Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe

by

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ABSTRACT

Zimbabwe is implementing a competence-based educational curriculum in response to the socio-economic challenges faced by the country. With regard to science education, the competence-based curriculum aims to expose learners to science practical work using pedagogies and assessments that are learner-centred and would foster self-reliance of the citizens. The current researcher focused on collecting data on the pedagogies and assessments that were used in the implementation of the competence-based curriculum in the teaching and learning of Combined Science practical work in relation to the agenda of citizenship education. The current research was carried out using a mixed methods research approach where a cross-sectional survey (a quantitative research design) and a multiple-case study (a qualitative research design) were both employed. The four sampled schools were in the Midlands province of Zimbabwe, namely Takudzwa Secondary School, Tatendashe Secondary School, Nothando Secondary School and Tivongereiwo Secondary School. The cross-sectional survey was conducted with five hundred and ninety-three (593) Combined Science teachers who were Combined Science examiners with the Zimbabwe School Examinations Council (ZIMSEC) in 2019. The research results indicated that science practical work was generally very limited in Zimbabwean secondary schools. It was also noted that science practical work was not linked to science citizenship education during the teaching and learning process. The research concluded that there was a general lack of integration of citizenship education to the pedagogy and assessment of Combined Science practical work as the programme lacked clarity, policy direction, resource support, monitoring and evaluation. The current researcher then developed a framework that may enhance the integration of citizenship education in the pedagogy and assessment of science practical work. The framework outlines that effective citizenship education has to be anchored by eight pillars of support which were identified from the results of the current research. The eight pillars of support, needed to support and sustain science citizenship education, are educational policies, staff-development, community challenges and needs, science content and objectives, constructivist pedagogies, constructivist assessments, programme monitoring and evaluation, and programme resource allocation. The eight pillars of support should be firmly in place for citizenship education to be effectively integrated to the pedagogy and assessment of science practical work.

KEY TERMS:

Citizenship education; Cross-sectional survey; Educational assessment; Framework for science citizenship education; Mixed methods research; Multiple-case study; Pedagogy; Science education; Science practical work; Social constructivism

ACRONYMS

APA	American Psychological Association
B Ed	Bachelor of Education degree
B Sc	Bachelor of Science degree
CE	Certificate of Education
COVID-19	Corona virus disease of 2019
Dip Ed	Diploma in Education
HOD	Head of Department
IPA	Interpretative Phenomenological Analysis
M Ed	Master of Education degree
MoPSE	Ministry of Primary and Secondary Education
PAAI	Practical Activity Analysis Inventory
PBL	Project-based learning
PCK	Pedagogical Content Knowledge
PED	Provincial Education Director
PhD Ed	Doctor of Philosophy in Education
SPSS	Statistical Package for Social Sciences
UNISA	University of South Africa
ZIMSEC	Zimbabwe School Examinations Council
ZPD	Zone of Proximal Development

DECLARATION

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Exact wording of the title of the thesis as appearing on the electronic copy submitted for examination:

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I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

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DEDICATION

This thesis is dedicated in honour of my departed father, Fana Hove and to my mother, Melania Hove (nee Matsongoni), for liberating their ‘girl child’ in laying a strong educational foundation for her.

This thesis is also dedicated in memory of my departed father in-law, Dzikai Javangwe and to my mother in-law, Fumisai Javangwe (nee Chabuda), for giving moral support to their daughter in-law in all her academic endeavours.

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CHAPTER 1: INTRODUCTION AND BACKGROUND TO THE CURRENT RESEARCH

1.1 Introduction

The global trend in science education focuses on meaningful and authentic science practical skills acquisition that leads to the development of informed citizens and collective solutions to socio-scientific issues (Blanco-Lopez, Espana-Ramos, Gonzalez-Garcıa & Franco-Mariscal, 2015; Eurydice, 2005; Mooed & Kaiser, 2018; Vesterinen, Tolppanen & Aksela, 2016). In the current research, the researcher examined the extent to which the pedagogy and assessment of science practical skills in the Ordinary Level Combined Science learning area in Zimbabwe supports citizenship education, which could foster improvement of life at personal, community, national and global levels. The current researcher also reviewed literature on the state of science citizenship education at the global stage. Vesterinen, Tolppanen and Aksela (2016, p. 30) view citizenship education as an "important element of science education." In the same vein, Eurydice (2005, p. 13) highlights that education is vital in "fostering active and responsible citizenship" and hence "provides pupils with the basic skills and knowledge that will help them to make a worthwhile contribution to society." The purpose of science education, in the current researcher's view, is to enable learners to live better lives that are enriched by the acquisition of science knowledge and skills. This goal can only be achieved when science education acknowledges the centrality of practical work and citizenship education in the pedagogy and assessment processes. This implies that science education in Zimbabwe as well as globally should make its contribution to produce an active and informed citizenry. In line with the global argument for citizenship education, the Ministry of Primary and Secondary Education in Zimbabwe updated the curriculum in 2015 in a bid to address the socio-economic challenges that the country was going through. The implementation of the updated, competence-based educational curriculum commenced in 2017.

