most often in their teaching was the computer projector, which was carried to the lecture rooms each time there was a lesson. The minimum qualification required to teach at this university was a master's degree in the relevant subject area. Very few teachers had PhDs, and there were only two professors. A qualification in pedagogy was not a requirement to teach at this university.

University **B** was a public, multi-disciplinary institution that offered undergraduate and post-graduate programmes in nine faculties. These included the Faculties of Agriculture, Arts, Commerce, Education, Engineering, Medicine, Sciences, and Social Studies. The faculty of education offered a post-graduate Diploma in Higher Education. The university also has a Teaching and Learning Centre which offered regular workshops in teaching and learning in higher education. The minimum qualification to teach at this university was a PhD in a relevant area. However, at the time of this research study, the teachers in some departments had a master's qualifications as the requirement for PhD had been introduced shortly before the study. As a result, the majority of teachers were still to acquire their PhDs. The ICT infrastructure for most departments was old and Internet access was very slow, especially when students were on campus. Teachers and students usually supplemented Internet access with private Internet hotspots and mobile data. As a result, the integration of ICT in education was limited. However, the university had its own learning management system that allows interaction between and among teachers and students.

University **C** was a public, multi-disciplinary institution that focused on the teaching of science subjects. The entry qualification for faculty was a master's degree in the relevant subject field. Very few lecturers had PhD qualifications. University teachers were expected (but not forced) to acquire a teaching qualification at some point during their employment. Very few teachers actually went on to acquire such qualifications. The ICT infrastructure for teaching was

outdated. Most of the university teachers used whiteboards, chalkboards, and computer projectors for teaching.

5.2.2 Participants' biographical information

The nine participants are identified as Teacher A, B, C, D, E, F, G, H, and I respectively.

Teacher **A** was male and taught in the Department of Pharmacy at University A. He was in his late twenties and had just completed his Master of Pharmacy degree. Soon after his Bachelor of Pharmacy degree, his university sponsored him to study for the master's degree. He had not practised as a pharmacist. He never had any intention to teach at university, but he had to fulfil a contractual obligation. The contract stipulated that he had to work at the university for a minimum of four years. Teacher A's original intention was to set up his own pharmacy after his undergraduate degree, but this changed when his university sponsored him to pursue his master's degree. He still had the intention to work in private practice after completing his four-year commitment with the university. He had no training or experience in pedagogy and was unwilling to enrol in a pedagogy programme.

Teacher **B** was female and taught in the Department of Material Science and Engineering at University A. She was in her late thirties. She had a Master of Technology in Material Sciences degree. She had no intention of teaching at a university when she finished her master's degree. However, the job that she found in the industry did not require her master's degree, and she had similar working conditions with technicians who did not have post-graduate degrees. This prompted her to look for "greener pastures" and she opted to apply to teach at University A. She was willing to consider any offers that would commensurate with her qualifications. She had no prior teaching qualifications and mainly used the lecture method in her teaching. She did not believe that a qualification in pedagogy was necessary for one to teach at university but believed that one had to be knowledgeable in his or her own academic field.

Teacher **C** was male and taught in the Polymer Technology Department at University A. He was in his late thirties and possessed a PhD degree in Polymer Technology. He had no prior intentions of teaching at university, but he could not find suitable work after finishing his master's degree. He did not find his teaching job very satisfying as he preferred to work in the industry. He was more interested in production than teaching, which he found to be too theoretical and monotonous. He had no prior training in pedagogy and was not very keen to acquire a teaching qualification. He believed he would find employment in the manufacturing sector when the country's economy improved and the industries strengthened.

Teacher **D** was female and taught in the Department of Chemistry at University B. She was in her mid-thirties and had six year's teaching experience. She had a Master of Technology Degree in Biochemistry. She became a lecturer after finishing her master's degree. The reason for becoming a lecturer was that she had spent much time looking for work after finishing her master's degree and the lectureship post was the first employment offer that came her way. When she was still studying at university, she never thought she would be a university teacher. She intended to work in the industry. She did not have any formal qualifications in pedagogy but had attended one workshop on teaching and learning in higher education. She did not believe that knowledge about pedagogy was necessary to teach at university.

Teacher **E** was male and taught in the Pharmacy Department at University B. He was in possession of a PhD degree in Pharmacy. Besides teaching, he ran his own private pharmacy. He had no prior intention of being a teacher but was approached by the university for his services. He divided his time between teaching at the university and managing his pharmaceutical business. He believed his teaching at university was very flexible such that it afforded him time to attend to his business. He had no training in pedagogy and was not very keen to enrol in a pedagogy class because of time limitations. He also believed that the knowledge that he had in pharmacy was enough to be able to teach.

Teacher **F** was male and taught in the Chemical Engineering Department at University B. He was in his mid-forties. He had a master's degree in Chemical and Process Systems Engineering. He was also a church pastor. He worked in the industry for several years before teaching at a polytechnic college and then moving to a university. He had no prior intention to work as a teacher but became frustrated when he could not realise his ambitions in industry. He wanted to set up his own manufacturing plant but could not raise the required capital. He also became frustrated by the administrative problems at the firm that he was working in. He did not have any qualifications in pedagogy and did not believe that it was necessary. If any offer came along for him to go back to work in the industry, he would consider it if it was lucrative and if it was at a senior level.

Teacher **G** was female and taught in the Chemical Engineering Department at University C. She was in her late forties. She had a PhD in Chemical Engineering degree. She had never done any work besides teaching at university. Initially, she wanted to work in the industry but started teaching at university because she could not find work after finishing her master's degree. She was then sponsored to pursue her PhD at a foreign university on condition that she would work

at the university for a minimum of four years. The four years had since passed, but she had not found any other job offer yet. She believed her PhD was enough to teach at university and was not keen to obtain teaching qualifications. She mainly used the lecture method in her teaching.

Teacher **H** was male and taught in the Biotechnology Department at University C. He possessed a PhD degree in Biomedical Technology. He was in his late thirties and had seven year's teaching experience. He had one year of industrial experience. His motivation for joining the university as a teacher was that he did not enjoy the industrial experience. The rigid working conditions as well as poor remuneration prompted him to move to university teaching when the opportunity arose. However, if an offer came from the industry with huge perks, he was willing to consider it. He did not have any qualifications in pedagogy and had not had any opportunity to attend any workshop in university teaching. He believed that teaching qualifications were not necessary.

Teacher **I** was a male teacher and taught in the Chemistry Department at University C. He was in his mid-forties and had a PhD in chemistry. He briefly worked as a teacher after finishing his first degree. He then quit and pursued his master's and subsequently PhD degrees. It was during his PhD studies that he became a part-time teacher at University C. After finishing his PhD, he was offered a full-time teaching post, which he accepted. To him, teaching was not his passion, but he found the salary attractive. The teaching conditions were flexible and would allow him to engage in his own private business venture. He, however, did not foresee himself teaching for much longer as he was exploring "other opportunities", which he did not name. He had no prior teaching qualifications and used the teaching methods that his professors used to teach him when he was still at university. These were the lecture and group work methods.

5.3 ANALYSIS, INTERPRETATION AND DISCUSSION OF FINDINGS

This section of the study presents the analysis, interpretation, and discussion of the study findings.

5.3.1 Thematic networks analysis of the data

The thematic network analysis (discussed in detail in Chapter 4) was used to analyse the data. Data were extracted at three different levels (i.e. basic themes; organising themes; and global themes) after deriving a cluster of basic themes, into organising themes and global themes according to the narratives that they were telling. The organising themes were categorised and grouped to represent the super-ordinate global themes. In Figure 13 the generic structure of the

thematic network structure is shown. It was needed to explain all the themes that would be derived from the data.

Figure 13: A presentation of the thematic network used to analyse data in this study. (Adapted from. Attride-Stirling, 2001).

5.3.2 Professional identity before engaging in inquiry-based pedagogy course

This section of the chapter presents findings of the prior beliefs, knowledge, and practices of the teachers before engaging in the IBP course. The findings were generated from semi-structured interview data. Nine university teachers from three different universities participated in these interviews, which were used to determine their professional identities at that point. These findings are a response to the first research sub-question: How do university chemistry teachers perceive their professional identities?

5.3.2.1 Theme 1: Participants' initial teaching beliefs

The first global theme to emerge from the data, expressed the teachers' initial teaching beliefs. The thematic network for this Theme 1 (see Figure 14) shows the organising themes surrounding this global theme and the basic themes that support them.

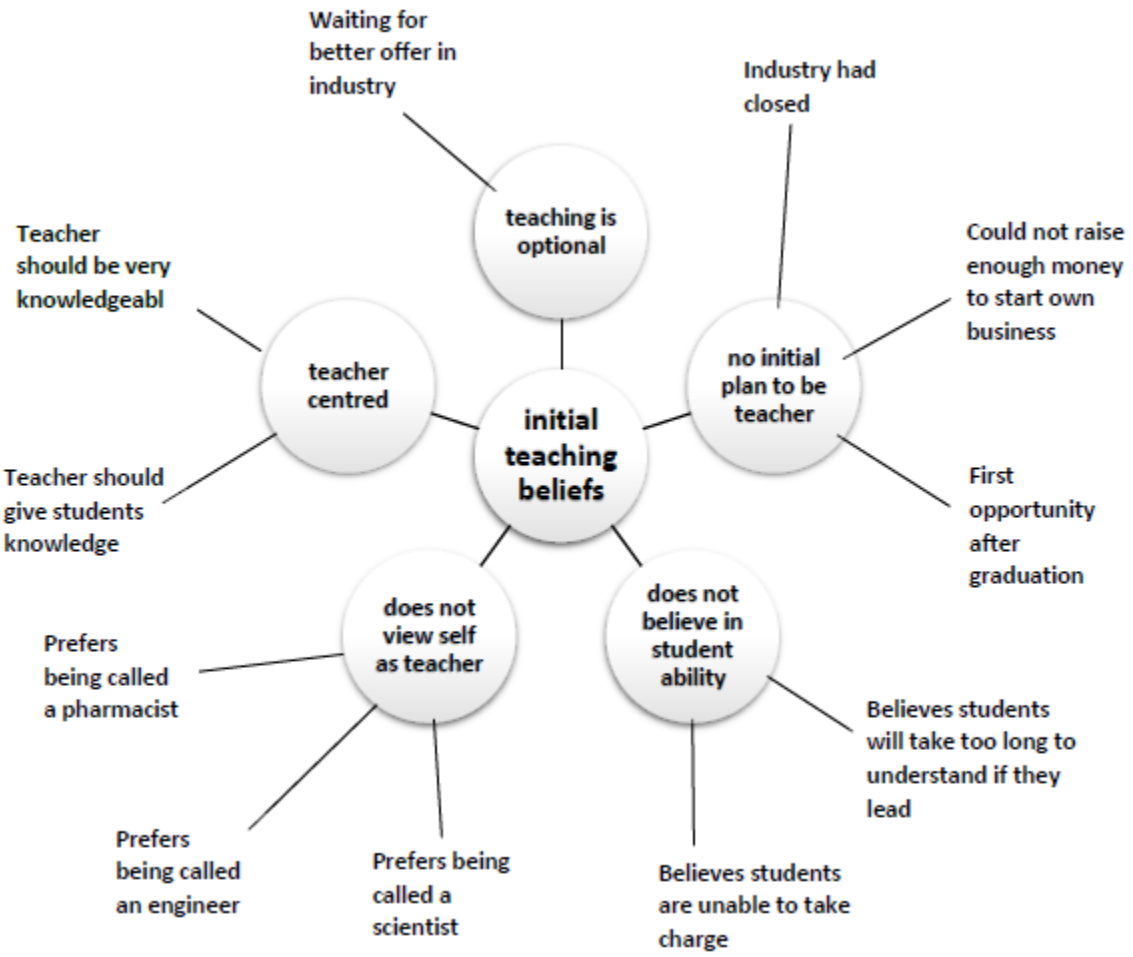

Figure 14. A presentation of the thematic network for teachers' initial teaching beliefs

A total of five organising themes emerged from the data to support this global theme:

Teacher centred – this organising theme was supported by two basic themes namely "teacher should be very knowledgeable" and "no initial plan to be teacher"

Teaching is optional – this organising theme was supported by the basic theme "waiting for better offer in industry"

No initial plan to be teacher – this organising theme was supported by three basic themes – "industry had closed", "could not raise enough money to start own business" and "first opportunity after graduation".

Does not believe in student ability – this organising theme was supported by two basic themes – "believes students will take too long to understand if they lead" and "believes students are unable to take charge".

Does not view self as teacher – this organising theme was supported by three basic theme – "prefers being called a pharmacist", "prefers being called and engineer" and "prefers being called a scientist".

The findings based on the manifest analysis (see Graneheim & Lundman, 2004) of the semi-structured interview questions, reveal that university teachers did not initially believe that they were pedagogues but subject matter experts. Of all the nine participants, none intended to be a teacher. Most of them had plans to work in the industry in their different fields of study. The participants proffered various reasons for venturing into teaching. For some, it was frustration in the working conditions in the industry, for others, it was a chance to attain higher qualifications, and for others, it was that they had no other choice. The economic situation in Zimbabwe, which saw many industries close, forced most of the participants to look for the most secure form of employment. Said Teacher D from University B:

'After finishing my Master's degree, I spent a long time looking for employment without success. When I saw the advertisement for teaching at my university, I decided to try my luck. Fortunately, I passed the interview, and . . . here I am'.

Where individuals are in a profession because of limited choices, their professional identities are negatively affected. This is consistent with the views of Tsakissiris (2015) that individuals in profession that they do not like, they do not have a sense of belonging to that profession. Such individuals need to be socialised into the norms and ethos of that profession so as to develop a positive identity towards their current profession.

Most of the teacher-participants still wished to be identified by their own academic qualifications. Teachers with engineering backgrounds or qualifications wanted to be recognised as engineers, similarly, teachers from pharmacy and biochemistry backgrounds wanted to be recognised as pharmacists and biochemists respectively. Teacher G from University C (who taught chemical engineering said:

'You can address me as Engineer "X". That is how my colleagues address me. The fact that I am teaching at university does not take away the fact that I am an engineer. I am an engineer first and foremost. I wish to be recognised as such'.

This showed that the participants did not identify with the teaching profession but identified with their academic professions. To them, teaching was a temporary venture as they awaited opportunities in what they considered to be their 'real' trades.

Most of the teachers interviewed (especially the male teachers), expressed their desire to go back into industry practice should the economic situation improve or if they received offers for higher positions. For the most part the female teachers, even though they would have wanted to go to the industry, had reluctantly given up on the opportunity to do so. They had now resigned to their fate and had to contend with being university teachers. They believed that university teaching offered them the flexibility to devote more time to their families. Said one female teacher, (Teacher D):

'I would have wanted to go back to industry should the situation change . . . but now I am a family woman. Teaching offers me a chance to be with my children. So, I do not see myself going to industry though it was my initial desire'.

From the above statement, a gender dimension in professional identity emerged. The gender roles that individuals play in society can influence their career choice even though it is in conflict with their desired profession (Mor, 2018; Cheng & Clerkin, 2015). As such, there is an element of 'compromise' identity in such individuals. In this case, the teacher felt like a teacher on the outside, but her passion lay somewhere else. Her decision to continue as a teacher was not driven by a passion for teaching but by the flexibility of the working conditions. However, this teacher believed that her services were more useful in the industry than at university.

The teachers believed that teaching was a teacher-centred endeavour where the teacher is the source of all the knowledge. They argued that a teacher should be highly knowledgeable in the subject area for them to be effective in their teaching. To most of them students did not have the capacity to take charge of their own learning. They believed learning, especially at a university level, is at a very high level and that students would struggle if they were to be taught content without the teacher being at the forefront. Teacher G, who taught Chemical Process Engineering, had this to say:

'To be honest with you, the level of chemistry in engineering is so high that these students would struggle if they were to be left to take charge of their learning. For your own information, they struggle with very simple issues. It will take the whole year for them to understand basic concepts. Besides the teacher is there to teach them, so there is no need to complicate the learning process'.

The above statement showed that the teacher might not have understood or been aware of the inquiry concept. To him, inquiry would have meant letting the student study on their own in an unstructured manner. His views mirrored those of self-centred teachers who believe that IBP leads students to acquire false facts and unreasonable knowledge (Nybo &May, 2015; Sowey, 2013) and can lead to the haphazard acquisition of knowledge if it is not done properly (Silby, 2013). The assertion also showed that the teacher might not have had any appreciation about the role that prior knowledge played in the construction of new knowledge. To him, chemical engineering was a subject that started at the university level and hence students were not expected to have any prior knowledge about it. In his view, it was the teacher who knew all that was to be known at that level and all learning had to be centred on the teacher. In other words, the teacher identity here was that of the "knower" of chemical engineering and the only source of knowledge. In this teacher's understanding, students were, therefore, to be told about what chemical engineering was.

On students' practical activities and experiments, most of the teachers used the cookbook approach where students were given a set of instructions that were designed to produce pre-determined results. Students were provided with well written, structured instructions, which the students used throughout the experiments. The experiments were usually conducted in groups to "save" time and resources. The experiments were done to fulfil the requirements of the syllabus, but there was little participation from the students as most of them would be watching others perform the experiments. Most of the teachers said they would never allow students to do experiments outside the set procedures (i.e. cookbook experiments). Said teacher B from University A:

'What? . . . No! I will never allow students to do their own experiments. One of the duties of the teachers is to protect students from accidents. If I allow them to experiment, they might burn down the whole laboratory and will be in serious trouble with the authorities. I would rather perform demonstrations so that students can see how the experiment is done'.

The response showed that the teacher was mainly interested in showing the students how experiments were done. As such, he would demonstrate the experiments to the students, or at least let them use pre-determined procedures. The use of a cookbook approach to experiments does not promote conceptual understanding (Bertsch, Kapelari & Unterbruner, 2014). The cookbook approach is, therefore, advocated by teachers who had no understanding of the

impact of pedagogical procedures on students' conceptual understanding. The teacher was, therefore, self-centred and had a negative sense of professional identity.

5.3.2.2 Theme 2: Participants' initial professional identification.

The second theme expresses the initial professional identification of the teachers. Some did not positively identify with other teachers and with the teaching profession; most were averse to professional advice; most believed that professional development was not useful; and some did not integrate their teaching roles with personal roles (refer to Figure 15).

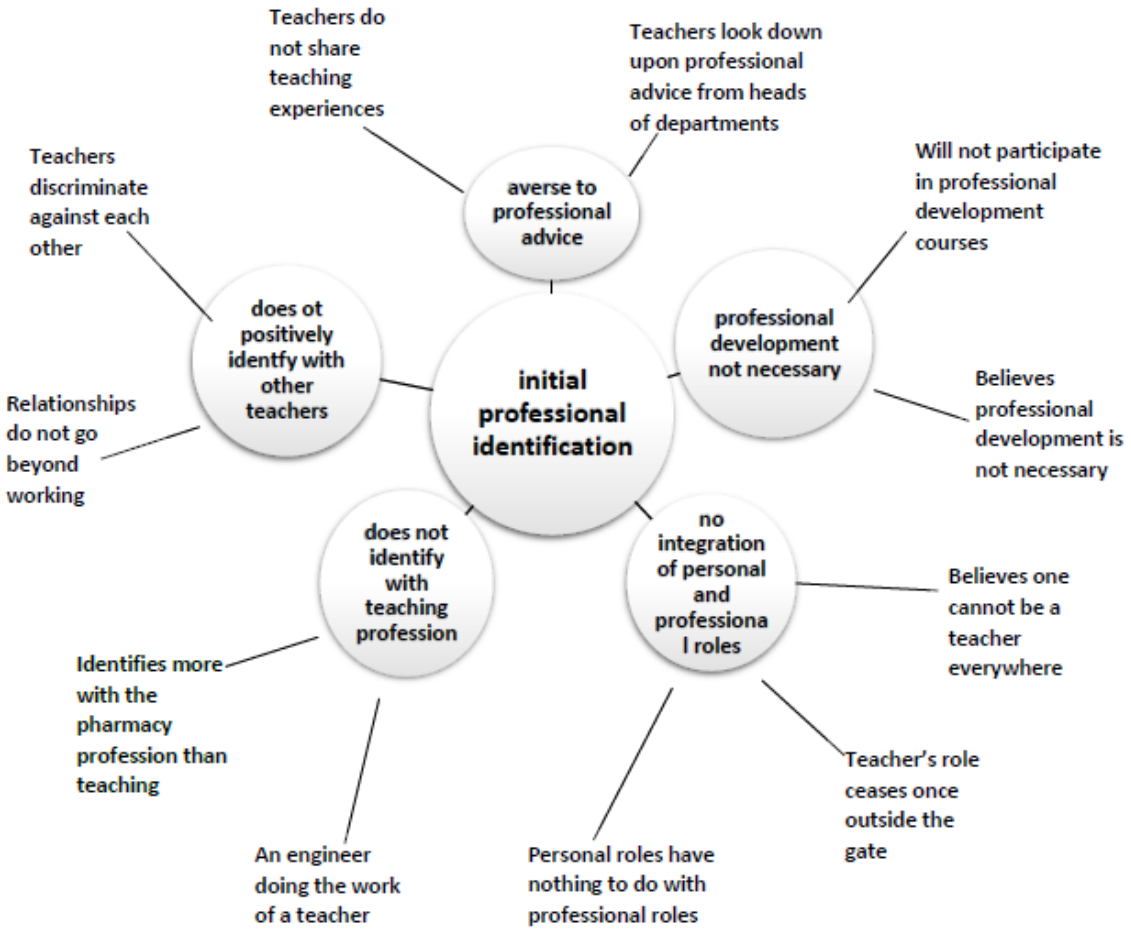

Figure 15: A presentation of the thematic network for teachers' initial professional identification

A total of five organising theme emerged from the data to support this global theme:

Does not identify positively with other teachers – this organising theme was supported by two basic themes – "teachers discriminate against each other" and "relationships do not go beyond teaching".

Averse to professional advice – this organising theme was supported by two basic themes – "teachers do not share teaching experiences" and "teachers look down upon professional advice from heads of departments".

Professional development not necessary – this organising theme was supported by two themes – "will not participate in professional development courses" and "believes professional development is not necessary".

No integration of personal and professional roles – this organising theme was supported by three basic themes – "believes one cannot be a teacher everywhere", "teacher's role ceases once outside the classroom" and "personal roles have nothing to do with professional roles".

Does not identify with teaching profession – "identifies more with the pharmacy profession than with teaching" and "an engineer doing the work of a teacher".

The teachers did not identify themselves with the teaching profession. Neither did they have any professional relations with other teachers in the same field. Said teacher A from University A:

'Our relationships do not go beyond the working hours. Everyone tends to do his or her own thing and goes away. We may not even meet or communicate unless there is a departmental meeting. The social aspect is missing. Sometimes it's even easier to relate with colleagues outside the institution who are in the same field than it is with internal colleagues'.

From the above comment, it could be deduced that the intradepartmental relations were not as cordial as they should be. This stemmed from the fact that the teachers did not identify positively with their profession and hence there was little attempt to relate to others in the same profession. Where individuals have positive professional identities, they seek to establish strong relations with others in the same profession (Caza & Creary, 2016; Eatough & Tomkins, 2014). That way, they can learn from each other and share their professional experiences. The teachers tended to be individualistic in their approach and were hesitant to approach each other on a professional basis. They planned their teaching independently of each other, and each would teach, evaluate, and grade students in a way that they saw fit.

The teachers also demonstrated that they did not integrate their professional roles with their personal roles. To most of them, their role at teachers ceased once they left the gate or, in some

instances, the classroom. They do not want to be recognised as teachers outside of the teaching premises.

Said teacher G from University C:

'Once I leave the gate I am no longer a teacher'.

Teacher E from University B concurred:

'One cannot be a teacher everywhere. There is no need to integrate personal and professional roles'.

From the above responses, it was clear that the teachers did not identify positively with the teaching profession. They did not want to be recognised as teachers in their personal lives. The teachers did not want to be professionally visible outside teaching contexts. Professional invisibility outside of one's workplace is a sign of lack of confidence in one's profession (Barbour & Lammers, 2015). This professional invisibility will lead to the professional not being recognised and acknowledged as such by those inside and outside the profession (Hatmaker, 2013).

The researcher also noted a discriminatory tendency among the university teachers that was based on where they earned their higher qualifications. Those who studied abroad had a tendency to look down upon their counterparts who attained their qualifications from local universities. This was confirmed by one of the participants who was a head of a department:

'The teachers tend to discriminate each other. You find those who went abroad have a superiority complex. They think their "local" counterparts are not that "exposed" and hence they have inferior qualifications. Some even look down upon their heads of the department if they attained their qualifications locally'.

The researcher found this to be a very serious issue as far as the professional socialisation of the teachers was concerned. It showed that teachers identified with where they went to for their university education and not necessarily with the ethos of the profession. This created an "us against them" scenario, which had the potential to disrupt the smooth operations of the departments. Such detachments caused a serious communication breakdown between the teachers. Lack of proper communication between teachers hinders knowledge sharing, and this has a negative impact on professional identity development (Smith et al., 2017). The fact that, in some cases, some teachers looked down upon their heads of departments showed that some

heads of departments had little control over their subordinates. This meant that learning was taking place in a haphazard manner.

Lack of training in pedagogy tended to negatively affect the communication and social relations among the teachers. In almost all the departments, no teacher had any training in pedagogy, and, therefore, no one could take the initiative to advise others. Said one teacher who was a head of a department:

'As a head of department, sometimes you want to advise the teachers on how best to approach the teaching process, but then you are limited because you are also not very sure about any pedagogical approaches'.

This assertion was of great concern since it was clear that even those who led the departments had low professional identities themselves, yet they were supposed to give direction to the rest of the members of the department. According to Eatough and Tomkins (2014), an individual's professional identity helps them in decision making. In this case, the departmental heads' decision-making abilities were compromised. Their roles were ceremonial to some extent as they could not offer any professional advice to their subordinates.

When asked about their views on attending professional development courses, most of the teachers were against the idea. They believed there was nothing to gain from participating in such programmes. They believed that the content knowledge that they already had was enough for them to teach effectively. Said Teacher H from University C:

'I have not had any chance to attend any professional development courses. Honestly, I do believe that they are very useful. With my qualifications, I would not require a teaching qualification to teach undergraduate students! . . . besides there are no such courses here, and the university does not emphasise on teaching qualifications'.

This teacher showed that he underestimated the role of pedagogical skills in teaching at a university level. He believed that his high academic qualifications were enough to enable him to deliver content effectively. His views were contrary to researchers of professional development who have found that university teachers need professional development in pedagogy for them to function effectively (Chabaya, 2015; Leavitt et al., 2015). Institutions also appeared to lack initiative in terms of facilitating the professional socialisation of their teachers. Most of the teachers had not attended any workshop or conference in pedagogy, either at the institutions or outside.

5.3.2.3 Theme 3: Participants' initial professional competency

The third theme represents the teachers' initial professional competency. Their responses showed the following: some paid no attention to teaching methods; some believed students were passive recipients of knowledge; some were opposed to the use of ICT in teaching; some believed that the teacher was supposed to be the purveyor of knowledge; and most of them lacked an understanding of the IBP approach (refer to Figure 16).

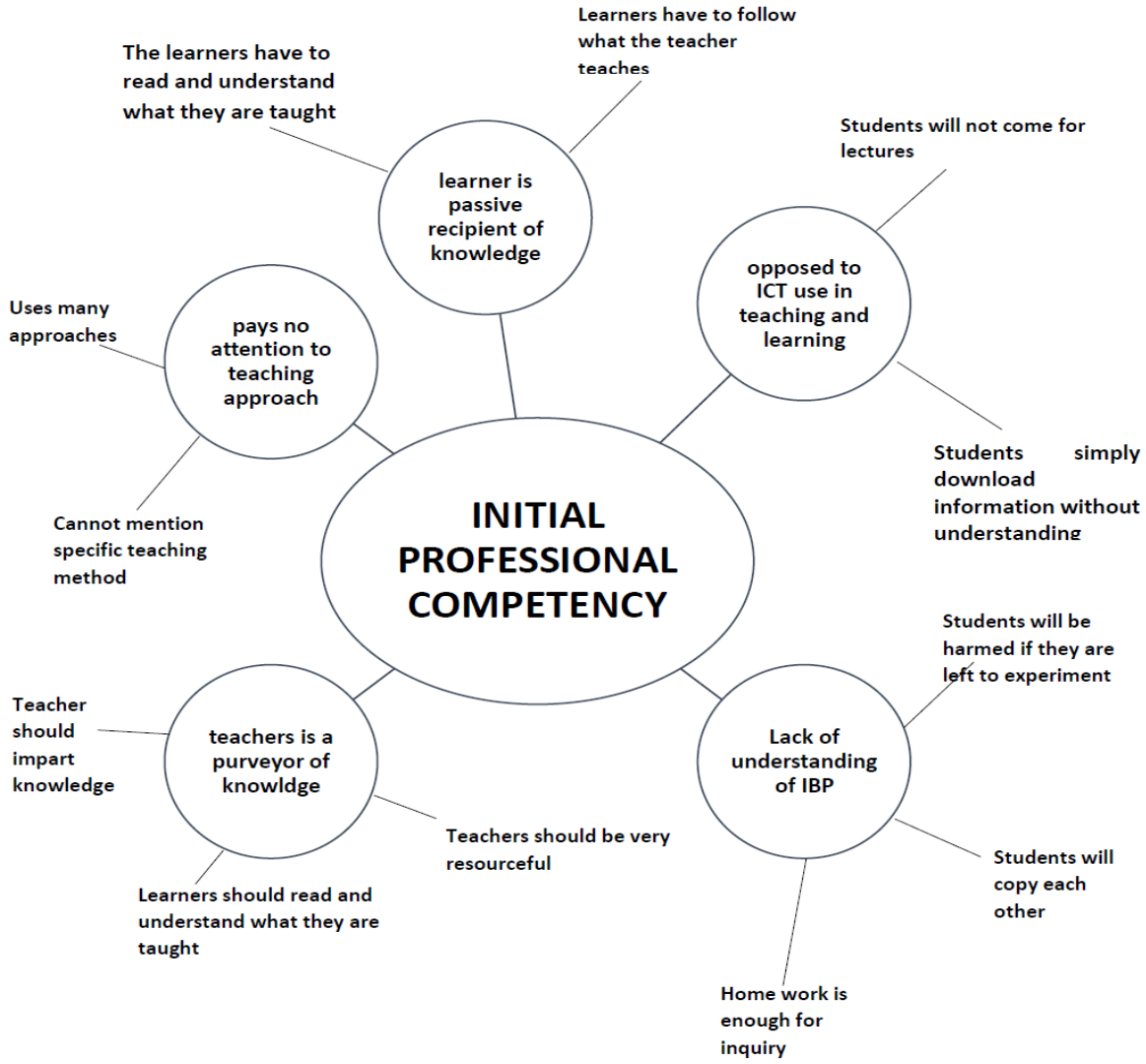

Figure 16: A presentation of the thematic network for teachers' initial professional competency

A total of five organising themes emerged to support this global theme:

Pays no attention to teaching approach – this organising them was supported by two basic themes – "uses many approaches" and "cannot mention specific teaching approach".

Learner is passive recipient of knowledge – this organising theme was supported by two basic themes – "the learners have to read and understand what they are taught" and "learners have to follow what the teacher teaches"

Opposed to ICT use in teaching and learning – this organising theme was supported by two basic themes – "students will not come for lectures" and "students simply download information without understanding".

Lack of understanding of IBP – this organising theme was supported by two basic themes – "students will be harmed if they are left to experiment", "students will copy each other" and "homework is enough for inquiry".

Teacher is a purveyor of knowledge – this organising theme was supported by three basic themes – "teachers should be very resourceful", "learners should read and understand what they are taught" and "teachers should impart knowledge".

The responses from the pre-intervention interviews showed that the teachers were mainly aware of, and were making use of the lecture method. They would give their students mass lectures, with little or no chance of discussions between the teacher and the students or among the students themselves. Lectures were usually accompanied by the dictation of notes by the teacher. In certain cases, the students would be given a soft copy of the lecture notes on their flash disks or email accounts. The teachers seemed to do everything for the students. Said teacher I from University C:

'When I go into the lecture room, I usually give a lecture to the students. After explaining a concept, I dictate the notes to them so that they can write the notes. I also give them handouts and well-prepared notes. I think this helps them to understand better'.

This response showed that this teacher used a teacher-centred approach (Shamsudin et. al, 2013; Ernst et al., 2017) to teaching where the teacher spoon-fed the student, even to the extent of writing notes for them. The teachers were of the view that they were supposed to play a more active role than the students in the learning process. The students, on the other hand, were supposed to be passive recipients of knowledge. In this particular teacher's view, students would not understand their own notes if he were to allow them to write on their own. So, to enhance student understanding, he would give them the whole package. The teacher believed in rote learning (Shamsudin et. al, 2013), where students were supposed to regurgitate the teacher's notes. This allowed him to finish the syllabus early and allow students to prepare for

their examinations. This showed the researcher that this teacher would teach with the aim of making his students pass the examination. He would do everything for them to make sure that they passed. He was not really worried about whether they internalised the concepts or not.

None of the participants had used IBP in their teaching. However, from the term word "inquiry" they seemed to get some idea of what was involved. They believed it would be difficult to use the approach for various reasons. These reasons included the complexity of chemistry as a subject at university; the academic calibre of the students; and the large classes involved. Most of the teachers actually believed it would be impossible to teach using IBP. Said Teacher H from University C:

'I am not sure about that approach. It will be very difficult to implement I think. You know with the calibre of our students . . . umm . . . I am not sure. Besides . . . .eh . . . the issue of time also . . .'

The researcher noticed a lot of hesitancy on the part of this respondent. He seemed to know his students and their capabilities and believed IBP would not work with his students. He thought his students would understand the subject matter better if he explained everything to them and gave them a well packaged set of notes. He did not believe that the students could have any useful, prior knowledge about chemistry at that level to construct any meaningful knowledge. To him, the students were empty slates that required filling from an outside source. These views betrayed a negative professional identity on the part of the teacher. Teachers with a negative professional identity tend to be self-centred and do not appreciate the role that students' prior knowledge plays in creating new knowledge (Fine & Desmond, 2015; Friesen & Scot, 2013; Khan, 2012).

Other teachers were against IBP from a student-safety point of view. They believed the use of chemicals was dangerous and required the teacher to lead the learning process. Some even preferred teacher demonstrations instead of allowing students to handle the chemicals themselves. They also believed if students would learn faster if the teacher was to demonstrate. Said Teacher F from University B:

'I believe teaching can occur faster, and students can understand better if the teacher leads the learning process. Besides, some of the chemicals can be harmful if they are not handled carefully. You know . . . (pause) . . . I have witnessed some accidents with chemicals, so I am now rather cautious'.

This response showed that this participant had some nasty experiences with chemicals. His experiences were now affecting how he was approaching chemistry teaching. He did not realise that IBP does not remove teacher supervision from the learning process (Kotsari & Smyrnaiou, 2017; Kuhn & O'Hara, 2014). To him, it was better to ensure that students are safe from accidents to ensure that they are not harmed. The teacher showed that he had not taught his students about laboratory safety procedures. He also believed that students did not know how to work with chemicals. This was rather surprising given that these were university students who were expected to have a great deal of knowledge about chemicals. The teacher showed a lack of appreciation that students had prior knowledge about chemicals.

Some of the teachers also believed that written assignments and homework allow students to learn on their own. However, the students ended up cheating. This was forcing the teachers to opt for class assignments where students are supervised as they do their assignment. Teacher A from University A said:

'Yah I believe that when I give students homework and assignments, they will be doing inquiry-based learning. But hey . . . sometimes this does not work. You see . . . chemistry is different from a subject like . . . sociology where students are asked to make their own interpretations. In chemistry you give . . . eh . . . say an assignment question and all students give the same answer which is correct. You don't know if they copied each other or not. So personally, I prefer that they write tests and I can see who prepared well'.

From the responses above, the researcher could tell that the teacher wanted each of his students to put the effort into learning but was frustrated by the collaboration that took place between students. He would then resort to giving students a supervised test to avoid cheating. The teacher showed a misconception of the IBP approach. While he was concerned about the originality of students' assignments, IBP is concerned with the construction of knowledge, which sometimes needs students to collaborate and share experiences (Calleja, 2016; Kogan & Laursen, 2014). The teacher preferred to judge students on their ability to regurgitate information that he had given then.

The teachers were also against reliance on computers and the Internet by students in learning chemistry. Their argument was that if students use computers in learning, they tended to rely more on Internet information than on the information that they were given by the teacher in the classroom. They were of the impression that computer usage was making them less important sources of information. With the availability of computers and Internet, students were

developing a tendency of absconding lessons believing that they could always get the information from the Internet. Said Teacher C from University A.

'Once you use too much Internet in teaching, the students tend to bunk lectures. There is this tendency . . . eh . . . you know these children nowadays . . . I mean, they think the Internet can replace the teacher. So, you find sometimes they don't come for lectures. You give them work . . . and what do they do? Sometimes a whole assignment is downloaded from the Internet. I prefer that they come to the lectures and write their notes as I teach. Actually . . . (laughing) my students know that they need to come for lectures. My examination questions come from lecture notes. So, you find now my students know that for them to pass they have to attend lectures. That is where I give them examination tips'.

By listening to this participant, one could tell he was a self-centred teacher. Self-centred teachers prefer to be the sole source of knowledge (Calleja, 2016). He felt that his role as the source of knowledge was under threat from the Internet so he would use attendance to lectures as incentive to pass exams. He would actually give his students tips on how to pass the exam. So, for any student to pass, they had to know what the teacher would have said in the lecture room. This teacher was the "knower" of chemistry and would discourage students from using other sources of knowledge. In other words, this teacher was inhibiting students' own agency in constructing knowledge.

On the issue of decision making, most of the teachers were of the view that it was not their responsibility to make decisions. They felt that their duty was to implement what they were given at the departmental level.

5.3.2.4 Theme 4: Participants' initial career progression plan

The fourth theme represents the teachers' initial career progression plan. Most of the teachers had no clear career progression plan. Their answers showed that some would consider taking up pedagogical courses if the course was flexible; some were considering higher qualifications in their academic field; some were unwilling to commit; and some believed it was not necessary to take up pedagogical courses (refer to Figure 17).

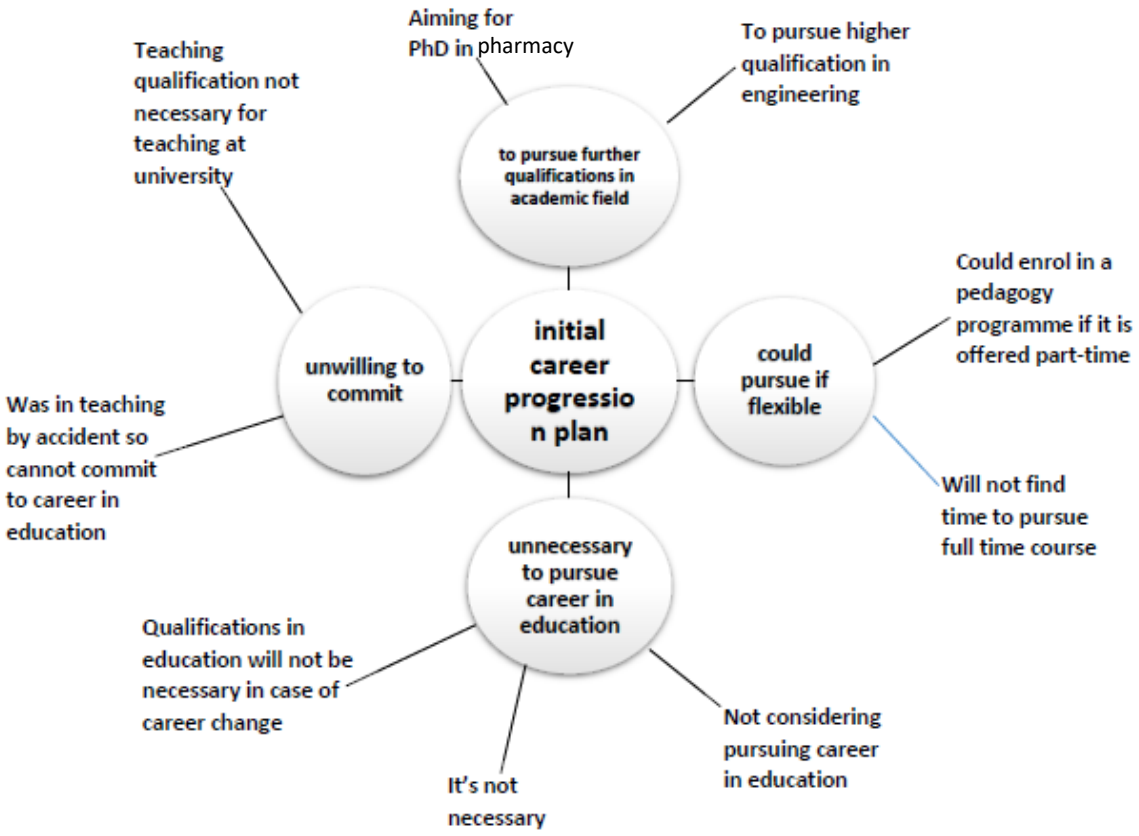

Figure 17: A presentation of the thematic network for teachers' initial career progression plan

Four organising themes emerged:

To pursue further qualifications in academic field – this organising theme was supported by two basic themes – "aiming for PhD in pharmacy" and "to pursue a higher qualification in engineering".

Could pursue if flexible – this organising theme was supported by two basic themes – "could enrol in pedagogy programme if it is offered part-time" and will not find time to pursue a full-time course".

Unnecessary to pursue career in education – this organising theme was supported by three basic themes – "not considering pursuing career in education", "it's not necessary" and "qualifications in education will not be necessary in case of career change".

Unwilling to commit – this organising theme was supported by two basic themes – "was in teaching by accident so cannot commit to career in education" and "teaching qualification is not necessary for teaching at university"

Their future professional engagements hinged on the financial security and stability of the various economic sectors. As far as university teaching was concerned, most of them were unwilling to commit their future to pedagogy. If opportunities were to arise in the industry, which paid better salaries than universities most of them said they would consider leaving university teachers. This was due to the fact that most of them had not initially planned to be university teachers. They, therefore, believed that new opportunities could come, which would influence them to abandon the teaching profession.

When asked about whether he was proud to be a university teacher, Teacher A from University A was initially hesitant to provide an answer. Then he had this to say:

'Well . . . as I said before I was in this profession by accident, so to say . . . I wouldn't say that I am proud as such. But of course, . . . I am OK'.

This teacher was not convinced that his job made him proud but admitted that at least he was engaged in some form of employment that would cater to his financial needs. According to Noi et al. (2016), when an individual is not sure about the satisfaction that comes with their job, that individual may be in the wrong profession and may have low professional esteem. An individual who has a positive professional identity should be ready to be identified with his profession. Professional identification reflects the extent to which individuals describe themselves in terms of their work and the characteristics normally assigned to people who do that work (Kim & Shin, 2018). People who positively identify with their profession tend to have self-defining beliefs about the profession and will closely associate with the professional group (Ivanova & Scara-Mincana, 2016). When an individual is not proud to be in a certain field, they do not have a positive professional identity.

On the issue of pursuing a career in education, most of the participants were of the opinion that it was not necessary as they were experts in their own fields. They would rather advance themselves in their academic fields rather than pursue a career in education. Others believed that they could teach without any need to acquire a pedagogical qualification. Most of the participants had taught for several years without pedagogical qualifications, and they believed that they could continue to do so. The few who would consider pursuing pedagogical qualification, would prefer to enrol in a flexible programme, which would not disrupt their academic work.

Said teacher F from University B:

'If I am to further my education, think I would pursue a PhD in my field. I don't see any benefits in getting a pedagogical qualification. After all, I might not use it anyway. . . . What if I get a job elsewhere? Would I be able to use it?'

Teacher B concurred:

'I might not really find it useful to pursue an education career . . . in case I find work in industry. I would be better of advancing myself in my career'.

From these responses, it was apparent that the teachers acknowledged the importance of qualifications in pedagogy, but only for those who would have committed themselves to be teachers. For them, it was not necessary at that juncture as they could find employment somewhere and find themselves with redundant qualifications. Pedagogical qualifications were for teacher, and hence they would not bother themselves as they did not consider themselves as teachers. The way that educators perceive themselves is influenced by their personal beliefs as educators (Izadinia, 2014). These perceptions about their professional 'self' play a critical role in how they teach, how they grow professionally, and how they adapt to educational change (De Vries et al. 2013)

On the issue of whether the teachers had a clear vision of how to become professional teachers in the university sector, most of them responded that they did not. For them, they had not troubled themselves to make inquiries about it. They did not even know that there were professional courses in teaching at the university level.

Said teacher H from University C:

'Well . . . I am not sure about that. What I am aware of are issues of research, university service, and the teaching aspect itself. Besides, I have not been asked about that here'.

From the response, it was clear that the issue of professional development was not taken seriously by the teachers. Even the universities themselves gave peripheral attention to the professional development of the teaching staff. As such, the teachers did not bother to acquire any skills that would enable them to improve their teaching practices in line with emerging trends. This indifferent approach meant that the university teachers continued to identify themselves with their academic fields rather than with the teaching profession. However, internationally, educators are considered to be professionally competent when they have a good understanding of the subject that they teach as well as the pedagogical knowledge about student

learning (Green, 2015; Izadinia, 2014). The participants' lack of pedagogical skills, therefore, affected their professional competencies and identities.

5.3.3 Experiences of university chemistry teachers

This section of the chapter presents findings of the experiences of the teachers as they discussed IBP on the WhatsApp Messenger platform. The findings were generated from participant observations. As they were discussing the researcher was making observations in order to answer research sub-question 2: What are the experiences of university chemistry teachers as they use WhatsApp Messenger to interact in the process of learning about inquiry-based pedagogy?

5.3.3.1 Participants' knowledge about WhatsApp Messenger

Generally, all the participants were well versed with the WhatsApp Messenger application. All of them had used it for socialising before the study. They knew how to send written messages, pictures, videos, and audio messages. They also knew how to upload and download documents in the Microsoft Office package. There were a few cases where participants asked for assistance in opening documents sent in PDF and PowerPoint format. In such instances, the participants assisted each other on the WhatsApp Messenger platform to download the relevant apps. A few of them had to be assisted with how to reply to specific messages on the platform and how to upload statuses.

5.3.3.2 Professional identity construction: the role of human agency

The professional identity construction process of participants in this study was an active process. Through their own actions on the WhatsApp Messenger platform, the participants managed to play a part in constructing their own professional identities. In other words, human agency played a critical role in shaping the professional identity construction process. Human agency refers to the actions that people take that shape their life trajectories (Cole, 2019). The researcher did not impose any thoughts and actions on the participants, but availed the WhatsApp Messenger platform through which they expressed themselves.

The roles that each individual played in the group activities played an important role in determining professional identity construction. In this study, group roles were not imposed on group members but arose from the natural attributes of the participants. These roles enabled individuals to contribute differently to the tasks and, in turn, resulted in their professional identities being shaped differently.

Teacher A

Teacher A was the youngest member of the group, and his behavioural patterns were consistent with group dynamics theorists who labels younger group members as group "playboys" (Gencer, 2019). This teacher was very often online and was quick with his responses. He was very active but at times displayed some attention-seeking behaviour in ways that were not relevant to the group objectives. His contributions were usually short answers or phrases that indicated that he paid little attention to the task at hand. He would easily get distracted or try to distract the group by posting irrelevant information. However, this behaviour would gradually change as the discussions continued.

Teacher A was a carefree participant who did not seem too concerned about where the discussions were heading. He was ready to accept the general trend that the group discussions were taking. As such, his professional identity formation was rather superficial. Strong professional identity formation occurs with the active participation of the individual in the activities that shape professional identity (Neary, 2014). Teacher A did not seem to be ready to fully engage in the transformative learning journey, but his participation in the discussions enabled him to gain an appreciation of the issues under discussion.

Teacher B

Teacher B was a very active participant. She always sought information and always presented well-researched arguments. She would regularly send academic articles with information on the topic under discussion. She would take time to respond to issues and displayed a lot of commitment to the tasks at hand. Her behaviour and actions were consistent with the provisions of the expectancy-value theory of Ecceles et al. (1983), which suggests that individuals who are convinced that they are engaged in a worthwhile activity, will attach value to it and get satisfaction from it. She would not rush with her answer but would take her time to research and analyse issues before responding.

As the study proceeded, the researcher noticed a gradual transformation in her views about teaching. While she initially was not keen to acknowledge the importance of pedagogy, she began accepting the importance of pedagogy in general and IBP in particular. The researcher noticed a gradual abandonment of the old mind habits as Teacher B began to reorient herself in accordance with new meaning perspective. When an individual abandons their frame of reference and adjusts to new realities as a result of a new experience, transformative learning has occurred (Mezirow, 2012). Teacher B gradually transformed from being a self-centred individual to a student-centred teacher. Her experience in the WhatsApp Messenger course had

allowed her to abandon her initial views about teaching as she replaced them with new knowledge generated from the network of teachers. This knowledge, according to the Connectivism theory (Siemens, 2005), did not originate from an individual but was generated within the nodes that made up the network.

Teacher C

Teacher C was a very active participant. He displayed high levels of interest in the course and was always made well-researched contributions. He would regularly provide links to websites where other participants could get more information on the topic. He was a highly motivated participant who was always ready to give his own opinion. Motivation allows humans to surpass the minimum expected accomplishments and enables them to set their own goals and values (Ryan & Deci, 2000). Highly motivated individuals value their engagements and invest time in achieving set targets (Eccles et al., 1983). As such, teacher C swiftly traversed the transformative learning process. He quickly accommodated new frames of reference (Mezirow, 2006) into his views about teaching chemistry at a university level.

Teacher C was also very technically competent in terms of the use of the WhatsApp Messenger platform and its related applications. He would assist other participants who encountered challenges with the technical aspects of the WhatsApp Messenger platform. For instance, when other participants needed assistance to open documents in PDF, he assisted that they download the relevant software from the Google App Store and installing it on their smartphones.