A major philosophical and pedagogical paradigm shift of the competence-based curriculum was for it to produce citizens who were job creators rather than job seekers. With regard to science, the competence-based curriculum was designed to address the findings and recommendations of the 1999 Presidential Commission of Inquiry into Education and Training which reported that many people wished that Science and Technology be "made the bed-rock of the Education system" (Report of the Presidential Commission of Inquiry into Education and Training, 1999, p. 402). The Commission proposed, among other things, the "massification of science" by offering it to all learners through inquiry and discovery learning (Report of the Presidential Commission of Inquiry into Education and Training, 1999, p. 404). The Commission also proposed that citizenship education should "be compulsorily taught in the entire school curriculum as a matter of urgency" (Report of the Presidential Commission of Inquiry into Education and Training, 1999, p. 354). The massification of science and the compulsory citizenship education aimed at producing citizens who were scientifically literate and would therefore have science enriched lives. Issues of health, diet, diseases, exercise, reproductive health, energy and sustainable environment, among other things, would then be effectively addressed by scientifically literate citizens.

The current Combined Science Syllabus Forms 1-4 replaced the General Science Syllabus, which was offered to Forms One and Two, as well as the Integrated Science Syllabus, which was offered to Forms Three and Four. Combined Science is one of the seven cross-cutting learning areas which are compulsory for all the learners to study. Combined Science in Zimbabwe is a science subject that has content drawn from Biology, Chemistry and Physics. In the competence-based curriculum, the teaching and learning process is learner-centred and inquiry-based and the "teacher is a facilitator and coach" (Curriculum Framework for Primary and Secondary Education 2015-2022, p. 42). The competence-based curriculum shifts the pedagogy from being teacher-centred to learner-centred and aims at "the development of diverse life and work skills" (Curriculum Framework for Primary and Secondary Education 2015-2022, p. 6). This places citizenship education at the epicentre of the education agenda. Learners may effectively acquire these skills through science pedagogies and assessments that aim for citizenship education. Eurydice (2005, p. 10) defines citizenship education as "school education for young people" which aimed to produce active, responsible and accountable citizens who were sensitive to matters of environmental sustainability and socio-economic well-being of their communities. The current researcher interrogated the extent to which citizenship education is implemented in the competence-based Combined Science curriculum in Zimbabwe and then proposed a framework for integrating citizenship education in the pedagogy and assessment of science practical work.

The competence-based curriculum also shifted the summative assessment of science practical skills from the use of an alternative to practical examination to a practical test examination. Integrated Science learners were assessed for practical skills using an alternative to practical examination which was predominantly meant to assess practical skills through a pen and paper examination (Zimbabwe School Examinations Council Ordinary Level Integrated Science Syllabus (5006), 2011-2020). Unlike Integrated Science, Combined Science does not have a pen and paper alternative to practical examination but instead has an actual practical examination (Combined Science Syllabus Forms 1-4).

The current research assessed if the imperatives in the teaching and assessment of science practical skills were clearly defined to teachers and learners. It also explored the nature of the science practical work done, and how the goal of citizenship education was addressed. The current research focused on the situation in Zimbabwean schools on the pedagogy and assessment of Combined Science practical work and how citizenship education was facilitated. The current research was crucial since it looked at practical ways of enhancing effective pedagogy and assessment of science practical skills in the Combined Science learning area in Zimbabwe and also examined the extent to which the pedagogy and assessment contributed to citizenship education. The current researcher then proposed a framework for the integration of science citizenship education to the pedagogy and assessment of science practical work in Zimbabwe and globally.