Teacher D

Teacher D was a passive participant. She was the 'social loafer' in the group. Social loafing is the tendency of certain group members to put the minimum effort into group tasks (Simms & Nichols, 2014). This usually occurs when an individual realises that their individual contributions would not be measured. In an online community, individuals who exhibit social loafing tendencies (so-called lurkers) passively follow the discussions without posting their own contributions (Shiue, Chiu & Chang, 2016). In the context of this study, membership was open and voluntary and there were no consequences for non-participation. Participants had been told that they were free to make their contributions as and when they had free time. However, the problem of loafing ended up spreading to other group members as time went on when other members also chose not to participate.

As with all social loafers, it was difficult to follow the professional identity construction process for Teacher D. Most of her comments were relatively short and offhand. This was a reflection of a lack of motivation on the part of the participant. Lack of motivation usually occurs when an individual is not prepared for a task or does not anticipate deriving any value from participating in the task (Hulleman, Durik, Schweigert & Harackiewicz, 2008). However, being part of the network made her an information node (Siemens, 2005). In a network, not all the nodes have the same strength. Some are stronger than others, and this can affect the way information is generated and transmitted within the network.

Teacher E

Teacher E was the group initiator. He was the one who usually started conversations on the WhatsApp Messenger platform. He was very resourceful and would regularly upload relevant articles. He had very high expectancies from the beginning of the course. Expectancies are an expression of an individual's confidence that the tasks they are performing will lead to a valuable outcome (Eccles et al., 1983). The interaction between expectancies and values helps to predict outcomes such as continued interest, continued engagement, and achievement. It was easy for the researcher to notice that Teacher E was motivated, was ready to participate in the activities, and had identified the subjective task value (Eccles et al.,) to be gained from the activities.

According to Eccles et al. (1983), subjective values can be divided into four categories: attainment value (importance of task for identity), intrinsic value (importance of task for enjoyment or interest), utility value (usefulness or relevance of task), and cost (what an individual stands to lose by participating in the task). A consideration of the subjective value of activities can, therefore, motivate or demotivate a participant. In the case of Teacher E, there was a high level of motivation to participate in the tasks. This enabled him to transform his identity from being the self-centred teacher he was before participating in the tasks.

Teacher E's readiness to participate as well as his appreciation of the subjective values enabled him to easily engage in a perspective transformation process. This process usually results from overcoming the disorienting dilemma (Mezirow, 2009), which was triggered by engaging in the WhatsApp Messenger-based IBP course. This transformation process occurred as a result of active participation in the life-changing activities of the WhatsApp Messenger group.

Teacher F

Teacher F was a very active participant. Just like Teacher E, he would also regularly post material for the other group members. However, unlike Teacher E, who would post ready-made material in the form of Word or PDF documents, teacher F preferred to post links on the WhatsApp Messenger platform. Members could easily click on these links to access and read the articles. He facilitated the acquisition of web-based information by utilising the digital connections of the network. According to the connectivism theory, knowledge does not exist in an individual but is found within and across networks (Siemens, 2005). Learning is, therefore, enhanced by connecting nodes that have specialised information. In the context of this study, the nodes were the individual teachers, websites, the facilitator, and other sources of information.

By referring other participants to particular websites, Teacher F activated the capacity of individual participants to generate knowledge within the network. In other words, the websites were nodes that had information and the individual participants also became knowledge generation nodes. According to Siemens (2005), the nurturing and maintenance of connections enhance continual learning. This continual learning enabled the participants to gain new knowledge that led to the transformation of their meaning perspectives (Mezirow, 2009). Therefore, by researching and referring other participants to websites, Teacher F enhanced their learning as well as his own learning.

Teacher G

Teacher G was the compromiser (Forsyth, 2014). Never the one to start a discussion or present an argument, his contributions were always in agreement with the last contributor. He shied away from controversy and would always take the middle-line in the discussions. Compromisers are important for group cohesion and growth (Forsyth, 2014), however, it is not easy to interpret their points of view. They might not agree with certain views but would not argue for the sake of progress. It was therefore not easy to follow his professional identity development.

Teacher G started with a disorienting dilemma (Mezirow, 2006) and went through the transformative process until he assimilated the provisions of the new professional identity influenced by the WhatsApp Messenger-based course. In other words, he started by identifying himself as the knower of chemistry but gradually came to accept that students can play an important part in their learning process. The transformation in meaning perspective occurred because the teacher was receptive to receiving alternative meaning of reality and then

recognised that this alternative meaning was authentic. The teacher went through a silent grieving phase of the transformation process, where he realised that his old way of doing things was no longer relevant and gradually moved to adopt new ways. According to Boyd and Myers (1998), transformation can also take place due to less dramatic predicaments that individuals encounter in a learning set up.

Teacher H

Teacher H was a pliant participant. He went through the course without any outstanding contributions to the discussions. He preferred others to do and post the research work, and would make short comments, which were generally in agreement with the last contributor. He was averse to controversy so he would not pass negative comments or criticise others. He was a group harmoniser (Forsyth,.2014) who did not want to criticise others. Though his actions were important for group cohesion, it was difficult to determine how his own efforts contributed to the construction of his identity. The identity construction process was, therefore, shaped more by being a member of the group and less by his own effort. Usually, when professional identity development occurs passively, it is not well established in the individual and alternative identities may form (Mathe & Hapazari, 2019). Such was the case with Teacher H. He could not commit himself to the dictates of the new professional identity and relapsed into his older self.

Undertaking a professional programme should result in individuals altering their existing identity (Frost & Regehr, 2013; Monrouxe, 2015). This involves deconstructing aspects of their existing identities and assuming new identities. If the individual is not prepared to change their image, they may not be prepared to participate in it. This is consistent with the expectance value theory, which insinuates that an individual attaches value to activities that align to their self-image (Ibrahim et al., 2017). Teacher H failed to deconstruct his image as a Biochemical Engineer and his image remained so during and after the course.

Teacher I

Teacher I was a very active participant. His responses were quick, and he would also regularly post information on the WhatsApp platform. He was very critical about issues and would not accept other participants' contributions at face value. He was quick to point out his reservations on certain issues and preferred to debate issues before coming to a conclusion. He was entitled

to his own opinions and would stick to them. He was the first person to point out the weaknesses of IBP as a teaching approach even though he acknowledged its effectiveness in the teaching of Chemistry. He spent a long time in the "self-examination" and "sense of alienation" stages of the transformation process (Mezirow, 2006). However, his arguments provided opportunities for reflection on the part of other participants.

Teacher I's arguments helped to keep the discussions balanced. Even though the course was about IBP, Teacher I managed to point out that it could not be used exclusively in teaching chemistry at a university level. This enabled the group to appreciate other pedagogies as well. When teachers begin to critique and evaluate elements of pedagogy, they would have reached a high level of professional growth and identity (Noi et al., 2016).

5.3.4 Experiences of university chemistry teachers about IBP

The teachers were asked to work in three groups to prepare lesson guides or activities that they will use to teach using IBP. Teachers from the same university were put in the same group. The groups were as follows:

Group 1 (Teacher A, Teacher B, and Teacher C);

Group 2 (Teacher D, Teacher E, and Teacher F); and

Group 3 (Teacher G, Teacher H, and Teacher I).

Group 1 produced a lesson guide (Appendix 1) with which students were supposed to perform tasks to identify the following metals using their reactivity: calcium, aluminium, magnesium, zinc, beryllium, and iron. The containers for these metals had come without labels. Students were required to identify and label all the containers. The teacher would explain that all the metals react with HCl to produce the particular metal chloride and hydrogen gas. For example, Aluminium and hydrochloric acid (HCl) react according to the following equation:

$$2Al_{(s)} + 6\ HCl_{(aq)} \rightarrow 2AlCl_{3\,(aq)} + 3H_{2\,(g)}$$

The students were expected to identify the reactivity of each metal and to arrange metals in order of their reactivity. From this order, they were expected to identify the metals and label the containers.

Group 2 proposed a research project (Appendix 2) where students would investigate the medicinal properties of plants. They were to be shown three plants and told that one of the

plants is a very effective cure for malaria. They were to devise their own procedures for sample collection, extraction, separation, maceration, infusion, decoction, and other steps. They were then expected to isolate the functional groups in the samples and compare them with quinine which is used to treat malaria. They were to be given the structure of quinine as shown in Figure 18 below.

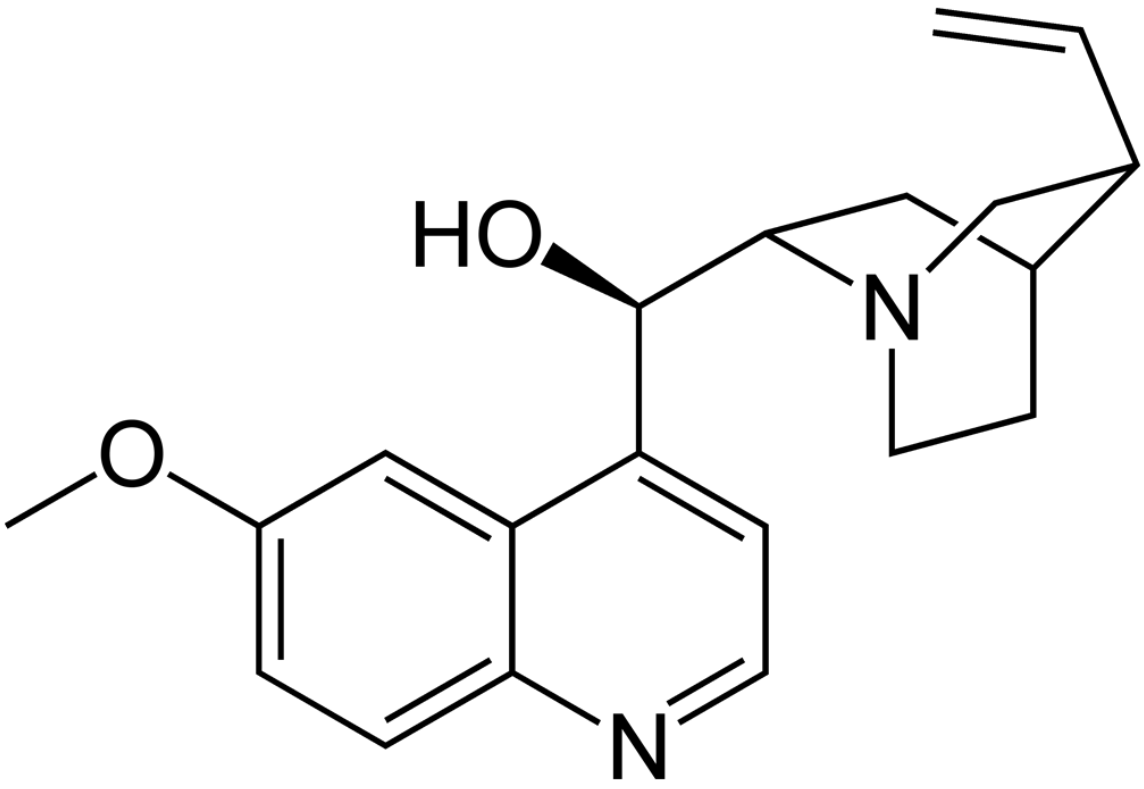

Figure 18: A depiction of the structure of quinine

Group 3 produced a lesson plan (Appendix 3) in which students were supposed to identify unlabelled samples of the following organic compounds:

Benzoic acid powder, salicylic acid powder, stearic acid powder, and peanut oil. They were to be given the following materials and chemicals:

Spatula; glass stirring rod; 10 mL graduated cylinder; 15 x 125-mm test tubes; test tube rack; pH meter; water; 3 ml graduated droppers; 5% $NaHCO_3$; 5% NaOH; 5% HCl; 5% H_2SO_4; diethyl ether and Hexane.

Students were supposed to devise their own procedures to identify the organic compounds. These procedures would be checked by the teacher for safety compliance. For safety, they were to be told that all reactions would take place in a fume hood.

From the lesson plans prepared by the teachers, the researcher could tell that there was a shift from their initial approaches to teaching. Whereas initially, the teachers would use cookbook instructions in their teaching, the new approach gave students the leeway to develop their own experimental procedures. They were now employing inquiry-based approaches that were more student-centred.

5.3.5 Professional identity after engaging in inquiry-based pedagogy course

This section of the chapter presents the findings of the beliefs, knowledge, and practices of the teachers after engaging in the WhatsApp-based IBP course. The findings were generated from semi-structured interviews. The aim of the interviews was to get further clarification on how teachers described their own experience as they learnt IBP through WhatsApp Messenger (see Sub-question 2) as well as to get answers to Sub-questions 3 and 4, as reiterated below:

Sub-question 3: How does the professional identity of university chemistry teachers change (if at all) as they interact through WhatsApp Messenger?

Sub-question 4: How do the pedagogical practices of university teachers change (if at all), because of learning inquiry-based pedagogy through WhatsApp Messenger?

5.3.5.1 Theme 5: Teachers' views about WhatsApp Messenger-Based learning

Theme 5 represents the views of the teachers about learning using WhatsApp Messenger. The organising themes around this global theme are that the teachers found the learning process to be very flexible; there was an efficient transmission of knowledge; they managed to send information to many people at the same time; they managed to connect with people from various academic backgrounds; it was easy to use, and there was efficient feedback (refer to Figure 19).

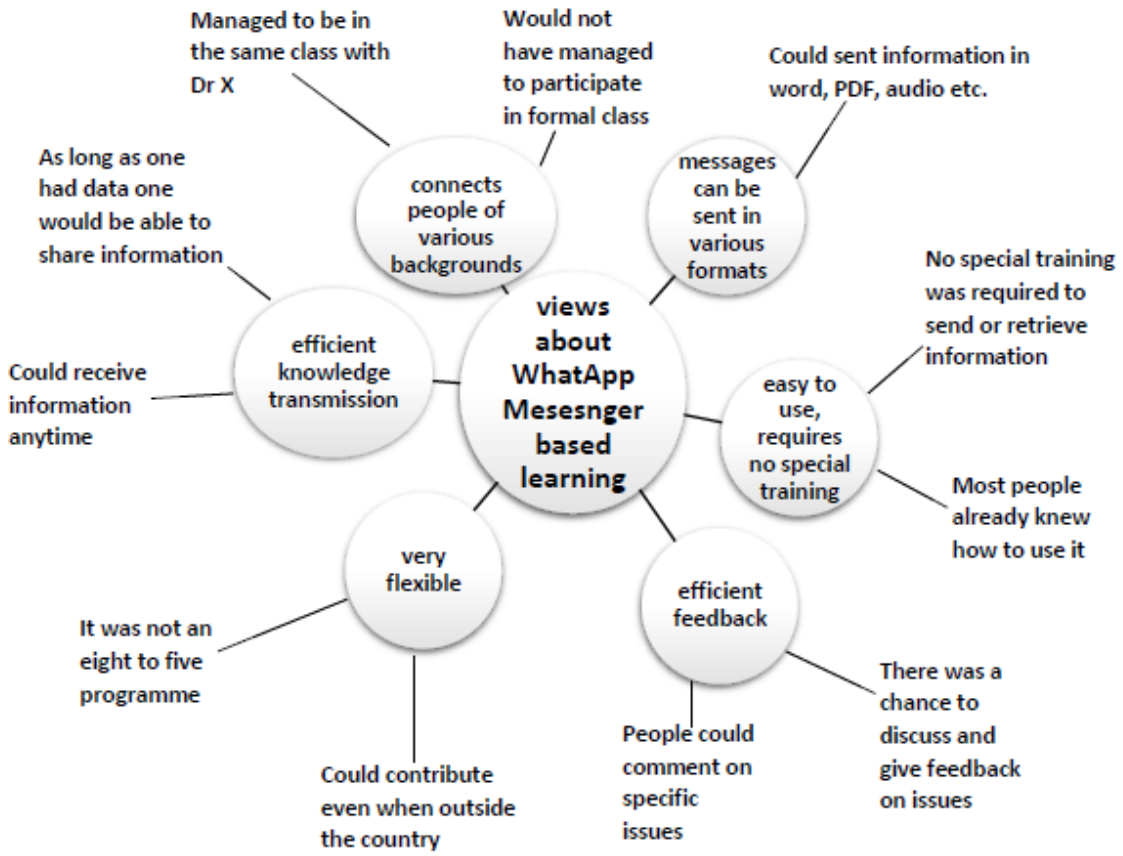

Figure 19: A presentation of the thematic network for teachers' views about WhatsApp Messenger-based**.**

Six organising themes emerged:

Connects people of various backgrounds – this organising theme was supported by two basic themes – "managed to be in the same class with Dr X" and "would not have managed to participate in formal class".

Messages can be sent in various formats – this organising theme was supported by one basic theme – "could send information in word, PDF, audio etc."

Easy to use, requires no special training – this organising theme was supported by two basic themes – "no special training was required to send or retrieve information" and "most people already knew how to use it".

Efficient feedback – this organising theme was supported by two basic themes – "people could comment on specific issues" and "there was a chance to discuss and give feedback on issues"

Very flexible – this organising theme was supported by two basic themes – "it was not an eight to five programme" and "could contribute even when outside the country".

Efficient knowledge transmission – this organising theme was supported by two basic themes – "as long as one had data one would be able to share information" and "could receive information any time".

They could access and share information at any time of the day. For those who were busy during the day, they could even give their contributions late at night. Participants also did not need to congregate in a physical classroom for learning to take place. This enabled them not to miss out on anything that was discussed when they were engaged with other issues. Said Teacher C:

'I found the learning to be very flexible. I could access my message at any time of the day. It is unlike the eight to four things . . . you know you don't have to stick to a timetable. You also don't have to be in class".

From this teacher's response, it was apparent that WhatsApp Messenger removed the time and place barriers from the learning process. Teachers did not have to be in the class every time they needed to deliver content. In line with the findings of Rambe and Chipunza (2013), this enabled the teachers to concentrate on their work and engage in the course when they had time. WhatsApp Messenger has also been found to enhance cooperation and increase motivation to engage in academic activities (Rambe & Bere, 2013).

The teachers also recognised the interactivity of the WhatsApp Messenger platform as a learning tool. It enabled them to share information with people from a variety of backgrounds. Some admitted that, in a normal situation, they would have been unable to communicate with certain individuals due to social barriers. For example, the junior teachers normally had a challenge in reaching out to their senior colleagues in a traditional working situation. They also believed that the seniors would never have agreed to be in the same class with them if the course was offered in the traditional way. Said Teacher E:

'I never knew that I was in the same class with Dr . . . [name withheld]. It's like we never talk to each other. I doubt if he would have agreed to be my classmate [laughing]. But seriously it was quite an amazing experience. I mean . . . I have used WhatsApp before . . . for socialising with friends and relatives. Usually for less serious business . . . ".

This response showed that WhatsApp Messenger removes social barriers that prevent teachers from interacting and sharing information. In formal setups, there is a social gap between senior teachers and their junior counterparts (Gasaymeh, 2017; Yin, 2016). This gap prevents information from passing from the senior teachers to the junior teachers. The response also showed that the seniors tended to look down upon their juniors and would consider it inappropriate to join them in a learning environment. Teacher E's last statement also showed that he believed that he had engaged in serious business, albeit in a non-formal manner.

On the issue of feedback, the teachers were in agreement that the WhatsApp Messenger platform had provided a conducive environment for feedback. The teachers could ask questions to the facilitator or to each other and feedback was done at a convenient time. The application has a facility where an individual can choose to respond to a specific question (Susilo, 2014). By pressing on a particular question, the app highlights and creates a field for response. This function made it easier for the users to know which questions were being responded to.

The teachers also found WhatsApp Messenger easy to use. No special skills were required to operate it. They could also send documents in Microsoft office packages that all of them were familiar with. Pictures, videos, and audio files could also be sent where it was possible and convenient. The teachers could carry their devices everywhere and this ensured the social presence of the teachers throughout the term. Teacher G had this to say:

'The good thing about WhatsApp was its ease of use. No special training was needed for us to use it. Besides that, everyone was already using WhatsApp before the course . . . and you could receive information in many forms, video, audio, PDF, word and so forth'.

The response showed the convenience provided for learning IBP using the WhatsApp Messenger platform. This convenience played a big part in the development of their professional identity. The environment plays an important role in professional identity development (Witworth & Chiu, 2015). Restrictive environments or those environments that place extra burdens on the participants, discourage full participation (Smith et al, 2017). The fact that participants already knew how to use WhatsApp Messenger meant that there was no extra burden on the teachers to master the technical aspects of the app. In other words, it provided a conducive environment for them to learn and for the development of their professional identities.

On the issue of the flow of ideas, the teachers noted the need for proper management to avoid confusion. This happened especially when responses came late. If the participant did not highlight the particular question they were responding to, it would confuse other participants. They, however, conceded that this was a minor issue encountered during the first few days. As the course went on, the flow of ideas improved. Teacher I from university C said:

'The flow of ideas needs to be managed; otherwise, the discussion can lose focus. We saw this during the first few days, but it improved as we went on'.

On the issue of transmission of information, the teachers were in agreement that they managed to send and receive documents in various forms. This included Word documents, PDF, and Excel. They could also send and receive links to websites. Information could also be sent in the form of pictures, videos, and audio messages. According to Sibanda (2016), packaging information in a variety of formats enriches the message. The information sent by participants could be received instantly for those who were online. Those who were offline could receive their messages when they connected to the Internet. This means the teachers would not miss out on any discussions that occurred when they were offline. Even those who travelled outside the country during the course did not lose touch as the WhatsApp Messenger app had a facility that transferred their conversations onto new sim cards in cases where they changed the sim cards. Said teacher F from university B:

'Information transmission was very efficient. You could send messages from wherever you are as long as you had Internet connectivity. Even the days I left the country, I did not lose out on the discussion, so I believe WhatsApp is a very effective learning tool'.

The response of the teacher showed that he was satisfied with the experience that he had with WhatsApp Messenger during the course. He believed that it was an effective tool because it enabled him to discuss with others without necessarily being in the same location. According to Rambe and Bere (2013) WhatsApp Messenger removes the effect of geographical location being a barrier to learning.

The other important issue raised by the teachers was WhatsApp Messenger's ability to store information. It has a facility that backs-up conversations (Giordano et al., 2015; Statista, 2016). This back-up facility enabled individuals to refer to the conversations later on. Even when a phone was lost, the particular participant could still recover their conversations. Teacher G from University C said:

'The good thing about the app is that you can recover your messages and documents in the event that you lose your phone'.

The issue raised by the teacher showed the ability of the WhatsApp Messenger to keep individuals connected even when internet connectivity is not there. A member of the network who lost connectivity due to loss of Internet or loss of the physical device, remained a member of the group and could catch up with the conversations at a later stage. The information generation node (Bockurt et al., 2016) remained active even though the connection would have been broken. Information could easily be retrieved because of WhatsApp Messenger's back-up facility.

5.3.5.2 Theme 6: New teaching beliefs

This theme represents the changes that occurred to the teachers' teaching beliefs as a result of engaging in the WhatsApp Messenger-based IBP course. The findings were generated from semi-interviews after the course. The theme responds to Sub-question 3: How does the professional identity of university chemistry teachers change (if at all) as they interact through WhatsApp?

From the thematic network, the researcher deduced that the teachers were now more student-centred; they believed in student ability; and viewed themselves as a teacher, and they now understood that teaching was a profession (refer to Figure 20).

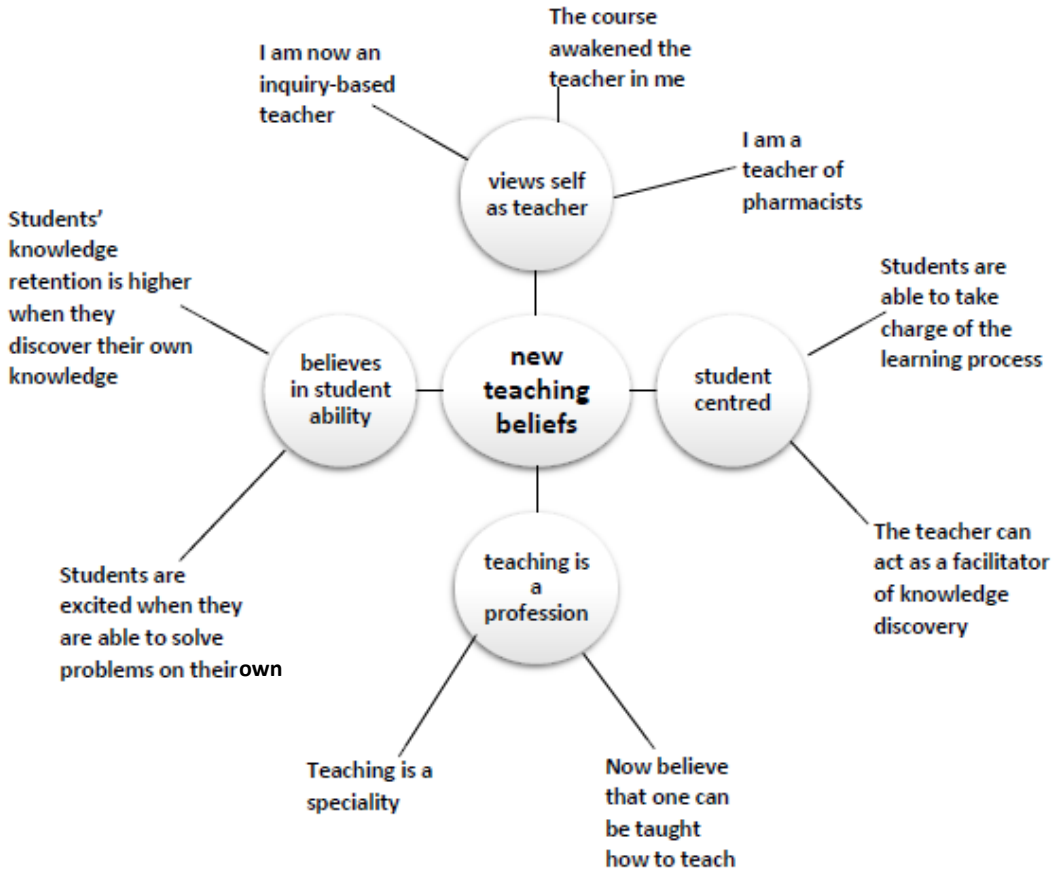

Figure 20: A presentation of the thematic network for teachers' new teaching beliefs

Four organising themes emerged:

Views self as teacher – this organising theme was supported by three basic themes – "I am now an inquiry-based teacher", "the course awakened the teacher in me" and "I am a teacher of pharmacists"

Student centred – this organising theme was supported by two basic themes – "students are able to take charge of the learning process" and "the teacher acts as a facilitator of knowledge discovery ".

Teaching is a profession – this organising theme was supported by two basic themes – "teaching is a profession" and "now believe that one can be taught how to teach".

Believes in student ability – this organising theme was supported by two basic themes – "students are excited when they are able to solve problems on their own" and "students' knowledge retention is higher when they discover their own knowledge".

Of particular interest was the realisation and admission by the teachers that teaching was a process of facilitating students' knowledge acquisition. The teachers recognised the importance of placing the students at the centre of the learning process so that they use their previous knowledge to create new knowledge. There was a shift from the belief that students had nothing to offer in the learning process and were there to be loaded with knowledge that existed in the teacher's mind. Said Teacher C from University A:

'I used to believe that the role of the teacher is to search for information and information sources for the students. You see . . . eh [pause] that is how we were taught when we were at university. Our lecturers used to give us notes. I mean . . . everything. Actually, you if you wanted to pass, you had to read the lecturer's notes. However, we would forget everything soon after the examinations as we prepared for the next examination. Through this course, I realised that the teacher can act as a facilitator of knowledge acquisition, and . . . actually . . . eh it seems students' retention is high when they discover the information through their own effort'.

From this participant's response, the researcher could tell that there was a shift in mindset from being a self-centred instructor to a student-centred facilitator. His initial teaching beliefs were influenced by the way he was taught when he was at university, where the teachers would arrive with prepared notes to give students. The students would acquire knowledge through rote learning (Chabaya, 2015; Leavitt et al., 2015). This would assist the students to gain knowledge that would enable them to pass the examinations, but they would forget everything after the examinations (Chabaya, 2015; Mgijima, 2014). The teacher also pointed out the fact that students tend to understand better and had better retention of knowledge when they discover knowledge through inquiry.

Teacher C also spoke about the aspect of student motivation when they learnt through IBP. He had this to say:

'You can actually notice a sense of motivation among students when they use IBP. They exhibited a lot of excitement when they managed to solve a problem through their own effort, and you could notice that their curiosity and inquisitiveness was elevated when one of them managed to discover something new or managed to solve some complex problem'.

The researcher could tell from this participant's response that he had managed to refine his IBP skills. He was beginning to notice the motivational aspects of IBP, which are supported by

proponents of IBP (Kazempour & Amirshokoohi, 2015; Kuhn & O'Hara, 2014). This realisation had the effect of strengthening his beliefs about the teaching approach and changing his initial beliefs about teaching. Indirectly, his professional identity had changed from being the imparter of knowledge, to being a facilitator of knowledge acquisition.

Some of the participants also highlighted the fact that they could learn something from their students when they allowed them to engage in open inquiry. Students were coming up with novel project proposals that could be turned into commercialisable products. The participants realised that they could make use of their students' abilities to generate knowledge for their own good as well. It is proven that students are rich sources of knowledge when guided properly (Kuhn & O'Hara, 2014). Some teachers actually took up the opportunity to co-author scientific papers with their students. Said Teacher H from University C:

'Students are actually capable of coming up with very good innovations if they are allowed to engage in open inquiry. They can actually play a leading role in their own learning . . . [slight hesitation]. They only need to be properly guided so that the whole thing does not become haphazard'.

From this teacher's response, the researcher could tell that he was very confident that students could lead the learning process. However, the slight hesitation was an indication that the teacher suddenly realised that he had removed the role played by the facilitator in the learning process. Though the students could engage in their own learning, the teacher should still play a key role. In the case of chemistry teachers, new roles have emerged that define teachers as designers, mentors, modellers, facilitators, and partners in the learning process (Vokatis & Zhang, 2016). The realisation by the teacher of these roles was an indicator that his professional identity had transformed from that of being an instructor to a mentor.

When the participants were asked what job title they preferred after their participation in the IBP course, it emerged that most of them realised the importance of their pedagogical function in their jobs. There was a realisation that even though they were experts in their academic fields, their work at the universities required them to realise the teacher in them. This would make them more effective in their duties and enhance their students' problem-solving skills. Teacher H from University C had this to say:

'Even though I had taught for some time, I had not realised that teaching could be a speciality. I did not even believe that someone could be taught how to teach. To me, I thought anyone with

higher qualification could teach the one with lower qualifications. The course was really an eye-opener for me. I am now an inquiry-based university teacher . . . [laughs] . . . yes . . . if there such a title. But seriously I really learnt a lot in the course'.

The response showed that Teacher H had found the course to be very useful in the development of his teaching skills. It had transformed his initial belief that anyone could teach those with lower qualifications than them. The transformation of teaching belief is an indication of transformation of professional identity (Noi et al., 2016). The experience in this course taught Teacher H that teaching was a specialised job with special approaches and skills (Kotsari & Smyrnaiou, 2017; Kuhn & O'Hara, 2014). Now that he had acquired these skills, he was more confident to let the world know that he could teach at university using special skills.

Other teachers preferred to be recognised for their dual role – being academics and being university teachers. Nevertheless, this was a shift from their initial preferences of being recognised as academics alone. They now had dual identities (Neary, 2014). There was now that recognition that having knowledge about how to teach at university gave teachers an added advantage over their academic peers. Said Teacher B from University A:

'I think you can now call me a teacher of engineers. I have the qualifications that allow me to operate as an engineer, but above that, the course gave an extra edge because I now know how to teach more effectively'.

From the teacher's answer, the researcher could tell that Teacher B believed that she would be more effective as a teacher after participating in the course. The course gave her an extra edge over other engineers because she now had pedagogical competencies. Knowledge about pedagogy improves teacher self-efficacy and professional identity (Owen, 2014; Vokatis & Zhang, 2016). Teacher B was no longer just an engineer but an engineer who could teach other people to be engineers.

When the teachers were asked the reasons why they had shifted their views about themselves, they pointed out that the course managed to impart in them new teaching skills that they did not have before, and this changed the way they viewed their roles in their workplace. They pointed out that, initially, they did not believe that they were teachers because they lacked an appreciation of the importance of pedagogy. They initially believed they were only academics who were doing the work of teachers. They did not have any knowledge about any theories and

approaches to teaching but knew about theories and formulas related to the academic qualifications. Said Teacher F from University B:

'The reason why I said I was not a teacher was that I was not a teacher. I had no knowledge about any teaching approaches except giving students lectures, notes and assignments. I did not know about any specific teaching approaches. To me, university teaching was just a process where one scientist was giving scientific knowledge to another . . . simple. I really considered this to be an interim thing as I waited for some opportunities to come. I think the course sort of awakened the teacher in me. Also, if you consider how the course was offered, it was very flexible . . . [pause] . . . you did not realise that you were learning. It was just like socialising . . . but then at the end, you realise something worthwhile has been imparted into you'.

To the researcher, this teacher was suggesting that he initially had a hands-off approach to teaching because he did not think teaching was a worthwhile venture. This thinking was informed by his initial belief that university teaching was something that is embarked upon by people who have not yet found the right job to do. This means he initially had negative beliefs about teaching. It is assumed that teachers' pedagogical beliefs play a very important role in determining teachers' decision-making processes as they plan and implement educational activities (Mihaela & Alina-Oana, 2014). So, Teacher F's belief that, by teaching at university, he was whiling time while waiting for a real profession, had negatively affected his teacher identity and ability to deliver. However, when he embarked on the course through WhatsApp Messenger, he realised that teaching was actually a profession that had its own established theories and procedures (Kuhn & O'Hara, 2014). These theories made him realise that teaching was actually a profession. It was only when this teacher started using the inquiry-based approach to teaching that he realised he was a teacher. The new experiences in the online professional development community, according to the dual systems theory, led to the development of System 1-based actions and heuristics, which became the new default processes (routines) and reduced the need to activate System 2 processes that require more effort (Kahneman, 2011). Teacher F also confessed that, were it not for the flexible environment afforded by WhatsApp Messenger, he could not have found any time to learn about pedagogy because he did not believe it was a worthwhile enough experience to make time for.

Even the few participants who still preferred their academic titles, wanted to be recognised as having pedagogical competencies. They had now developed positive professional

identification with the teaching profession. Professional identity development typically leads to a change in the way an individual presents themselves to other people as well as to themselves (Van der Want et al., 2017; Weld, 2015). The participants now wanted to present as pedagogically competent people. To them, their knowledge about pedagogy gave them an extra edge over their academic counterparts without pedagogical knowledge. This further showed that their interactions on the WhatsApp Messenger platform had transformed their professional identity. They now attached some value to their knowledge of pedagogy. According to the expectancy-value theory (Eccles et al., 1983), when individuals are engaged in an activity that they believe is worthwhile, they attach a value to it and enjoy being associated with it. And when an individual enjoys associating with the norms and values of a profession, it shows that they have developed a professional identity.

A few of the teachers held on to their initial beliefs that they were academics, not teachers. For these teachers, while they acknowledged that pedagogical skills were important in teaching at university, they considered themselves to be more inclined to their academic disciplines than the teaching profession. For example, Teacher A from University A said:

'Well, I still view myself as a pharmacist. That is what I have always been. But well, I do appreciate the importance of teaching skills for effective teaching . . . especially for those who want to remain as university teachers'.

Teacher A had shown throughout the study that his professional inclination was towards his academic qualifications. He had been consistent that teaching was not for him and he remained that way even after undergoing the WhatsApp Messenger-based IBP course. Even his participation in the course was peripheral. Where an individual does not believe that an activity is worthwhile, they will not derive any satisfaction in it (Eccles et al., 1983) and, for such an individual, it is difficult to change their frames of references and mind habits (Mezirow, 2012). However, Teacher A appreciated that the pedagogical skills were necessary for those who wanted to continue as teachers. This, according to the dual systems theory of Kahneman (2011) was an indication of a change in the conscious mind processes, but which failed to take place in the unconscious processes. The conscious processes, attitudes, and actions may be easily transformed by education and persuasion, whereas the unconscious processes and attitudes usually take longer to transform (Hattie & Yates, 2014).

5.3.5.3 Theme 7: Professional socialisation

The seventh theme represents the professional socialisation that occurred among the teachers as they discussed IBP on the WhatsApp Messenger platform. The teachers now identified more positively with the teaching profession as well as with each other. They were now also receptive to professional advice and spoke positively about professional development programmes (refer to Figure 21). The theme directly responds to research Sub-question 3: How does the professional identity of university chemistry teachers change as they interact through WhatsApp?

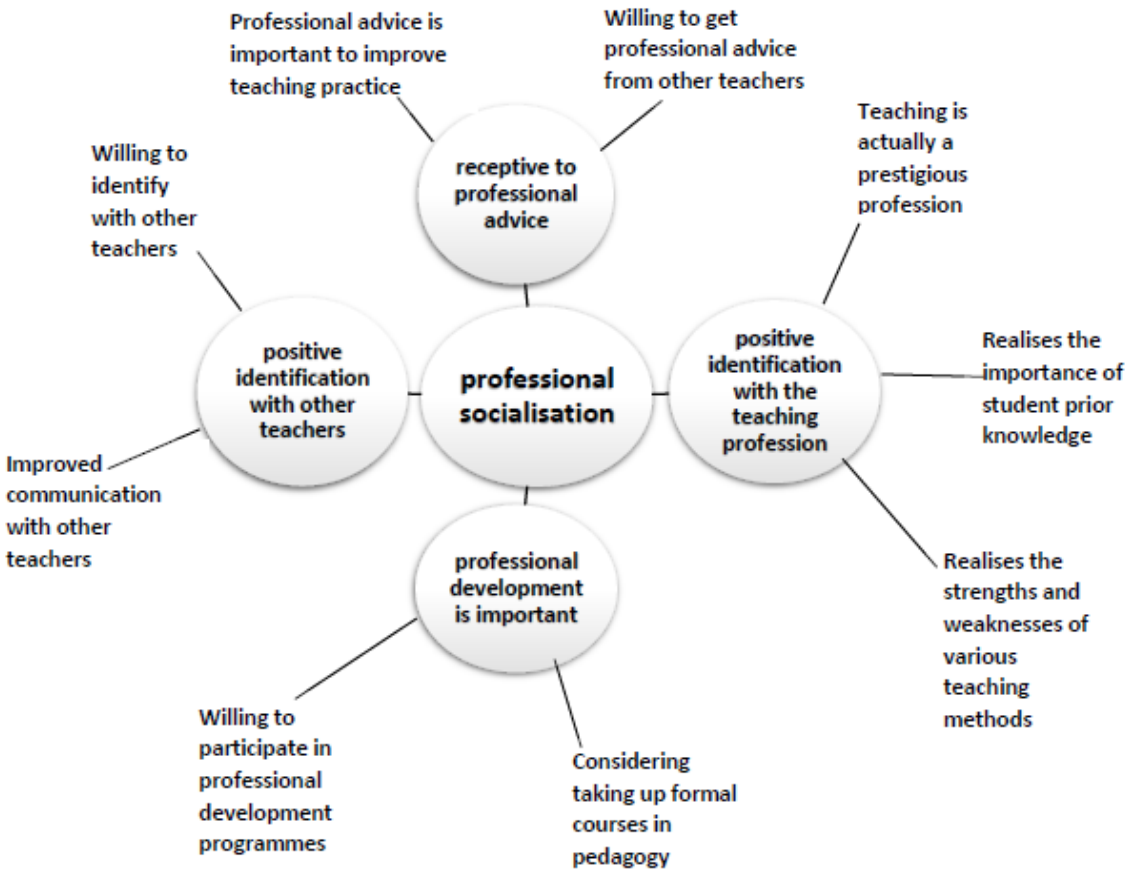

Figure 21: A presentation of the thematic network for teachers' professional socialisation

Four organising themes emerged:

Receptive to professional advice – this organising theme was supported by two basic themes – "professional advice is important to improve teaching practice" and "willing to get professional advice from other teachers"

Positive identification with the teaching profession – this organising theme was supported by three basic themes – "teaching is actually a prestigious profession", "realises the importance of

students' prior knowledge" and "realises the strengths and weaknesses of various teaching methods",

Professional development is important – this organising theme was supported by two basic themes – "willing to participate in professional development programmes" and "considering taking up formal courses in pedagogy"

Positive identification with other teachers – this organising theme was supported by two basic themes – "improved communication with other teachers" and "willing to identify with other teachers".

The WhatsApp-based IBP course may have improved the way that the teachers identified with the teaching profession as well as with other teachers in their universities and beyond. Initially, the participants pointed out that the social relations within and between departments were not very good. Several factors acted as barriers to social relations among the teachers. These included, amongst others, discriminations based on the level of education, and the country where individuals attended their university. However, WhatsApp Messenger provided them with a platform to socialise with people whom they would not normally have socialised with. It enabled them to socialise and learn from individuals who were even outside their departments and universities. It managed to break barriers that usually prevented them from interacting and sharing ideas. The anonymity of the WhatsApp Messenger platform enabled them to share without any prejudices. Some of the participants actually confessed that if the course had been offered in a traditional classroom, they would not have participated. Said Teacher H from University C:

'I think this course was very enlightening. It generally changed the way I viewed myself as a university lecturer as well as how I related to others. You know at university we tend to do our things independently of each other. There is no way really of knowing who knows what and who does what. People tend to do what they want with their courses. Sharing of teaching methods is difficult because people are generally suspicious if you want to encroach in their territory. There is also a lack of communication between the senior member of staff and the juniors. However, in this course, no one knew the academic credentials of the others. We were all at par, and everyone was free to contribute anonymously, and I think that helped even those who would not normally share information in a traditional classroom set up'.

From the way this teacher was responding, it was apparent that he was convinced that the WhatsApp-based course had been effective in helping the teachers improve their social and professional skills. It had helped to transform his professional identity by enhancing his interaction with peers as well as helping him realise the importance of acquiring professional teaching skills. An individual's professional identity is shaped by their participation in different professional communities (Barbour & Lammers, 2015; Cruess et al., 2015; Smith et al., 2017). By participating in these communities, certain norms and values are imparted to participants, resulting in them seeking to act in ways that conform to expectations (Eatough & Tomkins, 2014). Teacher H also highlighted the power of WhatsApp Messenger in breaking the barriers to social interaction (Rambe & Chipunza, 2013). According to them, it would have been impossible for a teaching assistant to sit in the same class as a Professor learning how to teach. But through WhatsApp Messenger, the barriers caused by different educational levels and qualifications were eliminated.

When asked about which teaching approaches they thought were effective, most of the participants conceded that those approaches that put the student at the centre of the learning process are more effective in enhancing students. This was a significant shift from the initial belief that teaching was a teacher-centred venture. This, according to the transformative learning theory of Mezirow (2006), represented a shift in mind habits occasioned by the experiences of the WhatsApp Messenger-based IBP course. The teachers explained that students become motivated, especially when their peers manage to solve problems or present new information to their peers.

Most of the participants were of the view that IBP was the best method for teaching chemistry but noted that there were some challenges with the approach. Notably, the issue of time was of concern to the participants. They argued that learning took longer when using the IBP approach. This was because the learning process was unstructured and as such, students could spend a lot of time engaged in unproductive activities. This is true, especially when the teachers are not well trained in its use (Dibiase & McDonald, 2015). In addition, misconceptions could also hinder their learning progress (Kotsari & Smyrnaiou, 2017). The teachers also noted that students could end up being confused and frustrated if they failed to solve problems, or if their efforts failed to satisfy the expectations of the teacher.

Another challenge noted was that a teacher might encounter problems when dealing with mixed ability classes, where it would be difficult to predict what students already knew about the

subject matter. By noting these challenges, the teachers were showing that they had now developed the traits of a real teacher as it is only those individuals who have acquired professional identity who can interrogate the strengths and weaknesses of certain pedagogical practices (Chabaya, 2015).

The discussions about IBP also enabled the teachers to read about other teaching methods that could be used to teach chemistry at a university level. This enabled the teachers to note that even though IBP was effective in enhancing students' problem-solving abilities, it could not be used exclusively. They suggested that other methods could also be used to complement IBP. For example, the teachers suggested that teacher demonstrations could be used where dangerous substances were involved, and lectures and group discussions could also be used for large classes. Said Teacher I from University C:

'As I was reading about IBP on the Internet. I found out that it has its own strengths and weaknesses and need to be complemented by other methods such as demonstrations, lectures, group work, class discussions, and so on. This would be important so that the weakness of one method can be ameliorated by the strengths of other methods'.

The above statement was a very important indicator of how participation in the WhatsApp Messenger-based course had developed the teacher's professional identity. Not only did his participation lead to him understanding the IBP concept, it also enabled him to read about other complementary methodologies that could be used in the teaching and learning of chemistry at a university level. From this comment, the researcher could tell that participating in the WhatsApp Messenger-based course had aroused the curiosity of Teacher I to know more about IBP in particular and other methodological approaches in general. Teachers with a positive professional identity are not only able to critique particular methodologies but are also keen to make suggestions on the use of complementary pedagogies (Vokatis & Zhang, 2016). The teacher ended up going deeper to analyse the strength and weaknesses of each teaching method. In this case, the teacher's pedagogical knowledge did not come from the facilitator but came from his own effort after learning about IBP in the WhatsApp Messenger group. This is consistent with the connectivism theory's assertion that an individual's current state of knowing is less important than his connectedness (Bockurt et al., 2016). It is from this connectedness with other teachers and the facilitator through WhatsApp Messenger and with sources of information (the Internet) that knowledge was developed.

After participation in the WhatsApp Messenger facilitated course, the teachers had transformed their views about their roles in the teaching and learning process. While they initially believed that the teacher should take a more active role in the process, after participating in the course they were advocating for a student-centred approach. Their belief systems about teaching and learning had changed. According to the transformative learning theory, transformation occurs when an individual's belief system changes as a result of participation in a meaningful activity (Mezirow, 2006). This means that they found their participation in the WhatsApp Messenger-based to be a worthwhile exercise. According to the expectancy-value theory, if an activity is worthwhile, an individual will find intrinsic value in it (Ibrahim et al., 2017).

The teachers noted the roles that they had to play in facilitating student-centred learning. They suggested that the teacher should provide a conducive environment to enable students to enhance their knowledge creation and problem-solving skills. They also noted that the teacher should make use of the students' prior knowledge to facilitate the acquisition of new knowledge. This was based on their understanding of the constructivist theories that they learnt in the WhatsApp Messenger-based IBP course. Said Teacher E from University B:

'It is important to take note of students' prior knowledge before engaging them in inquiry-based learning activities. Sometimes, as teachers, we assume that students don't know much, so we waste their time by going over things that they are familiar with. That can demotivate them. However, there is also a risk that we can over-assume their previous knowledge, and we end up pitching the activities at a level that is too high for them to comprehend. So, I believe that there has to be that balance'.

Listening to Teacher E, the researcher could tell that he had really understood the tenets of the IBP approach. He correctly outlined the importance of prior knowledge in the teaching and learning process. The clarity of the teacher's response was very important in showing a change in professional identity. Teachers who have a clear understanding of pedagogy have a more positive professional identity than those who do not (Cruess et al., 2015). In other words, it is only when an individual appreciates that they are a teacher, that they will appreciate the importance of pedagogical approaches.

The teachers were asked about their views about participating in professional development programmes. Most of them expressed their willingness to participate. This marked a departure from their initial stance where they did not see any need to participate in such professional development programmes. This shift in stance was interpreted to mean that the professional

identities of these teachers had developed as a result of their participation in the course. They had become aware of the importance of professional development in improving instructional skills. Said Teacher B from University B:

'Yes, I will definitely participate in professional development programmes, especially when they are offered in a flexible manner like the one we did. When offered on WhatsApp, the course does not have the pressure associated with the physical classroom. The atmosphere is relaxed, and people are not hesitant to share their views. It is also easy to share resources since these can be sent directly on the WhatsApp platform, and people can share website links to access Internet resources'.

Not only did this teacher express her willingness to participate in future professional development courses, she also added that online-based professional development programmes offer a more convenient environment for learning. This realisation of the importance of professional development programmes was an indication that Teacher B's professional identity had developed. Her willingness to participate in further professional development programmes showed that she was now more willing to be identified with the teaching profession. The experience had transformed her mind-set with regards to the teaching profession. This is in line with the transformative learning theory's position that adults can shift their views about the world if they encounter an experience that is meaningful to them.

Teacher B also specified that she would participate in online professional development programmes, especially if it is offered in a similar way to the WhatsApp Messenger-based program. She pointed out that the strength of the WhatsApp Messenger-based course was the ease with which information could be shared, including the sharing of Internet resources. This is consistent with the connectivism theory's view that knowledge is no longer hierarchical but has shifted to networks and ecologies. An individual's ability to link to these networks and ecologies determines the extent to which the individual acquires knowledge (AlDahdouh et al., 2015). The connectivism theory further suggests that knowledge is distributed through connections, across networks, and that learning entails the ability to construct the networks as well as traverse them (Ozturk, 2015). The knowledge emanates from the experiences and interactions that take place within the network. Therefore, by participating in these networks, the teachers gain knowledge that enhances their professional identity development.

However, two of the teachers (Teacher A and D) indicated that they might not find it necessary to participate in professional development programmes. For them, it was not really necessary

as they had not yet decided whether to continue as teachers or not. But if they were structured in the same manner as the one they had done in this study (WhatsApp messenger-based) they would participate.

Said teacher D from University B:

'I am not sure really if I can find time for professional development programmes in teaching. I don't know whether I will need that. But . . . honestly I believe it is important for teachers. Of course, if they are flexible like this one, I think I will participate'.