1.2 Problem statement

Science educators and researchers agree that authentic science education should be learner-centred, inquiry-based, experimentally-oriented and intrinsically-motivated (Abrahams, Michael & Sharpe, 2014; Abrahams & Millar, 2008; Babaci-Wilhite, 2017; Cobern, Schuster, Adams, Skjoid, Muĝaloĝlu, Bentz, & Sparks, 2014; Dagys, 2017; Fadzil and Saat, 2019; Furtak, Siedel, Iverson, & Briggs, 2012; Millar, 2010; Silm, Tiitsaar, Pedaste, Zacharia & Papaevripidou, 2017; Skelton, Blackburn, Stair, Levy & Dormody, 2018; Stone, 2014; Umami, 2018; Williams, 2011). The science educators and researchers also concur that a well-designed science curriculum should produce scientifically literate global citizens who can solve socio-economic problems of a scientific nature (Akuma & Callaghan, 2018; Eurydice, 2005; Report of the Presidential Commission of Inquiry into Education and Training, 1999; Rudolph & Horibe, 2016; Vesterinen, Tolppanen & Aksela, 2016; Zahabioun, Yousefy, Yarmohammadian & Keshtiaray, 2013). In Zimbabwe, the Ministry of Primary and Secondary Education (MoPSE) acknowledges these two positions as it advocates for the use of inquiry-based pedagogies which are learner-centred in the implementation of the competence-based curriculum. It also positions the competence-based curriculum to address the "real needs and issues" and argues that the curriculum "is a tool for promoting competencies for life and work in a global context", hence the need for science citizenship education. The philosophy underpinning the national curriculum in Zimbabwe, which also speaks for good citizenship education, is unhu/ubuthu/vumunhu (Curriculum Framework for Primary and Secondary Education 2015-2022, 2015). Combined Science, being a compulsory learning area at ordinary level, is, in the current researcher's view, the science of the nation that should be used to impart science citizenship education to all learners. The integration of citizenship education to the pedagogy and assessment of Combined Science practical work is vital to make it a useful science, lest it is rejected like its predecessor, Integrated Science.

Integrated Science was a science that could not take the learner to a science-related career or to Advanced level, which ended up frustrating those that had good passes. It is imperative that Combined Science, being a compulsory learning area, should open opportunities for learners in science-related careers and hence contribute to the socio-economic transformation of the country. Rudolph and Horibe (2016) stress that if science education is to effectively contribute to good citizenship, then instruction should be planned and implemented in a way that enhances socio-scientific discussions and engagements. Rudolph and Horibe (2016) also argue that scientific knowledge and expertise is required in issues related to the economy, health, technological advancement, public safety, environmental sustainability and national security. From this discourse, an emerging research gap relates to the extent to which science education at the global level as well as in Zimbabwe enables the learners to be able to meaningfully resolve the socio-scientific issues they encounter in their lives.

According to Barongo-Muweke (2016, p. 25), the main strategy used for disempowering the colonised was "the suppression of citizenship awareness." In view of this argument, there is an apparent need to explore how citizenship education could be infused in all learning areas in the curriculum to effectively address citizenship issues that are learning area specific. In light of the critical role played by citizenship education, the Report of the Presidential Commission of Inquiry into Education and Training thus laments the "marginalization and near-absence" of citizenship education in the Zimbabwean curriculum as "very serious and short-sighted" (1999, p. 353). Ironically, the competence-based curriculum is not explicit on the pedagogy and assessment that science citizenship education should take. This lack of policy clarity is what also obtains for the Dutch government. Veugelers (2011, p. 209) points out that the Dutch government emphasises the importance of citizenship education but "leaves it to schools to organise the subject and there is no direction in terms of the goals, assessment and qualification," hence citizenship education has no firm place in the school curriculum.

On the other hand, the 2016 International Civic and Citizenship education Study (ICCS) on civic and citizenship education in twenty-four European and Latin American countries focused on the students' awareness of, attitudes, appreciation and perceptions pertaining to civic and citizenship education. The report noted that different countries used different approaches to impart the skills related to citizenship education (Schulz, Ainley, Fraillon, Losito, Agrusti & Friedman, 2017). There is therefore a need for research to develop a framework for promoting citizenship education that would inform the global community of effective pedagogies and assessments that enhance best practice. This is even more important for the developing world where the role of science in social development is necessary. It is apparent that there is a research gap regarding science citizenship education in Zimbabwe and other developing countries. The filling in of this gap through the current research could aid curriculum designers and policy makers to develop effective pedagogies and assessments that could enhance authentic science learning.