It was clear to the researcher that Teachers A and D were still more inclined to their academic disciplines than the teaching profession. However, they both admitted that they found professional development to be necessary for teachers. It was important to note that even though it had not fully transformed them from academics to teachers, they acknowledged that the WhatsApp Messenger-based IBP course had enlightened them in terms of pedagogical knowledge and its importance in making teachers more effective instructors. They were, however, not willing to identify themselves as teachers because they believed that teaching was less worthwhile (Eccles et al., 1983) than their academic professions. They had even shown little interest in the tasks during the WhatsApp Messenger-based activities. Tasks are considered important if they relate to an individual's identity or if they enable an individual to express those aspects about their professional self that they consider being important (Ibrahim et al., 2017).

5.3.5.4 Theme 8: New professional competency

The eighth theme represents the change in professional competency that occurred in the teachers as a result of undertaking the WhatsApp Messenger-based IBP course. The participants showed that they were now paying attention to teaching approaches; they understood the role of both the teachers and students in the learning process; and they now appreciated the importance of integrating ICT in the teaching and learning process (refer to Figure 22). This theme specifically responds to Sub-question 4: How do the pedagogical practices of university teachers change (if at all), because of learning inquiry-based pedagogy through WhatsApp Messenger?

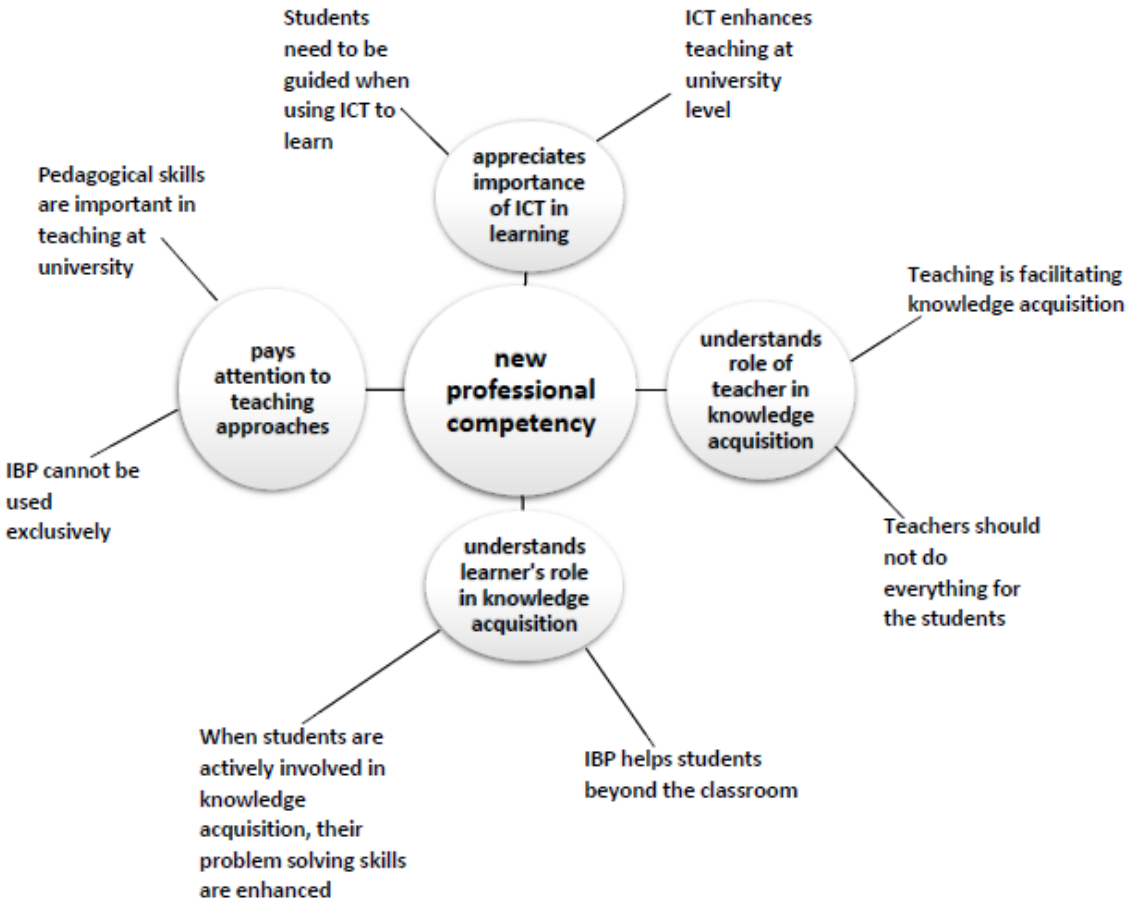

Figure 22: A presentation of the thematic network for teachers' new professional competencies

Four sub-themes emerged to support this global theme:

Appreciates importance of ICT in learning – this organising theme was supported by two basic themes – "students need to be supported when using ICT to learn" and "ICT enhances teaching at university level".

Understands role of teacher in knowledge acquisition – this organising theme was supported by two basic themes – "teaching is facilitating knowledge acquisition" and "teachers should not do everything for the students".

Understands learner's role in knowledge acquisition – this organising theme was supported by two basic themes – "when students are actively involved in knowledge acquisition, their problem solving skills are enhanced" and "IBP helps students beyond the classroom".

Pays attention to teaching approaches – this organising theme was supported by two basic themes – "pedagogical skills are important in teaching at university" and "IBP cannot be used exclusively".

Results from interviews after the WhatsApp Messenger-facilitated IBP course showed that there was a significant change in the teachers' perception about the role of pedagogy in student learning. The teachers were now appreciating that for one to be an effective teacher, they need to acquire pedagogical skills. This was a departure from their initial belief that anyone could teach those with lower academic qualifications than themselves. Said Teacher E from University B:

'I now really appreciate the need for pedagogical skills. Before this course I would literally do everything for the students . . . looking for information, giving notes and so on . . . ! The good thing about this course was the way it was carried out. You know . . . you carry your phone everywhere and it means you can learn any time you want. Like the other time I travelled to Australia during the course. I did not miss anything . . . you see. I could participate at any time. And also, could easily read more information on the Internet about the IBP. Again, it gave me a chance to read about other teaching methods as well'.

Such a change in perception showed the researcher that Teacher E's professional identity had changed positively as a result of learning IBP through the WhatsApp Messenger platform. The course had made him aware of the weaknesses of his initial teaching approaches. Previously he would play a more active role than the students themselves. The course had made him realise that it was the student who should be more active in the acquisition of knowledge. The change in perception is consistent with the transformative learning theory, which suggests that learning is a socially constructed phenomenon (Mezirow, 2009). Individuals can deconstruct and act upon their experiences to create new meanings. Learning experiences with peers on WhatsApp Messenger provided a common platform for individuals to reflect and discuss. The meanings that they attached to these experiences could be reflected upon and be amended to meet new realities.

Teacher E also acknowledges the role that WhatsApp Messenger played in the development of his professional identity. As a software package used on mobile communication devices, WhatsApp Messenger enabled the teacher to participate in the discussion with other participants irrespective of geographical location. The fact that he travelled to a different country during the course did not disconnect him from his peers. He still remained a member

on the online learning community. The Connectivist learning theory is supported by the use of blogs in learning (Garcia et al., 2013). Blog learning requires digital learning tools that connect students. WhatsApp Messenger, therefore, facilitated blog learning. Learning in blogs offers individuals a chance for online collaboration and communication.

The other notable observation that the researcher obtained from the interview with this particular teacher was that their interaction in the WhatsApp Messenger was so enriching that they also ended up exploring other teaching methods beyond just IBP. This shows a marked improvement in professional identity. When an individual goes beyond a certain task to know more about the profession, it is a sign of positive professional identity development. Teacher E's experiences in the course enhanced his urge to associate with the profession and his zeal to know more about it.

On the use of ICT in teaching, the teachers said that their experience in the course had taught them of the importance of using ICT in teaching. Though some had been using ICT in teaching before, none had used mobile communication technology to teach. There was a general agreement that WhatsApp Messenger was an effective tool for teaching, and all the participants had begun using it in their own teaching. They agreed that it offered a flexible environment for teaching and learning and aroused students' interest in acquiring knowledge. Said teacher C from University A:

'I have actually started using it with my students. Yah I do believe it's an amazing innovation. It just needs proper guidance so as to maintain focus.'

This comment was a change from the initial belief of the teachers about the use of ICT in education. Initially, Teacher C showed reluctance in integrating ICT in his pedagogical practices. He initially cited issues such as reduced attendance and plagiarism as reasons for his reservations in the use of ICT. He believed that students were supposed to attend lectures at all cost, where he would give them his own exam-tailored notes. However, his experiences in the WhatsApp Messenger-based IBP course made him realise that students could create their own knowledge, and the teacher was there to provide guidance. By this statement, the researcher could see that Teacher C was shifting from a teacher-centred approach to teaching to a more student-centred approach. This was a clear indication of the change in the professional identity of the teacher.

For others, technology integration in education was becoming so advanced that the role of the teacher was slowly diminishing. Said Teacher A from University A:

'*This technology issue has the potential of replacing teachers in universities . . . [pauses then laughs]. Now the students can almost do without teachers. Some students actually believe they understand better on the Internet'.*

The response from Teacher A showed that he acknowledged the power of technology as a teaching tool. He recognised its usefulness in facilitating the availability of knowledge to students, even without involving the teacher. However, the response also betrays the fear in the teacher about the future of the profession. He felt that "his" profession was under threat from technology. This was a strong indicator that he had transformed from being just a scientist, to a teacher. It made sense to believe only a teacher can fear for the future of the teaching profession.

Most of the teachers also felt that they were in a much better position to assist students to apply what they learnt in university to a real-life situation. They were of the view that since students who are taught using IBP can generate knowledge, it means they develop a working relationship with their teachers. With that relationship, it would be easier for them to work with students on applying what they learnt at university to real-life situations. Teaching using IBP requires special facilitation skills and, with more practice, the teachers could refine these skills. With these refined skills, the teachers felt that they could be in a much better position to assist students in applying their knowledge to solve real-life problems. Said Teacher E from University B:

'I believe . . . eh . . . yes. I am in a much better position now to assist students with applying their knowledge to real-life situations. You know what this IBP issue does . . . [pause]. Um as a lecturer you need to be very good at it. I guess it is a skill that develops with time. So, when you teach using IBP you are not only developing the student's knowledge creation and problem-solving skills . . . [pause]. You will also be developing your own teaching skills. So, it is a mutually beneficial approach. In the end, the experience that you earn as you teach will help you become a better facilitator, and you can assist the students even beyond the classroom'.

In his response, this teacher noted the role of practice in developing facilitation skills. Though he believed he was better positioned to teach and help students to apply their problem-solving

skills to real-life situation, he recognised that he still needed to learn and practice more on the use of IBP. This was a clear sign of professional identity development. When an individual realises the need for further self-development in a particular profession, it means that he would be identifying positively with that profession (Neary, 2014). Positive identification with a profession is a clear sign of professional identity formation.

Teacher E also highlighted the importance of IBP in developing both the student and the teacher. From this comment, the researcher could deduce that the teacher had clearly understood the IBP concept. He realised that IBP makes the teacher a co-creator of knowledge with the students. He was admitting that not all knowledge exists in the teacher but that it is "out there" and takes the effort of both parties to discover it. On the part of the teacher, more knowledge about how to teach certain concepts come from working with students as they solved problems. The teacher was indirectly admitting that he could not possibly have all the solutions to problems, but some solutions could come from working with students as they create knowledge. From this knowledge creation venture, the teacher would also be learning new things.

On their ability to respond to educational changes, the teachers felt that they were now in a better position to respond to changes in in the education system. They believed the changes were now taking place more rapidly, but the acquisition of pedagogical skills gave them the confidence to respond to these changes. Said Teacher E from University B:

'If you look at the way changes are taking place in the education sector, you can see that they are now taking place at a faster rate. They are also taking place from many fronts . . . there is the issue of new teaching approaches, the issue of technology . . . eh the issue of aligning the curriculum to industry need . . . [pause] so many issues! Personally, I believe the acquisition of teaching skills go a long way to help improve one's ability to respond to these issues. I mean I am now in a much better position to respond to educational change than I was a few months ago'.

The response showed the researcher that it was a change in the way the teacher viewed his role in the teaching profession. While the teacher initially seemed unaware or uninterested in the changes that are taking place in the education sector, he could now confidently point them out. His experience in the WhatsApp Messenger-based IBP course led him to realise how pedagogy and technology had impacted the education sector.

5.3.5.5 Theme 9: New career progression plan

The ninth theme depicts new career progression plans of the teachers after engaging in the WhatsApp Messenger-based IBP course. Some were considering enrolling for formal pedagogical qualifications; some talked about university teaching being a prestigious career; while others considered themselves to have a dual career (refer to Figure 23). This theme directly responds to Sub-question 3: How does the professional identity of university chemistry teachers change as they interact through WhatsApp?

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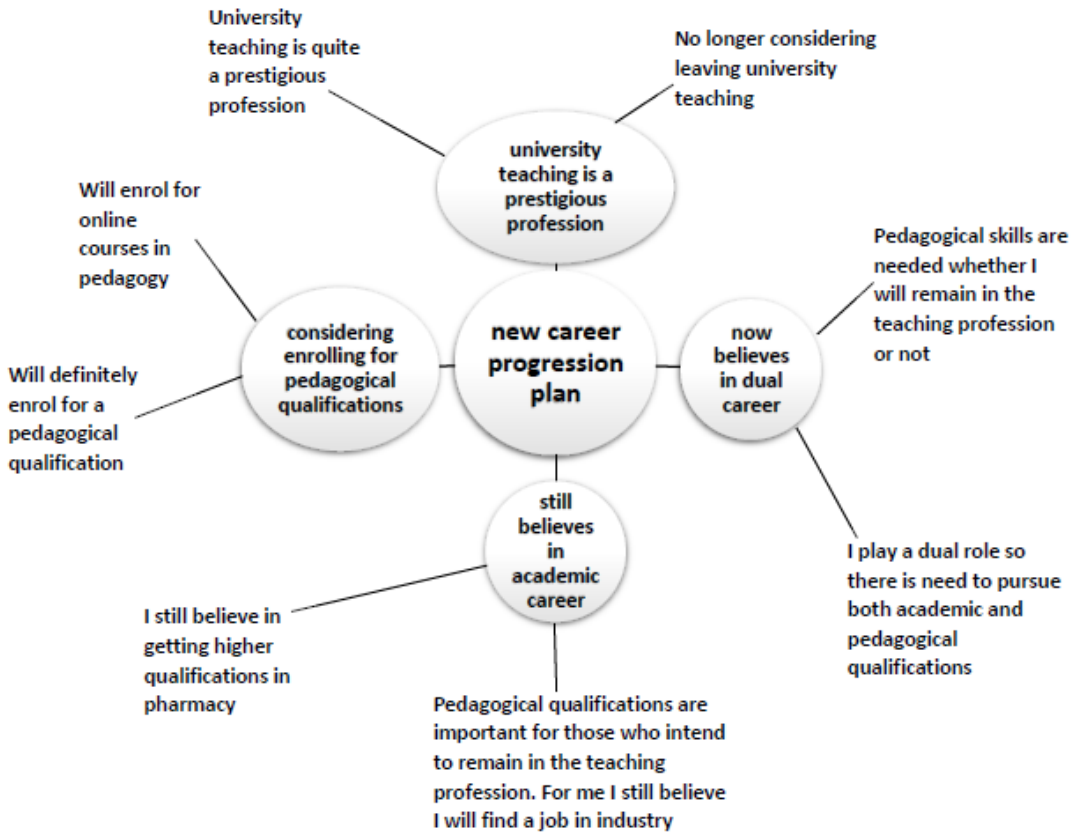

Figure 23: A representation of the thematic network for teachers' new career progression plans

Four themes emerged to support this global theme:

University teaching is a prestigious profession – this organising theme was supported by two basic themes – "university teaching is quite a prestigious profession" and "no longer considering leaving university teaching".

Now believes in dual career – this organising theme was supported by two basic themes – "pedagogical skills are needed whether I will remain in the teaching profession or not" and "I play a dual role so there is need to pursue both academic and pedagogical qualifications".

Still believes in academic career – this organising theme was supported by two basic themes – "I still believe in getting higher qualifications in pharmacy" and "pedagogical qualifications are important for those who intend to remain in the teaching profession. For me I still believe I will find a job in industry"

Considering enrolling for pedagogical qualifications – this organising theme was supported by two basic themes – "will enrol for online courses in pedagogy" and "will definitely enrol for a pedagogical qualification"

The responses from the interviews showed that the participants appreciated the role of having a teaching qualification for them to improve their pedagogical practices. Most of them said they had plans to enrol in formal pedagogical lessons apart from acquiring higher qualifications in their areas of expertise. They also indicated that they would prefer to do it in a flexible way as was done in the WhatsApp Messenger course. Some even asked the researcher to develop a full course that could lead to a formal certification in pedagogical competency. Said Teacher G from University C:

'I think the area of pedagogy is very important for university teachers. I am considering enrolling for a full course in pedagogy . . . eh I mean if I could get something online like what we recently did. Yah, of course, something that leads to a full certificate. Ah . . . but you can do this [laughing]. Why don't you make it a full course so that you could give us certificates?'

This response was a shift from the initial position of this participant, who initially felt that one could still teach effectively without pedagogical qualifications. There was now a realisation of the importance of pedagogical skills. Teacher G's experiences in the WhatsApp Messenger-based course had changed the way she viewed pedagogy. She now wanted to be identified with the teaching profession to the extent that she saw the importance of certification in pedagogy. She had developed a new professional identity as a result of her participation in the WhatsApp Messenger-based IBP course. This attainment of a new professional identity is consistent with the expectancy-value theory, which postulates that if an individual participates in an activity that is consistent with his own self-image, they get attainment value from it (Wigfield et al., 2009). For this teacher, there was a new belief in her that that participation in a fully online course would enable her to express more aspects of his new self that she considered to be important.

There was also a realisation among the participants that, even though IBP was a very important teaching strategy, there was a need to complement it with other teaching strategies. They felt that when other teaching strategies are used to complement IBP, they would minimise the weaknesses that are associated with IBP. They were in agreement that other existing strategies, such as the lecture method, were still useful and could not be discarded completely. Issues of time and large class sizes were cited as reasons to use other methods to complement IBP. Said Teacher I from University C:

'Definitely IBP is an important teaching approach. However, as a new approach, I will need more time to adjust . . . but because it requires a lot of time to implement it has to be used in conjunction with other approaches. Then there is another issue . . . that of class size . . . you see that should also be taken into consideration. When you have say forty students or more, it would be quite hectic. So, there is a need to complement it with other strategies such as the lectures, group work, class discussions and so on'.

From the way Teacher I was responding, the researcher could interpret that he was now talking as a real teacher. First, he managed to explain that IBP is a very useful teaching strategy. Second, he demonstrated that he was now aware of the existence of several teaching strategies that could complement IBP. The fact that he could name the approaches was a departure from his initial response where he could not name any teaching strategies used in higher education. This change represented growth in professional identity as it is only those who can identify themselves with the profession who can profess about teaching strategies and their strengths and weaknesses (Kristen et al., 2017). The WhatsApp-based IBP course had brought several changes to Teacher I: (1) he managed to learn and understand IBP, (2) he managed to identify its weaknesses and strengths and (3) he managed to identify other teaching strategies that could lessen the impacts of the weaknesses of IPB.

On the issue of the prestige of the university teaching profession, most the participants were of the view that university teaching was a prestigious profession. This was a departure from their initial view that it was less prestigious than their academic professions. Their view was informed by the fact that being a university teacher was an additional profession to their academic profession. They believed that when one acquires the right knowledge and skills to be able to teach at university, it meant that individuals are actually more superior to those with only the academic qualification. Said Teacher F from University B:

'Yes, university teaching is definitely very prestigious. You begin to see the prestige of university teaching when you know how to do it properly. When you do it without using the right skills and approaches, it is almost like a part-time job. You don't know the value of what you are doing sometime . . . especially when you are not sure whether you are doing it properly or not'.

According to Teacher F, the prestige of a profession came from being able to do the work properly and using the right tools and skills. He initially thought he was teaching at university as a temporary measure, and he initially did not mind how he went about his teaching. After participating in the WhatsApp Messenger-based IBP course, he realised that there was a proper way to do his work. This made him realise that what he was doing was very important. He now could see the prestige of being a university teacher. This is consistent with the expectancy-value theory that suggests that the self-perceptions that an individual has about their ability as well as the task value that they have, influences their activities and achievement-related behaviours (Ibrahim et al., 2017). For this teacher, teaching was now considered a very valuable task and, as a result, the way he was approaching it was now influenced by his belief that he was engaging in a prestigious endeavour. This was a very strong indicator of professional identity development.

Teacher E from University B added:

'Look I am teaching pharmacists. . . . If being a pharmacist itself is considered important, what more about being a teacher of pharmacists'.

This participant made a very important declaration that he was "a teacher of pharmacists". The researcher interpreted it to mean that by teaching pharmacists, Teacher E was engaged in activities that were far more important than the pharmacy profession. The participant was identifying himself with the teaching profession at a higher level than the pharmacy profession. In other words, his professional identity as a teacher was now rated higher than that of a pharmacist.

Most of the participants were of the view that their current duties were very relevant to their future careers. They believed that their teaching duties enabled them to continue with a dual identity – that of being a scientist and of being teachers. This meant they could operate in any field without any problems. Their acquisition of IBP skills enhanced their problem solving and knowledge creation skills. As such, as they taught their students using IBP, they were not only

sharpening their pedagogical skills but also improving their own problem-solving and knowledge generation skills. These skills were useful for the dual nature of their professions. Teacher G from University C had this to say:

'Look when you are teaching using IBP you are also developing your own knowledge generation and problem-solving skills. So, my current duties are beneficial to both myself and the students. If I decide to go to work in the industry the skills that I would have acquired here will be very useful there. The same [happens] if I decide to stay here, the skills and experience will even be more useful'.

Teacher G acknowledged the role her duties were playing in preparing her for her future. She admitted that it was not only the students that were going to benefit by using IBP to teach. She was also sharpening her problem-solving skills, which would be very useful to her whether she moves to industry or continues as a teacher. The most important thing noted from the response was that she said that if she continued teaching, the skills and experience would be more useful than if she would go into industry. This served to confirm that the teacher in her was benefitting from her current duties. She was, therefore, portraying a higher identification with the teaching profession than the industrial profession that was yet to be realised.

From this response, the researcher could tell that the teacher's experience in the WhatsApp Messenger-based IBP had helped to develop her professional identity as a teacher. She now believed that if she continued teaching, there was a likelihood that her effort would be more useful. In other words, she gained intrinsic value from participating in the WhatsApp Messenger-based course, and she believed by continuing to teach, that she would be engaging in a valuable enterprise. This is consistent with the expectancy-value theory's assertion that individuals are likely to consider engaging in activities that offer intrinsic value to them (Ibrahim et al., 2017).

5.3.6 Findings: Focus group discussions

This section of the chapter presents findings on the experiences of the teachers as they discussed IBP on the WhatsApp Messenger platform. The findings were generated from focus group discussions. The purpose of the focus group discussions was to extract any data that the researcher may have missed from the interviews and the participant observations. The focus group questions (Appendix 9) sought to obtain the participants' personal views about their experiences in the WhatsApp Messenger-based IBP course as well as how they now viewed themselves in the teaching profession. The findings responded to Sub-questions 2 and 3.

No new themes emerged from the discussions, but the responses helped to consolidate the data obtained from the interviews and participant observations. The participants were in agreement that their experiences in the WhatsApp discussions were very interesting, cordial, and informative. Said Teacher B from University A:

'I think generally the exercise was very informative. . . . It was actually a pleasant surprise because we normally use WhatsApp for social communication'.

To which Teacher D and E, both from University B, concurred:

'Yah, I believe it was very informative. The discussions went on very well and were very informative', (Teacher D).

'It was a very interesting discussion. It was actually better than a classroom environment. No pressure at all. Some of us had never met before, but we managed to engage in a fruitful discussion', (Teacher E).

From the responses, the researcher could tell that the teachers felt that they had a very positive view about the discussions that they conducted while they were learning IBP on the WhatsApp Messenger platform. Most of them had not anticipated that they could engage in a worthwhile discourse on a social media platform.

The teachers had various opinions about how WhatsApp Messenger facilitated their interactions. The following are some of the comments from the teachers:

- They were able to send and receive information instantly from many people at the same time;
- They could send information in various forms – written, audio, video, pictures, and PDF;
- Communication was possible without the need for them to be in the same location;
- They managed to communicate and share ideas with people whom they would not normally talk to;
- The WhatsApp messenger platform provided them with a relaxed atmosphere where they were not hesitant to give their opinions even where they were not sure about their answers;
    - They could send each other links and websites for research purposes. These could be opened directly on the smartphones;
    - They could easily catch up with discussions even when they went offline for some reasons; and

- They could participate in the discussions even when they were out of the country.

From the discussions, it was apparent that the teachers had derived many benefits from using WhatsApp Messenger for communication. They agreed that they had unhindered access to information, something that they could not achieve with traditional classroom learning. WhatsApp Messenger removed any barriers to communication that are usually associated with formal communication platforms.