Sigauke (2012, p. 222) posits that "citizenship and citizenship education are controversial and contested concepts" and Veugelers (2011) concurs with him by arguing that citizenship education is viewed differently by politicians, educators, scholars and members of the public. These arguments demonstrate that citizenship education implementation is complex and to come up with universally accepted goals is a mammoth task. In the case of Zimbabwe, it is crucial that a research that is informed by global practices be carried out. Also, since the national competence-based curriculum has just been introduced in 2017, and is embracing citizenship education, a research has to be carried out so that an effective framework for the pedagogy and assessment of the related concepts could be developed.

Rudolph and Horibe (2016) draw the attention of science educators to one of the major science education goals, which is, to promote citizenship education through the production of learners who could meaningfully engage in socio-scientific issues. They decry the general lack of progress by science researchers to clearly outline the nature of science-related interactions that may take place between school science and societies. The current research was therefore essential since it developed a framework for citizenship education that informs science practical work pedagogy and assessment. Science education is thus poised to play its critical role of producing scientifically literate and informed global citizens from an informed position. Recently, it has been noted that globally there is no universal model used to foster citizenship education (Schulz et al., 2017). As such, the current research proposed a framework for science citizenship education that could benefit the global science community.

Based on the above observation, the research gap which the researcher addressed in the current research is that, in spite of existing literature on citizenship education globally, there is a dearth of research regarding a framework for integrating citizenship education in the pedagogy and assessment of science practical work. As such, any attempts to foster the principles of citizenship among students may be futile.

1.3 Research aims and objectives

The current research aimed to use the Combined Science in Zimbabwe to develop a framework for integrating citizenship education in the pedagogy and assessment of science practical work. Such a framework could inform educators, curriculum developers and policy makers about the pedagogy and assessment models that could enhance citizenry and meaningful science education.

The objectives of the research were to:

1. examine the extent to which citizenship education is integrated in the pedagogy of science practical work in Combined Science in Zimbabwe;
2. examine the extent to which citizenship education is integrated in the assessment of science practical work in Combined Science in Zimbabwe;
3. explore how citizenship education could effectively be integrated in the pedagogy of science practical work; and,
4. explore how citizenship education could effectively be integrated in the assessment of science practical work.

1.4 Research questions

Emanating from the problem statement, the current research explored the following main research question:

How could a framework for integrating citizenship education in the pedagogy and assessment of science practical work be developed, using Combined Science in Zimbabwe as a case study?

Four research sub-questions were used to collect data in order to address the main research question as stipulated below:

1. To what extent is citizenship education integrated in the pedagogy of science practical work in Combined Science in Zimbabwe?
2. To what extent is citizenship education integrated in the assessment of science practical work in Combined Science in Zimbabwe?
3. How could citizenship education be integrated in the pedagogy of science practical work?
4. How could citizenship education be integrated in the assessment of science practical work?

1.5 Rationale for the research

Williams (2011, p. 111) argues that “experiments are the bread and butter of science,” while Millar (2010, p. 108) posits that “practical work is a prominent and distinctive feature of science education.” Abrahams and Millar (2008) report that it is generally agreed by stakeholders that science practical work done by learners was vital for effective science education. Wei, Chen and Chen (2019, p. 725) argue that “practical work, or experimentation, is an integral part of subject matter of sciences.” Literature thus reveals that practical work is at the centre of science education. Practical work enhances active involvement of the body as well as the mind of the learners. The learners would not find time to either doss or doze as is typical in lessons that are teacher-centred, and hence they learn better. Practical work should, therefore, be at the centre of the pedagogy and assessment methods in science education. Effective science pedagogy should make central the practical work and an authentic assessment should be aligned to the pedagogy as it is also commonly agreed that pedagogy and assessment, when aligned, have desirable outcomes to any education system (Beller, 2013; Dannefer, 2013; Frankland, 2007).

Literature also critically shows that educators, policy makers, curriculum developers and educational researchers concur that a central goal of science education is to equip learners with life-long skills that are applicable to their future roles as citizens and that learners would then be able to participate and engage in science related civic issues (Rudolph & Horibe, 2016; Zahabioun et al., 2013). The pedagogy of science therefore should have practical work so as to enable the learners to “link and scaffold scientific concepts with real world situations” (Helliar & Harrison, 2011, p. 15). Practical work should foster citizenship education which, according to Rudolph and Horibe, may result in “scientific-knowledge-use” or “scientific-knowledge-production” (2016, p. 809). Scientific knowledge generation and application would most likely lead to a better world. Science education should strive to enhance this kind of global citizenry. The current researcher joins other science educators and researchers on the grand stage that advocates for science practical work that enhance global citizenship on socio-economic issues of a scientific nature. If science practical work does not improve the lives of learners as future global citizens, then what is its purpose?

The current researcher explored the state of science citizenship education globally and also the state and quality of practical work in the Combined Science learning area in Zimbabwe and examined its contribution to citizenship education. Consequently, the research findings could be used by policy makers, curriculum designers and educational practitioners to understand the extent to which the citizenship education agenda is addressed in the pedagogy and assessment of science practical work. The current researcher proposed effective pedagogies and assessments of science practical work which enhance science citizenship education. In other words, the current research proposed a framework for science citizenship education for the global science community.

Literature also reveals that while science educators, learners and researchers acknowledge that practical work in science is essential, some question its effectiveness in serving its intended goal of leading to authentic science learning. Toplis (2012, p. 546) observes that "further research work on learning and practical work is needed" while Abrahams, Reiss and Sharpe (2013, p. 209) note that "there is very little literature on the assessment of school science practical work." On the other hand, Rudolph and Horibe note that "civic participation around issues that intersect with science has never been defined with any real precision" (2016, p. 806). The above deficiencies indicate that research on both the quality and purpose of science practical work and science citizenship education was necessary. The current research aimed to contribute to an effective science practical work pedagogy and assessment and reduce the gap in research which is lamented by Toplis (2012) as well as Rudolph and Horribe (2016), among other scholars and researchers. The current research proposed a framework for science citizenship education for the benefit of the Zimbabwean science education as well as the global science community. The linking of science practical work to citizenship education could benefit policy makers, curriculum designers and educational practitioners on effective science pedagogy and assessment which enhance citizenship education.

The current researcher examined the state and quality of practical work in the Combined Science learning area in relation to the enhancement of science citizenship education. Blanco-Lopez et al (2015) identify collaboration, scientific argumentation, analysis, evaluation skills, accountability, problem-solving and critical-thinking skills as attributes of good science citizenship education. It was imperative that the current research was carried out since it advocated for a framework for citizenship education in the pedagogy and assessment of science practical work. The current research also examined if there was an alignment between policy, pedagogy, assessment and citizenship education at the global stage as well as in the Combined Science learning area in Zimbabwe. The current research findings could contribute to an effective pedagogy and assessment of science in the Zimbabwean context and beyond. The current research also proposed a framework on how citizenship education could be effectively addressed in the pedagogy and assessment of science practical work globally.

1.6. Defining key terms

The terms which were considered to be most important in the current research were citizenship education, science practical work, pedagogy, assessment and mixed methods research. These terms defined the research topic and the research method employed in the current research. It was imperative that the terms be defined as that clarified the concepts around the research topic. The defining of the key terms was also vital as it stipulated the meaning of the terms in the context of the current research.

1.6.1 Citizenship education

Eurydice (2005, p. 10) defines citizenship education as "school education for young people" that enables them to "become active and responsible citizens" who can improve themselves and their communities. In the current research, science citizenship education is viewed as teaching, learning and assessment methods that promote active interaction of learners and their societies in issues that are related to science.

1.6.2 Science practical work

Practical work in science is defined as the various hands-on or practical activities carried out by learners during the teaching and learning process (Toplis, 2012; Wei, Chen & Chen, 2019). Millar (2010) defines practical work as school activities carried out by learners either in groups or as individuals that result in the learners manipulating equipment, apparatus or chemicals and making observations. In the current research, practical work refers to any procedure that is carried out by learners which enables them to construct knowledge including laboratory experiments, field tours and learner demonstrations.

1.6.3 Pedagogy

Alexander (as cited in Black, 2014, p. 487-488) defines pedagogy as "the act of teaching together with its attendant discourse of educational theories, evidence and justifications," and defines the core activities of teaching as tasks, activities, interactions and assessment. Corrigan, Buntting, Jones and Gunstone (2013) view pedagogy as inclusive of assessments used during instruction. Umami (2018) sees pedagogy as the choice and construction of relevant teaching and learning materials, and appropriate technologies in relation to the interests, needs and learners' developmental stages. Umami (2018) argues that assessment is not integrated in the pedagogy as it comes at a later stage. The current researcher, in support of Umami, defines pedagogy as the theories and practices that are involved during the teaching and learning process but without incorporating assessment.