On the factors that hindered participation and interaction during the course, the participants highlighted that lack of physical presence had, to some extent, the effect of trivialising the discussions, especially at the start of the course. This is because none of the participants had used WhatsApp Messenger for learning purposes before. They initially believed that it was mostly suitable for informal social interactions. Said Teacher A from University A:

'At the beginning it was a bit difficult to take the course seriously. You know…WhatsApp is mostly used for socialising. . . . I mean the sharing of less serious issues like getting in touch with family and friends. But as we went on it was like ahh . . . this thing actually works'.

The response was consistent with what the researcher observed at the start of the course where the participants would only give simple short statements as answers to questions. This gradually changed as the participants shared more information and referred each other to websites for further research.

On how the WhatsApp Messenger course affected the way the participants viewed themselves as teachers, there was a general agreement among the teachers that the course had changed their views and attitudes as teachers. They now believed that teaching was a profession with its own norms, values, and procedures. Said Teacher C from University A:

'Well . . . I used to take things for granted . . . I mean just teaching the way I was taught. It was when I was researching more about inquiry-based pedagogy that these issues have a lot of philosophy and theory behind them. It sorts of makes you realise how important teaching approaches are if you want students to learn effectively'.

This led to Teacher E from University B adding in:

'I actually didn't want the students to know more than me. . . . I wanted to be in control, and I would spoon-feed them. I was more interested in their passing . . .'

The responses from the teachers were consistent with the data that the researcher gathered from the interviews and participant observations. Before embarking on the WhatsApp Messenger-based IBP course, the teachers were all self-centred teachers. In fact, they did not believe that they were teachers at all. However, after the course, their views about teaching and their views about themselves as teachers had changed. They all attributed these changes to their participation in the WhatsApp-based IBP course. To the researcher, this was an indication that their participation had transformed their professional identities. Transformative learning, which, according to Mezirow (2006), refers to changes in individuals' meaning perspectives, had taken place in the teachers.

The teachers were of the belief that they learnt a great deal from each other during the WhatsApp Messenger-based IBP course. Said Teacher F from University B:

'I believe we learnt a lot from each other. You know . . . sometimes when you read something on your own you might fail to get the meaning. But when you get to hear a colleague saying it then you begin to believe it's something valuable'.

Teacher D from University B concurred:

'Yes . . . sometimes when you say something, and people comment on it helps you to understand it further and appreciate that it is important knowledge . . . so I believe that the WhatsApp Messenger platform gave us a platform to share ideas and learn from each other'.

The responses from the teachers were consistent with the views of the expectancy-value theorists such as Eccles et al. (1983) who suggested that individuals place importance to an activity when they believe that the activity is consistent with their self-image. Tasks are also considered to be important if they enable individuals to express those aspects of their self that they consider to be important (Ibrahim et al., 2017). To that end, the teachers' participation in the WhatsApp Messenger group enabled them to discover, as well as express those aspects about their professional identity that they believed to be important. To the researcher, these responses were very important indicators that the teachers had developed a positive professional identity.

On the issue of the weaknesses of WhatsApp Messenger as a learning tool, the teachers were in agreement that learning on the WhatsApp platform is something that might fail to produce the desired effects if it is not well planned. They cited potential issues such as an unstructured flow of information (especially when people are from diverse backgrounds); possible abuse of

the platform; negative perceptions of the students towards content delivered on social media; the need for Internet connectivity; and the expenses associated with the acquisition and maintenance of smartphones. One of the teachers (Teacher A from University A) had this to say:

'You know WhatsApp Messenger is traditionally used as a socialising tool . . . so to get people to appreciate that it can be effectively used for educational purposes . . . umm . . . think that might take time'.

Teacher H from University C added:

'Another thing . . . there can be disruptions . . . you know people can throw in some irrelevant messages or forward those chain messages and some dirty stuff. So those are some of the issues to consider'.

Though the teachers appreciated that WhatsApp Messenger was a powerful teaching and learning tool, they pointed out that it needed proper management to produce positive results. That observation, though an indictment on WhatsApp Messenger, was in itself an indicator of positive professional identity on the part of the teachers. It showed they now appreciated the need for planning and following proper procedures in teaching.

On the effectiveness of WhatsApp Messenger as a tool for professional development, the teachers were in agreement that it was very effective. They pointed out that, through the platform, they had managed to acquire new knowledge and skills without the need to enrol in a formal classroom. They also highlighted the fact that they managed to share ideas in a virtual space with other professionals from diverse backgrounds, whom they had not even met physically. Said Teacher I from University C:

'Personally, I believe WhatsApp Messenger is a very effective tool for professional development. As you know, university lecturers tend to do their work in isolation. They rarely share knowledge, moreover they don't get trained in pedagogy, so it's very difficult to tell whether they do their work properly or not. So, WhatsApp Messenger places you in a situation where you can discuss issues anonymously, and this helps people to open up and share their experiences'.

Teacher E from University B agreed:

'Yes . . . I think it's very effective. I like its flexibility . . . and . . . you don't have much pressure like in the classroom. You can participate in the discussions at any time, and you can also catch up with the debate if you get offline for any reason'.

Teacher D from University B also had this to say:

'I think it is effective. However, the facilitator or group administrator should always make sure that he lays some ground rules so that participants do not deviate from the purpose of the group. I have seen in many groups people opting out due to the behaviour of other group members. But . . . as in our case, the members were focused, and we did not face any challenges'.

The teachers' responses indicated that they found WhatsApp Messenger to be an effective tool for professional development. Through their discussions, they had acquired inquiry-based teaching skills and at the same time developed positive professional identities.

5.4 SUMMARY

This chapter was a presentation and research findings. The first section covered the research settings, which were three universities in Zimbabwe. The second section presented the biographical information about the participants in this study. These were university teachers who taught chemistry courses. The third section was the presentation and analysis of the views of the participants as well as a description of the observations made during the study. Appendices, and Figures were used to support the findings. It can be concluded that the professional identity of the teachers improved as a result of their participation in the WhatsApp Messenger-based IBP course. The next chapter provides a summary of the findings as well as recommendations and conclusions.

CHAPTER 6

SUMMARY OF CHAPTERS, FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

6.1 INTRODUCTION

In this chapter, the researcher sums up the research journey to determine how the use of WhatsApp Messenger in teaching inquiry-based pedagogy (IBP), transformed the professional identities of university teachers. The chapter starts with a summary of each of the five chapters. Subsequently, it presents the main findings of the study together with an analysis of the findings. The limitations of the study that could have affected how the research questions were addressed, are also presented. The chapter gives suggestions for further study as well as recommendations. In conclusion of the chapter, the researcher reflects on the research journey and experiences of conducting the study.

6.2 SUMMARY OF CHAPTERS

This section of the thesis summarises the issues that were covered in the previous five chapters.

6.2.1 Chapter 1

Chapter 1 included the introduction to the study. It also included the rationale of the study and the statement of the problem. The main research question and sub research questions were given. The significance of the study as well as the purpose and objectives of the study were discussed. In addition, a preliminary review of literature was included. The chapter also discussed the theories that underpinned the study. The research methods and design were also discussed. A discussion of the data analysis procedures as well as measures taken to ensure trustworthiness was also given. In addition, the ethical considerations taken in the conduct of the study were also included. The structure of the study outlined and key terms were defined.

6.2.2 Chapter 2

Chapter 2 consisted of a detailed literature review. It included the use of ICT in pedagogy, an ICT as a facilitator or barrier of knowledge creation and dissemination. It looks at the use of social media in higher education with particular emphasis to the WhatsApp Messenger phenomenon. The researcher further looked at the strategies, methods and tools used for the professional development of university teachers before looking at online professional learning communities. He then discussed some of the pedagogical tools and methods used in education, with particular emphasis on IBP in chemistry education. He then discussed the use of IBP as a

tool for teacher professional development. The researcher went on to discuss the concept of teacher identity with an emphasis on the role of their pedagogical beliefs. This was then followed by a discussion of teacher professional identity and its importance. The researcher then discussed the factors that affect professional identity development before discussing the roles that individuals play in professional identity development. The researcher further looked at the professional identity development process. Finally, the researcher discussed the determination of professional identity development through the process of professional identification and professional identity construction.

6.2.3 Chapter 3

This chapter presented the theoretical underpinnings that guided the study as well as the overall framework of the research. Several theories were used to guide the research process, namely:

- The Connectivism theory, which illuminated how knowledge is created and transmitted in an online network of individuals;
- The Transformative Learning theory, which explained the changes that occur in an individual's meaning structures as a result of encountering life-changing experiences;
- The Dual Systems theory, which complimented the transformative learning theory in explaining the conscious and unconscious processes that lead to transformation; and
- The Expectancy-Value theory, which explains the role of motivation in influencing humans to meaningfully participate in certain activities.

6.2.4 Chapter 4

In this chapter, a detailed research methodology was given. This included a detailed description of the research paradigm, qualitative research methodology, the case study design, population and sampling strategies used, instrumentation and data collection techniques, the data analysis process, measures to ensure trustworthiness and ethical considerations taken in the conduct of the study.

6.2.5 Chapter 5

This chapter included a detailed presentation and analysis of the research findings. The researcher gave a detailed description of the research settings. The universities from which the participants came from were described in terms of their ICT infrastructure and teacher professional development policies. The biographical information of the teachers was also presented. The researcher gave a description of the thematic network analysis process used in

data analysis. He then presented a detailed description of themes that emerged from data supported by the relevant theories and views from authors.

6.3 SUMMARY OF FINDINGS

The main aim of the study was to investigate the professional identity development of university teachers through the inquiry-based pedagogy (IBP) on the WhatsApp Messenger platform. The purpose was to determine the feasibility of offering professional development courses through mobile communication technology. Thus the objectives of the study were to:

- Establish the initial professional identities of university chemistry teachers without formal training in pedagogy and before engaging in the study;
- Establish the experiences of university chemistry teachers as they use WhatsApp Messenger to interact in learning IBP;
- Identify changes (if any) in the professional identity indicators of university chemistry teachers after learning pedagogy through WhatsApp Messenger; and
- Identify changes (if any) in pedagogical practices of university chemistry teachers after learning inquiry-based pedagogy through WhatsApp messenger.

6.3.1 University teachers' initial perception of their professional identities

The purpose of the first sub-question was to establish the professional identities of the university teachers before they undertook the WhatsApp Messenger-based IBP course. Findings from interviews with the teachers before they participated in the course, showed that they viewed themselves as chemistry experts and not as teachers.

6.3.1.1 Teachers' initial teaching beliefs

The findings based on the interview questions, revealed that the teachers had negative beliefs about the teaching profession. None of the participants had any plans to be university teacher before they finished their studies. Most of them had planned to work in the industry. Various reasons were proffered for venturing into teaching. For some, it was frustration in the working conditions in the industry, for others, it was a chance to attain higher qualifications, and yet for others, they had no other viable job opportunities. The poor economic situation in Zimbabwe saw many industries close and forced most of the teachers to look for the most secure form of employment.

Before the course, most of the teachers did not want to be referred to as teacher. They wished to be identified by their own academic qualifications. The teachers with the engineering

backgrounds preferred to be recognised as engineers. Those with pharmacy or biochemistry backgrounds preferred to be called pharmacists and biochemists, respectively.

In terms of their initial teaching approaches prior to the course, most of them used teacher-centred approaches. Some could not name the specific teaching approaches they used and the most popular approach was the lecture method. The teachers would deliver lectures to the students and give students ready-made notes. Teaching was done mostly to enable students to pass their exams with little regard to student conceptual understanding. To that end, some of the teachers would even suggest reading areas for examination as well as "tips" on how students could pass their examinations. They believed that it was a teachers' duty to find information for their students.

On experimental design, the teachers would use the cookbook approach where students were given clear instructions to follow when doing their experiments. Some would even demonstrate the experiments to students. According to the teachers, this saved them time and would reduce accidents. They viewed the purpose of chemistry experiments as processes of showing students how knowledge was discovered. They did not believe that experiments could be used by students to discover new knowledge.

6.3.1.2 Teachers' initial professional beliefs

The findings from the pre-intervention interviews showed that the university teachers had not been socialised into the norms and ethos of the teaching profession. As such, they did not identify themselves with the teaching profession. Neither did they have any professional relations with other teachers in the same field.

The teachers did not identify closely with their peers, and there was little professional interaction within or between departments. Most of the teachers would do their work independently of each other. Teachers viewed initiatives to share knowledge with suspicion, and it was difficult even for heads of departments to organise seminars on pedagogy. These would be boycotted by the teachers as they did not believe in the importance of pedagogy. Besides, the heads of department also had no formal qualifications in pedagogy and lacked the capacity to mentor their peers in that area.

The teachers viewed their roles as that of being sources of knowledge. They believed that a good teacher had to possess vast knowledge in the subject area so that they remained "above" the student. Students, on the other hand, had to be passive recipients of knowledge who had to

be told what was worthwhile and what was not worthwhile knowledge. They did not believe that students could use their prior knowledge to construct new knowledge.

Most of the teachers had not participated in any professional development courses or workshops. In fact, they had boycotted such workshops in the belief that they were a waste of time. They believed that they could not be taught how to teach by individuals who were not qualified in their respective areas of specialisation. They believed that being a teacher ended in the lecture room and would not want to be recognised as a teacher outside. They believed that this would lower their social standing, especially among their peers who were in the industry. As such, they would not want to mix their work duties with their personal lives.

6.3.1.3 Teachers' initial professional competency

The results of the interviews showed that most of the teachers were professionally incompetent in regard to their teaching skills. Their responses showed that some paid no attention to teaching methods; some believed students were passive recipients of knowledge; some were opposed to the use of ICT in teaching; some believed that the teacher was supposed to be the source of knowledge; and most lacked an understanding of the IBP approach.

The responses from the pre-intervention interviews showed that the teachers primarily knew and made use of the lecture method. They would give their students mass lectures, with little or no chance of discussions between the teacher and the students or among the students themselves. Lectures were usually accompanied by dictation of notes by the teacher. In certain cases, the teachers would be given a soft copy of the lecture notes on their flash disks or email accounts.

None of the participants had used IBP in their teaching. However, from the term 'inquiry', they seemed to derive some idea of what was involved. They believed it would be difficult to use the approach because of various reasons including the complexity of chemistry as a subject at university student; the calibre of the students; and the large classes that were involved. Most of the teachers actually believed it would be impossible to teach using IBP.

The teachers were also against the students placing too much reliance on computers and the Internet when learning chemistry. Their argument was that if students use computers in learning, they tended to rely more on Internet information than on the information that they are given by the teacher in the classroom. They were of the belief that computer usage was making them, as teachers, less "important" sources of information. They also believed that with the

availability of computers and Internet, students were developing a tendency to abscond lessons believing that they could always get the information from the Internet.

6.3.1.4 Teachers' initial career progression plans

The results from the interviews showed that most of the teachers had no clear career progression plan. Their future professional engagements hinged on the financial security and stability of the various economic sectors. As far as university teaching was concerned, most of them were unwilling to commit to their future there. This was due to the fact that most of them had not initially planned to be university teachers. They, therefore, believed that new opportunities would come and influence them to abandon the teaching profession.

The teachers' career progression plans were inclined to their academic fields. They believed it was important to pursue their academic disciplines, whether one was to remain in the teaching field or not. None of them were interested in pursuing qualifications in pedagogy. They had taught for some time without those qualifications, and their students had passed so they believed the additional qualifications would do little to enhance their professional standing.

On the issue of whether the teachers had a clear vision of how to become professional teachers in the university sector, most of them responded that they did not. For them, they had not taken the time to make inquiries about that. They did not even know that there were professional courses in teaching at a university level.

6.3.2 The experiences of the teachers as they used WhatsApp Messenger to discuss inquiry-based pedagogy

The purpose of the second sub-question was to establish the experiences of the teachers as they discussed IBP on the WhatsApp Messenger platform. Findings from observations showed the role of human agency in the profession identity construction.

6.3.2.1 The roles of human agency in professional identity construction

Human agency played a key role in the transformation that occurred to the professional identities of the teachers. The process did not happen passively; it took the active participation of the teachers in the generation, dissemination and deliberation on the new knowledge created within the online community of practice (CoP). Where the teachers were not active or were disinterested, the process of identity construction did not reach its completion or never took off at all.

6.3.2.2 WhatsApp Messenger competencies

The findings of the participant observation showed that the participating teachers were knowledgeable in the use of WhatsApp Messenger. They had used it previously for social networking but not for educational purposes. A few of the teachers needed assistance in the installation and use of certain applications on their smartphones.

6.3.2.3 Interactivity

The WhatsApp Messenger platform provided the participants with an interactive online environment where they managed to share ideas, ask each other questions, critique each other, and discuss issues. They interacted as equal partners and there were no hierarchies usually associated with traditional groups. There were none of the hindrances that are normally caused by geographical location. The participants could interact and share their ideas without meeting in the same room. Everyone had an opportunity to post their contributions at their own convenient time.

6.3.2.4 Knowledge generation

There were many information generation centres (nodes) in the WhatsApp Messenger group as each individual teacher acted as an information generation node. In addition, they could refer each other to other online information sources, which helped to strengthen the knowledge generation capacity of the whole network. However, the knowledge generation capacity was not uniform throughout the whole network. Where individuals were not very active, this tended to affect a particular knowledge generation node.

6.3.2.5 Knowledge transmission

Knowledge transmission was dependent on how active individual participants were. Where participants were very active, there were high levels of information generation and transmission. However, passive participants tended to slow down the movement of information in the network. The issue of connectivity also affected knowledge transmission. However, this was not very widespread as network connectivity was generally readily available. Even the few times that the network was not available, the situation was mitigated by the fact that WhatsApp Messenger has a function that keeps and delivers prior messages once an individual is able to reconnect.

6.3.2.6 Teachers' views about WhatsApp Messenger-based learning

Results from the semi-structured interviews after the WhatsApp Messenger-based course showed that the teachers found the learning process to be very flexible. They could access and share information at any time of the day. Those who were busy during the day could give their

contributions even late at night. They also did not need to congregate in a classroom for learning to take place. This enabled participants not to miss out on anything that was discussed when they were engaged with other issues. The teachers had various opinions about how WhatsApp Messenger facilitated their interactions.

The teachers were able to send and receive information instantly from many people at the same time. They could also send information in various forms – written, audio, video, pictures, and PDF. It was possible for them to communicate without the need for them to be in the same place.

The WhatsApp Messenger platform also removed the barriers to communication that are normally associated with different educational backgrounds and levels. It also provided them with a relaxed atmosphere where they were not hesitant to give their opinions even where they were not sure about their answers. The teachers also managed to send each other links and websites for research purposes, which they could open directly on their smartphones. They could easily catch up with discussions even when they went offline for some reasons.

6.3.3 Changes in teachers' professional identities after using WhatsApp Messenger to discuss inquiry-based pedagogy

The third sub-question sought to establish how learning IBL through WhatsApp facilitated transformative learning in university teachers. Findings from the interviews and focus group discussion showed that changes had occurred in the professional identities as a result of their participation in the WhatsApp Messenger-based IBP course.

6.3.3.1 Changes in teaching beliefs

The findings showed that the teaching beliefs of the teachers had changed. Whereas most of them initially did not feel comfortable to be identified as teachers, they now had no problems with being called as such. They realised that, even though they had their own areas of expertise, their roles at their universities made them teachers and were required to act in ways consistent with the norms of the profession. They demonstrated an understanding that teaching was truly a profession on its own, and their role was to be a facilitator of knowledge acquisition and not just givers of knowledge.

The teachers were now more student-centred. They believed that it was important to place students at the centre of the learning process, with teachers guiding them to acquire knowledge. According to the teachers, students became excited when they discovered their own knowledge and their retention capacity was enhanced. Some teachers even believed that they could learn

something from their students if they allowed them to engage in inquiry. The WhatsApp Messenger-based IBP course had changed their beliefs in teaching in accordance with the transformative learning theory.

A few of the teachers, however, still believed that they were subject matter experts rather than pedagogues. These few, however, acknowledged the importance of pedagogical skills for those who wanted to remain in the teaching field.

6.3.3.2 Changes in professional identification

The findings show that the WhatsApp Messenger-based course had improved the way the teachers identified with the teaching profession and with each other. It managed to break barriers that limited social and professional interactions, such as discrimination based on age, level of qualifications, where they were acquired their qualification, and fields of study. The course interaction also made them realise the importance of pedagogical skills for teachers at a university level.

The teachers were now receptive to professional advice and expressed their willingness to share professional experiences with other teachers. They also believed that professional advice can help them to improve their pedagogical practices. Most of the teachers also expressed willingness to participate in professional development programmes that are flexible in nature. They believed that online-based professional development programmes suited their work schedules. Others were also considering completing formal courses in pedagogy.

6.3.3.3 Changes in professional competency

The findings from the interviews showed that the professional competency of the teachers had significantly improved after the course. They now paid attention to pedagogical approaches and understood the roles of teachers and students in the teaching and learning process. There was a realisation among most of the teachers of the importance of student-centred approaches in facilitating conceptual understanding. The teachers also managed to discuss other teaching approaches besides IBP and managed to point out the strengths and weaknesses of these approaches.

The teachers realised that they were not supposed to limit students' quests for knowledge by restricting their knowledge acquisition process; instead they were supposed to leverage on the students' natural zeal to learn. This, they realised, would make them co-creators of knowledge with the students and improve conceptual understanding. Their perception of teaching had shifted from being the sources of knowledge to being the guides in knowledge creation.

6.3.3.4 Changes in career progression plans

An analysis of the findings showed that the teachers had varying views on how they would progress in their teaching careers. Some of them believed that teaching was a prestigious career and would consider enrolling for pedagogical courses. This would help them in their future teaching endeavours as they could now see themselves remaining in the teaching profession for some time. Others were of the view that they were dual professionals and, as such, they would pursue further qualifications both in the teaching profession and in their own areas of expertise.

6.3.4 Changes in teachers' pedagogical approaches after using WhatsApp Messenger to discuss inquiry-based pedagogy

The fourth sub-question was aimed at determining (from the teachers' own narrative) any changes that occurred in the pedagogical practices of university teachers because of learning IBP through WhatsApp Messenger. Findings from interviews and the focus group discussion after the teachers had participated in the WhatsApp Messenger-based IBP course showed that there were changes in the pedagogical approaches of the teachers.

6.3.4.1 Pedagogical approaches

The teachers highlighted the importance of student-centred teaching approaches in the teaching of chemistry at a university level. They also acknowledged the importance IBP in developing both the student and the teacher. They realised that IBP makes the teacher a co-creator of knowledge with the students. The teachers admitted that knowledge did not exist in the teacher only but required the efforts of both the teachers and students to discover it. The teachers were in agreement that those pedagogical approaches that promoted collaboration between the teachers and students were more effective in developing students' problem-solving abilities. The teachers indirectly admitted that they could not possibly have all solutions to problems, but some solutions could come from working with students as they created knowledge. From this knowledge creation venture, the teachers would also be learning new things.

6.3.4.2 Use of ICT

On the use of ICT in teaching, the teachers noted that their experience in the course had taught them of the importance of using ICT in teaching. Though some had been using ICT to teach before, none had used mobile communication technology. Their comments were a change from their initial beliefs that showed reluctance in integrating ICT in their pedagogical practices. They initially cited issues such as reduced attendance and plagiarism as reasons for their reservations in the use of ICT.

The responses from the teachers showed that they acknowledged the power of technology as a teaching tool. They recognised its usefulness in facilitating the availability of knowledge to students, even without involving the teacher. However, their responses also betrayed the fear about the future of the profession. They felt that their profession was under threat from technology. This was a strong indicator that they had transformed from being just scientists to teachers. It made sense to believe that only teachers can fear for the future of "their" teaching profession.

6.4 LIMITATIONS OF THE STUDY

Despite careful planning on the part of the researcher, the study (like most studies of this magnitude) faced some hurdles. Obtaining permission from universities to conduct research was a big challenge as most of the university administrators were unclear, and to some extent, suspicious about the researcher's intentions. The research touched on a sensitive aspect of most university governance and staffing issues. They were unsure about what the findings of the study would reveal and their implications for the credibility of their institutions. The findings had the potential to affect the credibility of the universities in terms of staff qualifications and quality of their academic programmes. There had been a few cases where some universities had been embroiled in legal issues due to their operational procedures. As such, any information that had the potential to cast universities in a bad light was not for public consumption. As a result, some of the initially targeted universities refused the researcher permission to conduct the research. The researcher then approached other universities. Following lengthy meetings with the university administrators, it was agreed that the researcher would be granted permission on condition of anonymity. As such, the names of the universities at which the participating teachers taught, were kept anonymous throughout the study. The fact that permission was grudgingly awarded may have had the unintentional effect of distorting the researcher's description of the research settings.

Apart from the issues of access to research sites, it was also a very difficult process to get willing participants. Some of the targeted participants who initially agreed to take part in the interviews, withdrew citing a variety of reasons. The bottom line was that university teachers were not an easy population target for research. As a result, the process of accessing the research site as well as getting willing participants took longer than expected. In the process, valuable time was lost in setting the research process in motion. However, to maintain objectivity in the data collection, the researcher did not change any aspect of the research instruments.