1.6.4 Assessment

Educational assessment can be viewed as the process of appraising knowledge, skills and competencies of learners. Assessment falls into two categories, formative and summative. Formative assessment is diagnostic in nature as it is used to give feedback to both the teacher and the learner with regard to the mastery of the concepts taught (Black & Wiliam, 2009). Formative assessment is the dialogue primarily between the learner and the teacher that is aimed at improving the teaching and learning process. Assessment is actually a dialogue that may take place before, during or after instruction, leading to necessary corrective measures being taken (Dixson & Worrell, 2016). The formative assessment may be done orally by presenting prompting and probing questions and hence having a discussion or by giving written work. Summative assessments are usually "high-stakes" and they generally pressurise learners with the desire to attain good grades (Long et al., 2011, p. 55). Summative assessment is thus judgmental since it is used to evaluate learning outcomes for placement and promotion decisions (Dixson & Worrell, 2016; Elmore, 2019). Summative assessments are generally blamed for narrowing the curriculum as they cause teachers to teach to the test.

1.6.5 Mixed methods research

Mixed methods is a research approach that combines qualitative and quantitative research designs, data collection and data analysis in a single research in a bid to improve the research findings as the methods complement each other (Creswell, 2009; Creswell, 2014; Gray, 2014; Johnson & Christensen, 2017; Punch & Oancea, 2014).

1.7. The theoretical framework employed in the current research

The current section outlines the theoretical framework developed and applied in the current research. The theoretical framework was drawn from the concepts and theories that informed the current research topic. Kivunja (2018) defines a theoretical framework as a research skeleton that outlines the main theories and concepts upon which a research is based. Adom, Hussein and Agyem (2018, p. 438) equates a theoretical framework to a "foundation" that keeps a research firmly grounded. Grant and Osanloo (2014) concur with Adom, Hussein and Agyem (2018) by also defining a theoretical framework as the anchor upon which academic knowledge and arguments are based. The vital contribution of these scholars is that a good research is premised on a good theoretical framework. In the current research, the research approach, data collection and data analysis processes were anchored on the theoretical framework, which is an attribute of quality research (Adom, Hussein & Agyem, 2018; Grant & Osanloo, 2014; Kivunja, 2018). Results which are discussed within a relevant theoretical framework provide the research with "academic rigor" (Kivunja, 2018, p. 46). In this regard, the results analysis, presentation and discussion in the current research were based on the theoretical framework. In the current research, the theories which were defined in the theoretical framework were also applied in drawing the research sub-questions and in proposing the research method. Kivunja (2018) argues that a relevant theoretical framework should be closely related to the literature review. A similar position is taken by Grant and Osanloo (2014) when they posit that a theoretical framework is interwoven with the literature review. As such, the current researcher reviewed the literature basing on the concepts highlighted in the theoretical framework. Grant and Osanloo (2014) propose the application of concept mapping in defining a theoretical framework arguing that it is a clear way to illustrate the links among concepts and theories. The current researcher agrees with Grant and Osanloo (2014) on the clarity of illustrating the theoretical framework using a concept map hence she also illustrated the theoretical framework using a concept map.

The current researcher adopted social constructivism as the basis of the theoretical framework. Social constructivism argues that learners use their experiences to actively construct new knowledge as they interact with learning materials. Social constructivism views learning as a collaborative process, which is based on principles of cognitivism and constructivism. Arguing against cognitivists, Vygotsky suggested that learning cannot be separated from the social context from which learning takes place. This view is held by a number of researchers who suggest that a school is an extension of society (e.g., Dewey, 2013; Neamtu, 2013). Social constructivists believe that social interactions lead to the development of cognitive functions as knowledge is generated through these social interactions which learners are part of. Vygotsky (1978, p. 57), argues that "every function in the child's cultural development appears twice: first, on the social level and, later on, on the individual level; first, between people (inter-psychological) and then inside the child (intra-psychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals."

While cognitivists suggested that knowledge was constructed through active interactions between learners and their environment, social constructivists argued that social language, culture and norms led to the development of the intellect. In fact, Vygotsky (1978) suggests that learners experience, assimilate, communicate and understand their environments through social language and culture. To this end, Vygotsky (1978, p. 85) argues that,

> "the level of actual development is the level of development that the learner has already reached, and is the level at which the learner is capable of solving problems independently. The level of potential development (the "zone of proximal development") is the level of development that the learner is capable of reaching under the guidance of teachers or in collaboration with peers. The learner is capable of solving problems and understanding

> material at this level that they are not capable of solving or understanding at their level of actual development; the level of potential development is the level at which learning takes place. It comprises cognitive structures that are still in the process of maturing, but which can only mature under the guidance of or in collaboration with others."

Social constructivism, therefore, suggests that social interactions, through language and culture are essential to learning. Given the importance of social interactions, other researchers have suggested that "the school is a microcosm of the community in which it exists and which it serves" (Haupt, 2010, p. 2). As a result, there is a need for a symbiotic relationship between the school and the society which shapes learners through social constructivism. Such a mutual relationship can be understood within the context of citizenship education.

Citizenship education suggests that the school, through education, has the responsibility to prepare learners for their roles in society. In fact, citizenship education has become a central element of schooling in most European and North American countries (Kiwan, 2008; Print, 2007). Citizenship education is based on the notion that learning occurs when learners are actively involved, through social constructive activities. This view is based on Dewey (1915, p. 3) who argues that teachers should "give the pupils something to do, not something to learn; and the doing is of such a nature as to demand thinking; learning naturally results." Citizenship education therefore promotes the construction of knowledge and the development of competencies that will enable learners to be actively involved in social process and decision-making. By developing these skills, learners construct new knowledge through social constructivism learning.

Based on the preceding arguments, the current researcher views social constructivism as better equipped to provide effective pedagogies and assessments of science practical work that enhance citizenship education. A framework based on social constructivism has the scope to effectively link the research aims and objectives to the research designs which were used to collect and analyse data. Figure 1.1 presents the theoretical framework employed in the current research in form of a concept map.