6.5 SUGGESTIONS FOR FURTHER STUDY

The results of this study reflect a lot of glaring shortcomings in the university education system in Zimbabwe. At the time of the study, most of the universities were manned by teachers who had a very negative professional identity. They did not view themselves as teachers, but rather believed that they were academics who were teaching only while they awaited opportunities elsewhere. There is a need for further research about how the professional identity of teachers affects the way they deliver content and how this affects the conceptual understanding of the students.

There is also a current lack of understanding of pedagogical approaches among university teachers. They tend to have a negative attitude towards pedagogy. Studies could be carried out on the correlation between pedagogical skills and students' achievement.

Studies should also be carried out on how students who learn chemistry through IBP perform in their practical examinations. Follow-up studies can be carried out to discover how they will perform their duties in places of work and other life ventures.

This current study also uncovered that mobile communication technology can be very useful in the professional development of university teachers. Further studies can also be carried out on the possible use of mobile communication technology in delivering content to students. Studies on various other applications, besides WhatsApp Messenger, could be investigated. Such studies need to look at the effectiveness in content delivery as well as their effect on achievement.

This study found that WhatsApp Messenger can be used anonymously to train teachers in pedagogy. Further studies can be carried out on how to use WhatsApp Messenger and other mobile communication apps to provide anonymous assessment. This could be either in student-to-student assessments, teacher-student assessments, and teacher-to-teacher assessments. This can alleviate the biases associated with assessing familiar individuals in an education set up.

This study noted some gender-based differences in the development of professional identity. Male teachers tended to prefer industrial work than university teaching. Further research could be done on the gender factor in professional identity development.

6.6. RECOMMENDATIONS

The findings of this study will help to understand the *gaps* that exist in the pedagogy of science in general and chemistry in particular at university. The findings first highlight the major

problem that exists, that is, the lack of pedagogical training among the majority of university teachers. This has been proven to have a negative impact on their professional identity. They regard themselves as academics rather than teachers. As such, they do not seek to deepen their understanding about the teaching methodologies that enhance students' conceptual understanding, in the case of this study, IBP. The results of this study show that social media platforms such as WhatsApp Messenger can be used as effective tools for professional development of university teacher so that they can identify positively with the teaching profession as well as acquire the relevant pedagogical skills. In light of these findings the researcher makes the following recommendations:

- Universities need to professionally develop their teachers so as to transform their professional identities;
- Teachers of professional development can develop and implement online staff development programmes that leverage on the WhatsApp Messenger platform; and
- University chemistry teachers should use student-centred approaches such as IBP to enhance students' conceptual understanding

6.7 REFLECTIONS

In this study, the researcher interviewed university teachers to determine their professional identities. Findings showed that the issue of professional identity is currently not taken seriously by most academic institutions. The tendency is that when universities advertise for teaching staff, they concentrate on the content knowledge of the teachers. This is despite the shift in paradigm in the knowledge world occasioned by advances in technology, where TPCK is the buzz word.

Because of the researcher's work in a university Teaching and Learning Centre, he has had a chance to interact with teachers from various academic backgrounds. There was a lot of resistance when it came to staff professional development in teaching methodologies. Various workshops, seminars, and meetings held on the issue of professional development were marked by apathy. "What are the teachers going to teach us?" was the most common question. After all, these university teachers were highly qualified in their academic fields. Some were professors of pharmacy; some had doctorates in engineering, chemical technology, and so forth. What more could be taught to these academics?

However, the academics always had a problem. They could not understand why any student could fail what they believed to be simple concepts. Explanations were various. It was either

that the students nowadays were dull, lazy, or both. It was never about the delivery of content. The expectation was that if a student were to sit in class, listen to the teacher speak, and write the notes that the teacher gave, then it was not supposed to be a problem to regurgitate those facts and pass their examinations. For most of the academics, the objective was for students to pass the examinations. It was never about conceptual understanding.

However, the field of education is a profession on its own with its own standards and procedures. For pedagogues, like the researcher, the means always justifies the end. Instruction is a procedural issue, and an individual has to believe that they are a teacher for them to begin behaving as one. In other words, one has to identify positively with the teaching professional before they can teach well. However, for one to identify themselves as a teacher, they first need to acquire the skills that qualified them to be one. For the university chemistry teachers in this study, IBP skills were considered to be relevant based on their proven effectiveness. However, because of various reasons proffered (most of them bordering on pride) the teachers would not seek to acquire those skills. The teachers did not find time to attend professional development courses.

Mobile communication technology has provided new ways of communication that are flexible, cheap, and eliminate the need for individuals to be in the same place at the same time for them to share information. The researcher saw this as an opportunity to provide a staff development course through the WhatsApp Messenger platform, which is one of the applications with the widest use among mobile communication users. So that is how the journey began, as the researcher tried to discover how the professional identities of the university teachers would change by undertaking an IBP course on the WhatsApp Messenger platform.

In this study, the researcher was not sure whether he would get the university teachers to agree to participate in a course that they normally would not want to participate in. The fears were confirmed as many targeted participants gave various reasons for not being able to participate. However, the researcher eventually managed to recruit enough participants for the required sample, which enabled him to kick start the research.

In this study, the researcher interviewed university chemistry teachers from three universities. The teachers had various educational backgrounds – engineers, pharmacists, biomedical scientists, and others. One common characteristic among all these teachers was that they did not think they were teachers. If time had permitted the researcher to interview the whole university, it would not have been surprising if most of the teachers had said the same. This

was a curious state of affairs, where most of the individuals involved in a profession did not identify with the profession. They had not been trained or socialised to acquire the ethos and norms of the profession mostly because their universities did not have provisions for that and also because the teachers themselves did not believe they were important.

As the teachers were drafted into the WhatsApp Messenger group, there was a mixture of anxiety and uncertainty on the part of the researcher and on the group of teachers as well. For the researcher, the main worry was whether the participants would find the activities worthwhile and more importantly, whether they would not abandon the course midway. For the group of teachers, the researcher believed they were all asking themselves: 'What is this all about?' They did not immediately engage in fruitful discussions but encountered several hitches before they became productive.

Initially, the discussions were marked by short sentences or phrases in response to questions, but as the discussions progressed, there was a gradual increase in interest in the discussions. The teachers ended up doing their own research and making unsolicited contributions to the discussions. The WhatsApp Messenger application gave them a platform where they could express themselves without any hindrances. They discussed issues, shared ideas, and referred each other to websites where they could get more information. Knowledge did not reside in individuals (Bockurt et al., 2016), but was generated from websites and transmitted throughout the network through the connections of individual teachers (AlDahdouh et al., 2015).

As the teachers participated in the discussions, human agency played a very important role in professional identity development. In the WhatsApp Messenger group, some individual became very active, giving their responses and well-researched contributions. In accordance with the work of Mathe and Hapazari (2019), professional identity developed as a result of an individual's active participation in a CoP. These participants showed a lot of interest in the activities and the researcher could easily follow their professional identity construction process. Their professional identity development could also be confirmed in the subsequent interviews. Such participants (who were the majority) developed a strong professional identity (from their own narrative) as a result of participating in the WhatsApp Messenger-based IBP course.

There were also some individuals who were very active in the discussions but without contributing anything of substance. They would give hurried responses without giving much consideration on the issues under discussion. These individuals, the group playboys (Forsyth, 2014), would also post irrelevant content on the platform. Such individuals did not enrich and

were also not enriched by the discussions. These individuals would not develop a strong professional identity towards the teaching profession but would remain inclined to their academic professions. Only meaningful participation in a CoP leads to the development of positive professional identity (Oyserman et al., 2017). Individuals whose participation was not task-related were not ready to let go of their initial frames of reference in terms of who they were professionally. They were not ready to adopt new meaning perspectives, and they did not contribute much to the debates. In the end, there was no transformation in their professional identities.

In addition, there were passive participants who did not contribute much in terms of original ideas. Their contributions were either to respond to other participants' contributions, or to agree with what had been posted by others. These participants tended to follow the general direction that the group was taking. It was difficult to follow their professional identity construction process but, from their own narrative in the interviews, they had managed to acquire some intended traits in terms of professional identity.

6.8 SUMMARY

This marks the end of the investigation into the professional identity development of university chemistry teachers as they learnt IBP on the WhatsApp Messenger platform.

A summary of issues covered in each of the topics gives the reader a guide on how to navigate the thesis. The summary of the findings describes in brief, how the findings of this study tried to answer the research questions, and how the objectives of the study were met. The limitations of the study, which could have hampered the successful accomplishment of these objectives, are outlined. These limitations may have affected the overall results of the study.

In the course of the study, there were other issues that arose, which were not necessarily included in the objectives of the study. However, these provided interesting insights into the subject of professional identity and may warrant the attention of researchers. These were outlined as suggestions for further study by researchers interested in the topic.

The researcher also provided recommendations for policymakers, educational practitioners and other interested parties based on the findings of the study. The recommendations are aimed at closing the gaps that have been identified in the course of the study.

Finally, the researcher provided his own reflections as the conclusion to the study.

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APPENDICES

Appendix 1: Ethics certificate

UNISA university of south africa

UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE

Date: 2019/04/17

Ref: **2019/04/17/55756999/41/MC**
Name: Mr P Mutanga
Student no: 55756999

Dear Mr Mutanga

Decision: Ethics Approval from 2019/04/17 to 2024/04/17

Researcher(s): Name: Mr P Mutanga
E-mail address: pmutanga06@yahoo.co.uk
Telephone: +263 77 212 1157

Supervisor(s): Name: Dr AR Molotsi
E-mail address: molotar@unisa.ac.za
Telephone: +27 12 429 3265

Title of research:

The use of social medial in professional identity development: A case of using WhatsApp Messenger to inquiry based pedagogy to university chemistry teachers

Qualification: D Ed in Science and Technology Education

Thank you for the application for research ethics clearance by the UNISA College of Education Ethics Review Committee for the above mentioned research. Ethics approval is granted for the period 2019/04/14 to 2024/04/17.

*The **low risk** application was reviewed by the Ethics Review Committee on 2019/04/14 in compliance with the UNISA Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.*

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
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www.unisa.ac.za

2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the UNISA College of Education Ethics Review Committee.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
7. No field work activities may continue after the expiry date **2024/04/17**. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number **2019/04/17/55756999/41/MC** *should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Kind regards,

Prof AT Motlhabane
CHAIRPERSON: CEDU RERC
motlhat@unisa.ac.za

Prof PM Sebate
ACTING EXECUTIVE DEAN
Sebatpm@unisa.ac.za

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Appendix 2a: Letter addressed to university A seeking permission to carry out research

Harare Institute of Technology Box 227, Belvedere Harare

The Registrar

University A

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I, Patrick Mutanga am doing research under supervision of Dr A. R. Molotsi a senior lecturer in the Department of Science, Mathematics and Technology Education towards a PhD at the University of South Africa. My study is titled: *The use of social media in professional identity development: A case of using WhatsApp Messenger to teach inquiry-based pedagogy to university chemistry teachers*

The general aim of the study is to explore and describe the development professional identity of university teachers as they undertake a professional course in IBP through the WhatsApp Messenger platform. The study will entail offering a course in inquiry-based pedagogy to university chemistry teachers through the WhatsApp Messenger platform. During the course we will observe the development of their professional identity.

The benefits of this study are that the results will be used to assess the feasibility of using social media as a tool for professional development.

The research does not pose any risks to the participants.

There will be no reimbursement or any incentives for participation in the research.

Feedback procedure will entail availing copies of the thesis to the participants

Yours sincerely

Patrick Mutanga

PhD student

Appendix 2b: Letter addressed university B seeking permission to carry out research

Harare Institute of Technology Box 227, Belvedere Harare

The Registrar

University B

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I, Patrick Mutanga am doing research under supervision of Dr A. R. Molotsi a senior lecturer in the Department of Science, Mathematics and Technology Education towards a PhD at the University of South Africa. My study is titled: *The use of social media in professional identity development: A case of using WhatsApp Messenger to teach inquiry-based pedagogy to university chemistry teachers*

The general aim of the study is to explore and describe the development professional identity of university teachers as they undertake a professional course in inquiry-based pedagogy through the WhatsApp Messenger platform. The study will entail offering a course in inquiry-based pedagogy to university chemistry teachers through the WhatsApp Messenger platform. During the course we will observe the development of their professional identity.

The benefits of this study are that the results will be used to assess the feasibility of using social media as a tool for professional development.

The research does not pose any risks to the participants.

There will be no reimbursement or any incentives for participation in the research.

Feedback procedure will entail availing copies of the thesis to the participants

Yours sincerely

Patrick Mutanga

PhD student

Appendix 2c: Letter addressed to university C seeking permission to carry out research

Harare Institute of Technology Box 227, Belvedere Harare

The Registrar

University C

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I, Patrick Mutanga am doing research under supervision of Dr A. R. Molotsi a senior lecturer in the Department of Science, Mathematics and Technology Education towards a PhD at the University of South Africa. My study is titled: *The use of social media in professional identity development: A case of using WhatsApp Messenger to teach inquiry-based pedagogy to university chemistry teachers*

The general aim of the study is to explore and describe the development professional identity of university teachers as they undertake a professional course in inquiry-based pedagogy through the WhatsApp Messenger platform. The study will entail offering a course in inquiry-based pedagogy to university chemistry teachers through the WhatsApp Messenger platform. During the course we will observe the development of their professional identity.

The benefits of this study are that the results will be used to assess the feasibility of using social media as a tool for professional development.

The research does not pose any risks to the participants.

There will be no reimbursement or any incentives for participation in the research.

Feedback procedure will entail availing copies of the thesis to the participants

Yours sincerely

Patrick Mutanga

PhD student

Appendix 3: PARTICIPANT INFORMATION SHEET

Date……

Title: *The use of mobile communication technology in professional identity development: the case of using WhatsApp Messenger to teach inquiry based pedagogy to university chemistry teachers.*

DEAR PROSPECTIVE PARTICIPANT

My name is Patrick Mutanga and I am doing research under the supervision of Dr A. R. Molotsi a senior lecturer in the Department of Science, Mathematics and Technology Education towards a PhD at the University of South Africa. We are inviting you to participate in a study titled: *The use of mobile communication technology in professional identity development: the case of using WhatsApp Messenger to teach inquiry based pedagogy to university chemistry teachers.*

This study is expected to collect important information that could help to inform policy on professional development of university teachers using modern information communication technologies. You are invited because you are a university teacher who has not undergone any training in pedagogy. I obtained your contact details from…….. The number of participants in this study is nine.

The study involves taking a course in inquiry-based pedagogy through the WhatsApp Messenger Platform. Before this course interviews will be done to get your perceptions yourself as a teacher. These interviews will also be repeated after the course. The course is expected to be completed in three months while both interviews will take one and half hours each. The focus group discussion will take three hours. Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent. You are free to withdraw at any time and without giving a reason. While your participation in this study will not have material benefits to you as an individual it will contribute significantly to the creation of knowledge in the area of university staff professional development using information communication technology.

There are minor risks of psychological harm associated with misuse of (or inability to use) cell phones in this study. Your name will not be recorded anywhere and no one will be able to connect you to the answers you give. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. Your answers may be reviewed by people responsible for making sure that research is done properly, including the transcriber, external coder, and members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records. Your anonymous data may be used for other purposes, such as a research report, journal articles and/or conference proceedings but individual participants will not be identifiable in such a report.

For your participation in focus group discussions please note that this group will be composed of eight other participants. While every effort will be made by the researcher to ensure that you will not be connected to the information that you share during the focus group, I cannot guarantee that other participants in the focus group will treat information confidentially. I shall, however, encourage all participants to do so. For this reason, I advise you not to disclose personally sensitive information in the focus group.

Hard copies of your answers will be stored by the researcher for a period of five years in a locked filing cabinet at the Harare institute of Technology for future research or academic purposes; electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. At the end of five years, hard copies will be shredded and electronic copies will be permanently deleted from the hard drive of the computer through the use of a relevant software programme. Any costs that you will incur as a result of participation in this research will be reimbursed upon production of verifiable receipts.

This study has received written approval from the Research Ethics Review Committee of University of South Africa. A copy of the approval letter can be obtained from the researcher if you so wish. If you would like to be informed of the final research findings, please contact Patrick Mutanga on +263772121157 or email pmutanga06@yahoo.co.uk or the UNISA website. The findings are accessible for ten years. Should you require any further information or want to contact the researcher about any aspect of this study, please contact Patrick Mutanga on +263772121157 or pmutanga06@yahoo.co.uk. Should you have concerns about the way in

which the research has been conducted, you may contact Dr A. R. Molotsi at molotar@unisa.ac.za or phone number 0124293265.

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.

_____

Patrick Mutanga

Appendix 4: INFORMED CONSENT LETTER

CONSENT TO PARTICIPATE IN THIS STUDY (Return slip)

I, …….. (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the interview

I have received a signed copy of the informed consent agreement.

Participant Name & Surname (please print)

_____ _____

Participant Signature Date

Researcher's Name & Surname (please print) Patrick Mutanga

_____ _____

Researcher's signature Date

Appendix 5: FOCUS GROUP CONSENT AND CONFIDENTIALITY AGREEMENT

I_____ grant consent that the information I share during the focus group may be used by **PATRICK MUTANGA** for research purposes. I am aware that the group discussions will be digitally recorded and grant consent for these recordings, provided that my privacy will be protected. I undertake not to divulge any information that is shared in the group discussions to any person outside the group in order to maintain confidentiality.

Participant's Name (Please print): _____

Participant Signature: _____

Researcher's Name: (Please print): **PATRICK MUTANGA**

Researcher's Signature: _____

Date: _____

Appendix 6: Pre-intervention interview guide

Teaching beliefs

1 Why did you become a university teacher?

2 Have you always wanted to be a university teacher?

3 Are you a teacher or as a scientist?

4 If you had a wider career choice what would you have become?

5 Now that you are teaching at university are you comfortable being called a teacher?

6 Now that you are teaching if a new opportunity comes up which allows you to become who you really wanted to become will you take it?

7 What do you think are the qualities of a good teacher? Which of the qualities do you possess yourself?

8 What role do you think a lecturer should play to provide a conducive learning environment?

9 How do you ensure active participation by your students?

10 Are you aware of the learning needs of your students? Can you briefly describe them?

11 Are you interested in the well-being of your students? How do you ensure that you cater for their well-being?

12 How important is it provide good education for your students?

Professional socialisation

1 How do you identify yourself with other lecturers in your institution and outside your institution?

2 How important is teaching as a profession to you?

3 Do you share new teaching ideas/knowledge with colleagues? If yes Through which media?

4 Do you collaborate with your colleagues?

5 Have you ever participated in professional development/training/conferences?

within your institution

outside your institutional

6 Do you think it is important to learn from other lecturers within and outside your institution?

7 Have you worked in industry before? If yes, how has that influenced your teaching?

Career progression

1 Are you proud to be a university teacher?

2 Do you consider pursuing a career in education?

3 Do you have a clear vision on how you can become a professional in teaching at your institution?

4 To what extent do you think your job assignments help your professional development at your institution?

5 Do you consider your job to be of a high prestige as compared to your colleagues in industry?

6 How do you feel society views your job in terms of status?

Professional competence

1 Do you have sufficient knowledge about the subject that you teach?

2 Which approaches do you use to guide your students' learning?

3 Which technologies do you use to deliver content to your students?

4 How do you think these technologies facilitate students learning?

5 Are you able to make important decisions on the curriculum?

6 How do you foster a conducive learning environment for your students?

7 How do you help students apply what they have learnt in real-life situations?

8 Do you allow students to discover new knowledge on their own?

9 How do you do this? What role do you play?

10 How often do your students carry out practical work?

11 What role do you play in students' practical work?

12 Do you use the inquiry-based learning approach in your teaching?

Appendix 7: Interview Guide during the WhatsApp discussions

1. Have you used social media before? If yes which social media have you used?

2. Have you been interacting with other professionals in your field?

3. If yes, how have you been interacting with them? If no can you explain why you have not been doing so?

4. Do you think WhatsApp enhances any meaningful interactions with other professionals?

5. To what extent has WhatsApp improved your interaction with your colleagues?

6. To what extent has it affected disturbed your interactions?

7. Are there any things that you could not do in your real world which you can now do on WhatsApp?

8. How have been the interactions so far in the WhatsApp group?

9. Have you are learning anything from your colleagues through your interactions via WhatsApp? Please explain.

10 Do you think others are learning anything from you through your WhatsApp interactions? Please explain.

11. Would you recommend WhatsApp as a learning platform to your other colleagues in your department/institution?

12. Would you recommend it to your students?

13 Do you think you will remain in this WhatsApp group after this study? Why?

14 Do you think in future you will join WhatsApp groups with colleagues from your institution/department? Why?

15 Would you consider being in a WhatsApp group with your students? Why?

Appendix 8: Post-intervention interview guide

Teaching beliefs

1 How did your WhatsApp interactions affect your view about the role of a teacher?

2 From your WhatsApp interactions with colleagues do you believe that it is worthwhile to be a university teacher?

3 After your discussions with other teachers on WhatsApp would you consider changing profession if offered a chance?

4 After your WhatsApp discussions what do you think are the qualities of a good lecturer? Which of the qualities do you gain from the WhatsApp interactions?

5 From your discussions with colleagues what role do you think a lecturer should play to provide a conducive learning environment?

6 What new ideas did you learn through WhatsApp about how to ensure active participation by your students?

7 Has your participation in WhatsApp discussions made you aware of the learning needs of your students? Can you briefly describe them?

8 Do you think your WhatsApp interactions have helped you get interested in the well-being of your students? How do you ensure that you cater for their well-being?

9 How important is it provide good education for your students?

Professional socialisation

10 How has WhatsApp messenger influenced the way you identify yourself with other lecturers in your institution and outside your institution?

11 After interactions with colleagues through WhatsApp how important is lecturing as a profession to you?

12 Did you manage to gain any new teaching ideas/knowledge with colleagues through WhatsApp? If yes do you think you could have gained this knowledge without the use of WhatsApp?

13 To what extent do you think WhatsApp helped you to share teaching ideas with other colleagues?

14 What are some of the issues that you managed to address through WhatsApp that you could not do in the real world?

15 What are some of the difficulties that you encountered when using WhatsApp that could have not occurred in the real world?

16 Will you continue collaborating with your colleagues through WhatsApp?

17 Will you consider using WhatsApp in future for professional development programmes

within your institution?

outside your institution?

18 Do you think it is important to learn from other teachers within and outside your institution?

19 Has the use of WhatsApp changed the way you teach? If yes, how has that influenced your teaching?

20 How can WhatsApp be used to enhance collaboration with industry?

Career progression

1 How did the use of WhatsApp change your view about lecturing as a profession?

2 Do you consider pursuing a career in education through WhatsApp?

3 Have you developed a clear vision on how you can become a professional in teaching at your institution?

4 To what extent do you think WhatsApp helped your professional development?

5 How can institutions use WhatsApp for professional development?

6 After your interactions with other professionals do you consider your job to be of a high professional status?

8 How do you feel society views your job in terms of status?

Professional competence

1 Do you have sufficient knowledge about the subject that you teach?

2 Did your WhatsApp interactions make you change approaches you use for teaching?

3 Have you tried using WhatsApp to deliver content to your students?

4 How do you think using WhatsApp would facilitate students learning?

5 Do you think you are now able to make important decisions on the curriculum?

6 How can you use WhatsApp to foster a conducive learning environment for your students?

7 How do you help students apply what they have learnt in real-life situations?

8 How can you use WhatsApp in student assessments?

9 How can you use WhatsApp to motivate students in their learning?

19 How can you use WhatsApp to cater for the diverse learning needs of your students?

11 How can you use WhatsApp to maintain good rapport with your students?

Appendix 9: Focus group questions

1 How do you describe your experiences as you were learning IBP using WhatsApp?

2 To what extent did WhatsApp enhance interaction with your colleagues?

3 To what extent has it affected/disturbed your interactions?

4 How have your interactions affected your views as teachers?

5 Do you think WhatsApp Messenger is a suitable platform for professional development?

6 Have you learnt anything from your colleagues through your interactions via WhatsApp? Please explain.

7 Do you think others learnt anything from you through your WhatsApp interactions? Please explain.

8 Would you recommend WhatsApp as a learning platform to your other colleagues in your department/institution?

9 Would you recommend it to your students?

10 Do you think you will remain in this WhatsApp group after this study? Why?

11 Do you think in future you will join WhatsApp groups with colleagues from your institution/department? Why?

12 Would you consider being in a WhatsApp group with your students? Why?

Appendix 10: Example of teachers' answers

Table 5. Examples of teachers answers to questions about their teaching beliefs

Question	Answer	Interviewee
Why did you become a university teacher?	I got sponsored for my master's programme by this university on the understanding that I will serve for four years	Tr A
	You know what… I once worked in industry and I was being treated as a technician. The nature of my job did not require a degree. So I felt underutilised. At university at least they recognise that.	Tr B
	Industries had closed so decided to find a job as a teacher as I wait for openings in the industry	Tr C
	After finishing my Master's degree, I spent a long time looking for employment without success. When I saw the advertisement for teaching at my university I decided to try my luck. Fortunately, I passed the interview, and …… here I am.	Tr D
	I was approached by the university to teach on a part time basis at first. I later realised that I could still run my pharmacy while teaching full time	Tr E

	I could not raise money to start own production plant so I decided to find a job a teacher.	Tr F
	I could not find any work after finishing my master's degree. So I tried teaching…. then I got sponsored by the university for my PhD.	Tr G
	I did not enjoy the industrial experience. The rigid working conditions as well as poor remuneration prompted me to move to university teaching once the opportunity arose.	Tr H
	After my first degree I became a teacher. I then went for my masters and I was offered work as a teaching assistant. After masters I became full-time lecturer	Tr I
What is your preferred title?	I am a pharmacist who is doing the work of a teacher.	Tr A
	I prefer to be called a scientist rather than a teacher. I think it is more prestigious	Tr B
	I am technologist. That is how my colleagues address me.	Tr C
	I am a biotechnologist but I don't mind being called a teacher because that is what I am doing.	Tr D

	I am a pharmacist.	
	I am an engineer	Tr E
	You can address me as Engineer "X". That is how my colleagues address me. The fact that I am teaching at university does not take away the fact that I am an engineer. I am an engineer first and foremost. I wish to be recognised as such	Tr F
	My first profession is a biomedical technologist. Teaching is secondary to me.	Tr G
	I am a scientist	Tr H
		Tr I
What teaching approach do you normally use?	I use different approaches to teaching but I cannot give specific names of the approaches.	Tr A
	I mainly use the lecture methods	Tr B
	Usually I lecture to the student but I also use group discussions.	Tr C

	Is mainly the lecture method	Tr D
	Lecture method	Tr E
	I use the lecture method	Tr F
	Lectures, seminar and group work.	Tr G
	Mainly the lecture method and experiments.	Tr H
	We use lectures experiments and tutorials	Tr I
Do you think students can be able to take charge of the learning process?	It is the teacher's responsibility to teach the students. That is why they are there in the first place. It will take too long for students to understand if they are at the forefront of the teaching process.	Tr A
	The students we have nowadays are too shallow.	Tr B
	It will be difficult to let students take charge of the learning process. They don't know anything	Tr C
	It is not always possible to do that. The students need to be given direction by the teacher.	Tr D

	I think it will be difficult for them. It is the teacher who can interpret the syllabus. We also set the examinations so we need to guide them accordingly.	Tr E
	To be honest with you the level of chemistry in engineering is so high that these students would struggle if they were to be left to take charge of their learning. For your own information, they struggle with very simple issues. It will take the whole year for them to understand basic concepts. Besides the teacher is there to teach them so there is no need to complicate the learning process.	Tr F
	With the numbers that we teach……um. I think it will be too hectic.	Tr G
	There are certain tasks that they can do on their own but the teacher should be overly in charge.	Tr H
	Teachers should take centre stage….. that's why they are there	Tr I
Do you allow students to do	The teacher should provide clear procedures for experiments so that they are successful	Tr A

their own experiments?	What!... No! I will never allow students to do their own experiments. One of the duties of the teachers is to protect students from accidents. If I allow them to experiment they might burn down the whole laboratory and will be in serious trouble with the authorities. I would rather perform demonstrations so that students can see how the experiment is done.	Tr B
	I would be in serious trouble with the authorities if there were to be accidents. They can burn the whole laboratory	Tr C
	I will never allow students to do their own experiments. It will be too dangerous for them	Tr D
	They cannot do their own experiments. It's me who determines what's practical to do.	Tr E
	They can end up doing all sorts of funny mixtures so I will not allow that.	Tr F
	No they don't do any practical on their own	Tr G
	I have to give them carefully made instructions to avoid accidents	Tr H

	No they don't	Tr I
Now that you are teaching if a new opportunity comes up which allows you to become who you really wanted to become will you take it?	I would consider a career in industry if an offer comes that is better than the one I have now.	Tr A
	Yes! Definitely.	Tr B
		Tr C
	It depends on the remuneration	
		Tr D
	I would have wanted to go back to industry should the situation change…… but now I am a family woman. Teaching offers me a chance to be with my children. So I do not see myself going to industry though it was my initial desire.	
	I will consider any offers that are better than my current conditions of service.	Tr E
	Yah…. Yes… I think so	Tr F
	I will consider moving if I am offered a post with high perks.	Tr G
		Tr H

	If the job offers interesting opportunities, I will move. Yes I will take it	Tr I
What do you think are the qualities of a good teacher? Which of the qualities do you possess yourself?	A good teacher should be very knowledgeable in the subject area so that he can be able to teach. A good teacher should have more knowledge than the students. A teacher should be able to avail learning materials. A teacher should be eloquent and should be able to deliver content. I think a good teacher should prepare the lessons in advance so that he can be able to give students useful information. A teacher should be able to stand confidently in front of students and provide students with good learning materials. A teacher should be smart, presentable and very knowledgeable	Tr A Tr B Tr C Tr D Tr E Tr F Tr G

	For university teaching I think one should be highly qualified. One should also be confident in front of the student.	Tr H
	A teacher should be very knowledgeable because these students have access to many sources of information so you can be behind them if you are not careful	Tr I
What role do you think a teacher should play to provide a conducive learning environment?	Teachers should maintain discipline in the class.	Tr A
	Teacher should give clear instructions to students.	Tr B
	I think a teacher should act as a parent. Some of the student need a lot of counselling.	Tr C
	The teacher should treat students with respect	Tr D
	I think discipline is important.	Tr E
	The teacher should be approachable.	Tr F
	The teacher should take the role of a leader. He has to be exemplary in his behaviour.	Tr G

	The teacher need to treat students fairly….. without favouritism. The teacher should be clear in his teaching otherwise students lose concentration.	Tr H Tr I
How do you ensure active participation by your students?	By asking questions I pick them at random to ask questions. I try as much as possible not to be predictable. I can give my students class exercises at any time during the lecture. Um……. I sometimes give them work to do in groups. It is difficult especially when the group is large…...eh…. you can't really tell if everyone is listening. But sometimes I ask them questions so that they remain alert. By giving them work to research on their own. When doing experiments …. especially…… I make sure that everyone works on his own	Tr A Tr B Tr C Tr D Tr E

	I ask them question during the lectures. You can try several tricks…. you know…... some bit of humour works. You also need to give them breaks so that they can rest…...and also asking them questions	Tr F Tr G Tr H Tr I
Are you aware of the learning needs of your students? Can you briefly describe them?	That's a bit difficult. Sometimes it is not possible to tell the learning needs of the students. Yes, I know them. Um ……I mean to say that I make assumptions based on the requirements of the course outline. Well……I believe their learning needs vary. They come from various backgrounds so when giving them exercises that is when you notice their differences. Um…... to be honest I can't say that I know their learning needs. My main concern is that they have to finish their syllabus so that they can pass their courses. Sometime we don't get enough time with these students to be able to understand their needs. You see….. its	Tr A Tr B Tr C Tr D

	roughly ten weeks of teaching and you may never meet them again.	Tr E
	I believe that I know some of their needs. Actually…eh…they are diverse. You get in a class and you find that there are some very bright students and some need more time with the teacher.	Tr F
	Yes…..I think there is that gap between what they know and what they ought to know.	Tr G
	From my own observations the students lack the requisite skills to perform certain tasks. So sometimes I give them work so that they practice.	Tr H
	Their learning needs vary. You really can't tell until you have taught them for some time. That is when you will realise that some are very sharp and some need to help from the lecturer.	Tr I
Are you interested in the well-	Yes, I am very much interested in their welfare. I always create time for them if they have individual needs. So I even post consultation times on my door.	Tr A

being of your students? How do you ensure that you cater for their well-being?	Most of our engagements are academic. For social well-being and other personal problems I refer them to the dean of students.	Tr B
	You know…… university education is adult education. It's sort of difficult to then try to deal with their other issues.	Tr C
	Well, I am more interested in their academic issues. I think Student Affairs is responsible for that.	Tr D
	Yes, I am interested in their well-being. Their well-being affects their performance so I try to be there for them. I have counselled numerous students.	Tr E
	You know what? Sometimes you can be very concerned about their well-being but at the same time you are unable to offer any help. For example, the most common problem these days are financial in nature……so as a lecturer how can you help? I mean it doesn't mean that I don't care, but sometimes it's very difficult.	Tr F
	Yah I am concerned about their welfare. I try to understand their problems and offer advice and counselling.	Tr G

	Yes…. actually I am a student mentor so I am very much involved in looking after their well-being. Obviously I should be concerned about their welfare but sometimes they don't really open up……you know these are adults so you try as much as possible not to interfere with their personal issues.	Tr H Tr I
How important is it to provide good education for your students?	Good education guarantees a better future for the students. I think it's important to give good education to the students because they are the future leaders in many spheres of society. A good education enables the students to improve their decision-making abilities. I think with good education the students stand a better chance of getting good jobs…..eh…. I mean it's good for their future.	Tr A Tr B Tr C Tr D

	I think good education is important for the students in such a way that it develops their critical thinking skills…that…I think is necessary when they go into the job market.	Tr E
	Good education enables students to navigate their way in society. You know…...modern society transform too fast so they need to be able to cope.	Tr F
	It's important to give students good education to improve their competitiveness in the job market.	Tr G
	Good education is important for their future. Everyone is getting educated these days and it will be very difficult for those without good education.	Tr H
	Education opens up the mind. With good education the sky is the limit for them when it comes to seeking employment.	Tr I

Appendix 11: Group 1's lesson guide

Problem

The following metal reagents have been ordered for your chemistry lab - Calcium, Aluminium, Magnesium, Zinc, Beryllium, and Iron. The containers for these metals have come without labels. Students are required to identify and label all the containers.

Teacher demonstration

Teacher explains that all the metals react with HCl to give the metal chloride and hydrogen gas. For example, Aluminium react according to the equation:

$2Al_{(s)} + 6HCl_{(aq)} \rightarrow 2AlCl_{(3)(aq)} + 3H_{(2)\,(g)}$

The teacher uses a demonstration to show how this reaction occurs. For safety's sake the teacher should wear goggles. Since hydrogen evolves the students should also wear goggles and stand back. The demonstration should be held in a well-ventilated room or in a fume cupboard.

Materials provided

Solid piece of each of the following metals (Al, Ca, Mg, Zn, Fe, Be), water, unmarked hydrochloric acid, glassware, thermometers, ice, stopwatch, electronic balance, ruler, litmus paper (red and blue)

Expected solution

The students are expected to identify the acid using the litmus paper. The students are then expected to take equal masses of each of the metals and drop it into an equal amount of acid and simultaneously start the stop clock. They are expected to stop the clock as soon as the metal disappears. They are supposed to record time taken for the reaction to occur (time taken for the metal to disappear). They are expected to record their results in the table 6.

Table 6. Reactivity of metals

Metal	Reaction time (s)
A	
B	
C	
D	
E	

The students are expected to arrange the metals in terms of the ascending reaction time. The one with the lowest reaction time is the most reactive. They will then compare their results with the reactivity series of metals.

Errors expected from students

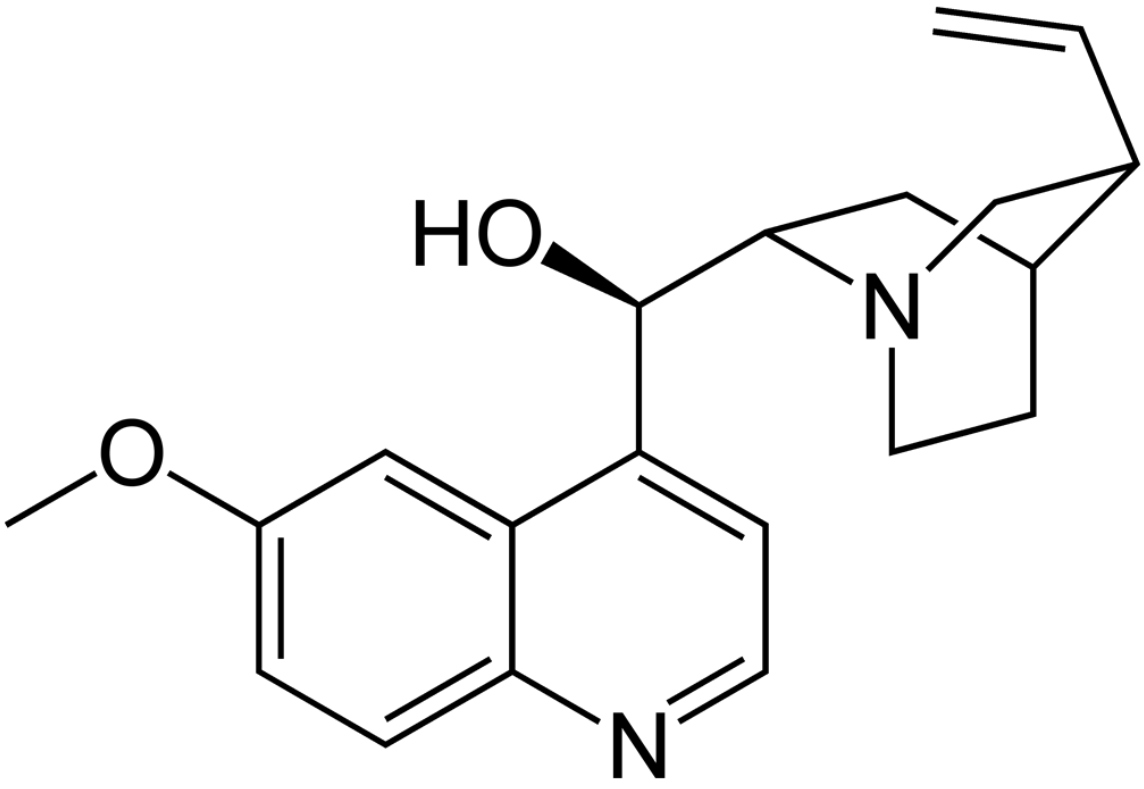
- Failure to distinguish between acid and water (some of the metals will not react with water)
- Failure to use same amount of metal or acid
- Failure to maintain other conditions constant e.g. concentration of acid, temperature, surface area of the metal.
- Using too little acid (reaction will not complete)
- Using too much of the metal sample (reaction will not complete)
- Failure to label samples prior to the experiment
- Not knowing the starting and stopping point of the experiment

Appendix 12: Group 2 Lesson guide

Task: Among the following plants is a plant that is used as a traditional cure for malaria. Students are required to perform a series of experiments to determine which plant contains a substance with the same chemical properties like quinine.

Aim: To extract the active ingredients in a medicinal plant and determine the functional groups.

Theory: Quinine is the most effective drug against malaria. It is suspected that one of the plants, which has been shown to have anti-malarial properties contains naturally occurring quinine. The molecular formula for quinine is shown below:



Assumed Knowledge

Students are assumed to have knowledge about functional groups

Procedure

They are expected to device their own procedure to identify which of the plants was most likely to be effective. They are expected to use the following procedures:

Extraction, Separation, Identification, Characterisation

Appendix 13: Group 3 Lesson Guide

Title: IDENTIFY UNKNOWN ORGANIC COMPOUNDS USING THEIR SOLUBILITY

Aim: To investigate the solubility characteristics of the following organic substances:

Benzoic acid powder, salicylic acid powder, stearic acid powder, peanut oil

Objective:

- Perform subsequent solubility tests.
- To examine the relationships between the solubility properties of an organic molecule and its structure, and *vice versa*.

Materials and chemicals

Spatula glass stirring rod

10 mL graduated cylinder

test tubes, 15 x 125-mm

test tube rack

pH meter

water

3 ml graduated droppers

5% $NaHCO_3$

5% NaOH

5% HCl

5% H_2SO_4

Diethyl ether

Hexane

Assumed knowledge

In this task it is assumed that students will have the following knowledge about solubility:

At the molecular level, solubility is controlled by the energy balance of intermolecular forces between solute-solute, solvent-solvent and solute-solvent molecules.

Recall from general chemistry that intermolecular forces come in different strengths ranging from very weak induced dipole – induced dipole interactions to much stronger dipole-dipole forces (including the important special case, hydrogen bonding).

There is a simple rule that says "**like dissolves like**" and it is based on the **polarity** of the systems *i.e.* polar molecules dissolve in polar solvents (*e.g.* water, alcohols) and nonpolar molecules in nonpolar solvents (*e.g.* the hydrocarbon hexane).

This is why ionic compounds like table salt (sodium chloride) or compounds like sugar, dissolve in water but do not dissolve to any great extent in most organic solvents. It also applies to the separation of oil and water (e.g. in salad dressings).

The polarity of organic molecules is determined by the presence of polar bonds due to electronegative atoms (*e.g.* N, O) in polar functional groups such as amines (-NH2) and alcohols (-OH).

The lecturer <u>may</u> give the following hints:

- Organic compounds follow three interdependent rules of solubility:
- small organic molecules are more soluble in water than are large organic molecules;
- polar organic molecules, especially those capable of hydrogen bonding, are more soluble in water than are nonpolar molecules; and
- compounds in their ionic forms are more soluble in water than their neutral forms.

Solvent Some solubility or complete miscibility

Water ……alcohols, amines, acids, esters, ketones, aldehydes

(typically only those with 4 carbons or fewer)

5% $NaHCO_3$ ……carboxylic acids

5% NaOH …….carboxylic acids and phenols

5% HCl …… amines

diethyl ether ……most organic molecules

Expected student procedures

The amounts of material to use for a solubility test are somewhat flexible. Use 2-3 drops of a liquid or approximately 10 mg of a solid. Unless the solid is already a fine powder, crush a small amount of the solid on a watch glass with the back of a spatula. Do not weigh the solid; simply use enough to cover the tip of a small spatula. Place the appropriate amount of either your solid or liquid unknown in a small test tube and proceed with the following solubility tests.

For every sample, students are expected to examine the physical characteristics which are:

a. Condition: solid or liquid

b. Colour

c. Odour

1) Water Solubility

Add approximately 1ml of water to the test tube containing your unknown sample. Shake the tube and stir with a glass stirring rod. A soluble unknown will form a homogeneous solution with water, while an insoluble liquid will remain as a separate phase. A liquid which is soluble in water may be either a low molecular weight polar compound of up to 5 carbon atoms or less. You may add additional water, up to 1 mL, if your compound does not completely dissolve with the smaller amount.

Check the pH of the water to determine if your unknown is partially or completely soluble in water and whether your compound has changed the pH of the water.

- pH paper turns red: water soluble acidic compound
- pH paper turns blue: water soluble basic compound

- pH paper does not change colour: water soluble neutral compound or insoluble compound

An organic compound which is soluble in water is typically a low molecular weight polar compound of up to 5-6 carbon atoms or less.

2) 5% NaOH Solubility

Add approximately 1 mL of 5% NaOH in small portions to the test tube containing your unknown sample. Shake test tube vigorously after the addition of each portion of solvent. Solubility will be indicated by the formation of a homogeneous solution, a colour change, or the evolution of gas or heat. If your sample is soluble in 5% NaOH, then your unknown is behaving as an organic acid. The most common organic acids are carboxylic acids and phenols. Carboxylic acids are usually considered stronger acids than phenols, but both of these acids will react with NaOH (a strong base).

3) 5% $NaHCO_3$ Solubility

Add approximately 1 mL of 5% $NaHCO_3$ in small portions to the test tube containing your unknown sample. Shake test tube vigorously after the addition of each portion of solvent. Solubility will be indicated by the formation of a homogeneous solution, a colour change, or the evolution of gas or heat. If your sample is soluble in 5% $NaHCO_3$, then it is a strong organic acid. If not, then it is a weak organic acid, if it dissolves in NaOH. The most common weak organic acid are phenols. Typically, only a carboxylic acid will react with $NaHCO_3$.

4) 5% HCl Solubility

Add approximately 1 mL of 5% HCl in small portions to the test tube containing your unknown sample. Shake test tube vigorously after the addition of each portion of solvent. Solubility will be indicated by the formation of a homogeneous solution, a colour change, or the evolution of gas or heat. If your compound is soluble in HCl solution, then it is an organic base. Amines are the most common organic base.

5) Hexane Solubility

CAUTION— Hexane is volatile and use a fume hood to carry out this experiment.

Add approximately 1 mL of hexane in small portions to the test tube containing your unknown sample. Shake test tube vigorously after the addition of each portion of solvent. Solubility will

be indicated by the formation of a homogeneous solution, a colour change, or the evolution of gas or heat. If your compound is hexane-soluble, then it is a nonpolar organic compound.

6) Concentrated Sulphuric Acid Solubility Test.

CAUTION — Concentrated sulphuric acid (H_2SO_4) is toxic and oxidising. Use a *fume hood* when working with H_2SO_4.

If the compound is insoluble in 5% HCl and 5% NaOH, add approximately 0.5 mL of concentrated sulphuric acid (H_2SO_4) in a dry test tube to the test tube containing your unknown sample. Tap the tube with your finger to mix or stir gently with a glass stirring rod. Do not use a metal spatula. Record the sample as soluble or insoluble. Interpret a colour change or a precipitate as soluble. If the compound is soluble in H_2SO_4, the sample is an alkene, an alcohol, an aldehyde, or a ketone. If the compound is insoluble in H_2SO_4, the sample is an alkane or an alkyl halide.

Appendix 14: Certificate of language and reference edit

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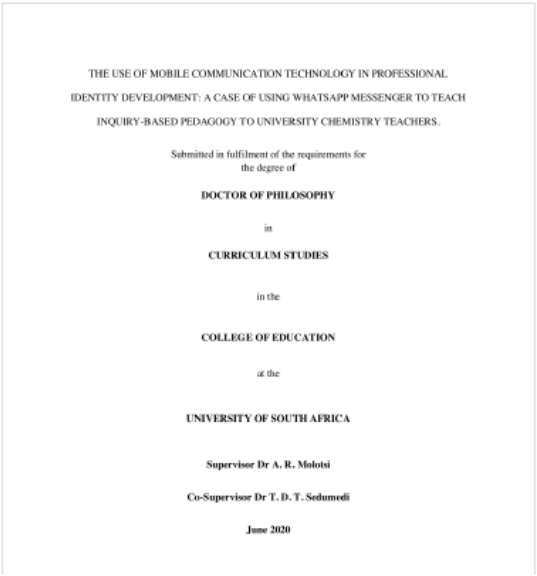

THE USE OF MOBILE COMMUNICATION TECHNOLOGY IN PROFESSIONAL IDENTITY DEVELOPMENT: A CASE OF USING WHATSAPP MESSENGER TO TEACH INQUIRY-BASED PEDAGOGY TO UNIVERSITY CHEMISTRY TEACHERS.

Submitted in fulfilment of the requirements for the degree of

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in

CURRICULUM STUDIES

in the

COLLEGE OF EDUCATION

at the

UNIVERSITY OF SOUTH AFRICA

Supervisor Dr A. R. Molotsi

Co-Supervisor Dr T. D. T. Sedumedi

June 2020

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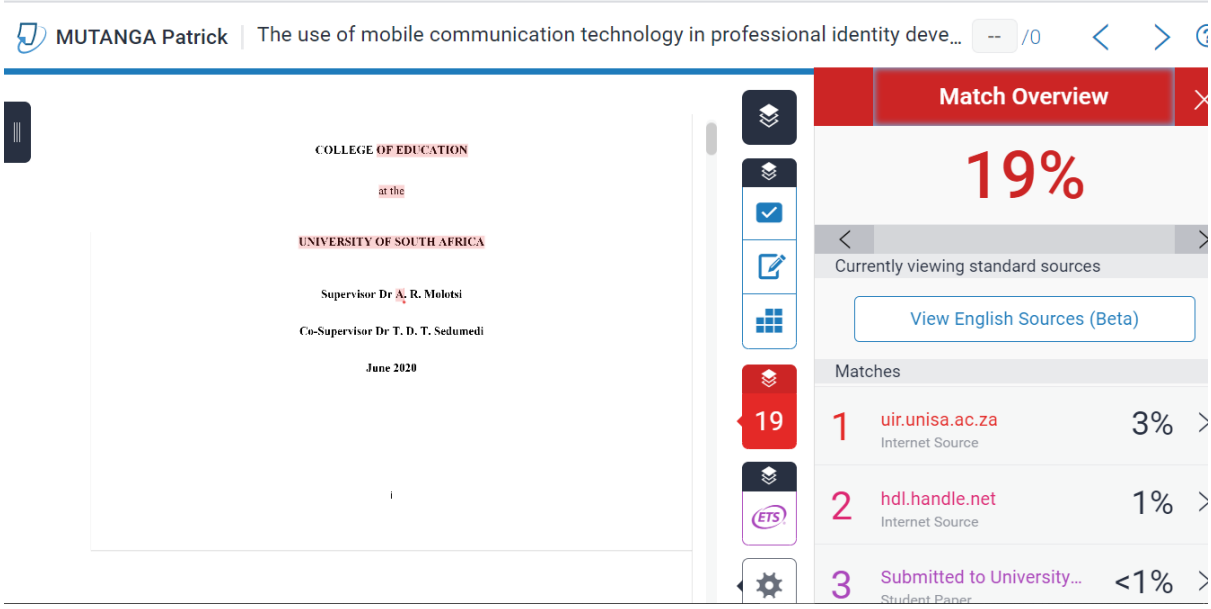

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