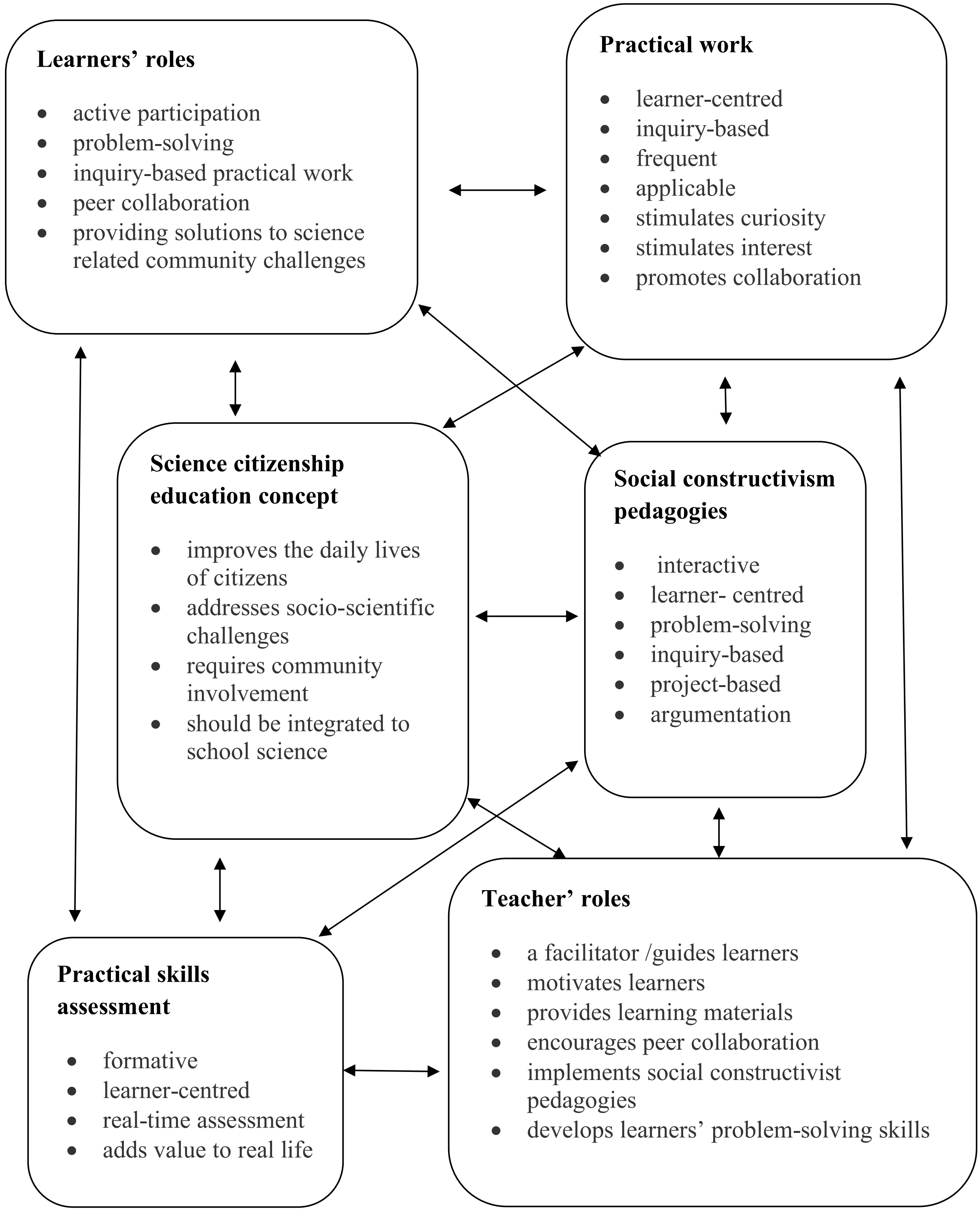

Figure 1.1. *Concept mapping of the theoretical framework (Adapted from Kivunja, 2015 as cited in Kivunja 2018)*

The current research's main concepts were science citizenship education, effective pedagogies employed during science practical work and effective practical skills assessments. These concepts were explored through investigating the roles of the learners and teachers during science practical work, during science practical skills assessments and in the promotion of science citizenship education. The framework shows that science citizenship education can be enhanced if science practical work actively engages learners in carrying out the practical activities. The framework also shows that social constructivist pedagogies should be employed. The pedagogy should thus be learner-centred and the teacher takes the role of a facilitator. Assessments of science practical skills should be related to the learners' real lives. The concepts were thus integrated in the theoretical framework employed in the current research. The theoretical framework, being the foundation of the current research, informed the pedagogy by proposing effective roles of teachers and learners during the teaching and learning of practical work. It also proposed effective guidelines for the assessment of science practical work and effective citizenship education. In that way, the theoretical framework guided the research processes in the current research.

1.8. Conclusion

The current chapter outlined the research topic, the problem statement, the research aims and objectives, the research questions and the rationale for the research. Key words were also defined as they were used in the context of the current research. The theoretical framework employed in the current research was also presented. It was important to present the theoretical framework in this chapter as it (the theoretical framework) was the foundation upon which the current research was developed. The next chapter elaborated the state of citizenship education globally as well as in Zimbabwe.

1.9 Research preview

Chapter 1: Introduction and background of the current research

The chapter gives an overview of the research focusing on the background to the research, the rationale, the statement of the problem, research questions, research aims and research objectives. The chapter also defines key terms in the context of this research. The chapter also presents an argument for social constructivism as the theoretical framework that informs the pedagogy of practical work in science education.

Chapter 2: Reflecting on citizenship education

The chapter reviews scholarly literature on citizenship education, the global state of citizenship education and the state of citizenship education in Zimbabwe. The chapter goes on to define science citizenship education as used in the context of the current research.

Chapter 3: Perspectives on pedagogy and assessment

The chapter traces the history of the acquisition of knowledge from structuralism, functionalism, behaviourism, cognitivism, the socio-cultural theory to social constructivism. The pedagogies that are effective for the acquisition of science practical skills are also outlined. An account of educational assessment is given and assessment methods that are best for the assessment of practical skills are presented.

Chapter 4: Research methodology

The chapter describes quantitative research, qualitative research and mixed methods. It then gives justifications for using mixed methods, multiple-case study and cross-sectional survey in the current research. The chapter also focuses on the sampling and data collection procedures, validity and reliability, credibility and trustworthiness as well as the research ethics employed in this research.

Chapter 5: The analysis and presentation of data

This chapter describes the quantitative data analysis using the SPSS software as well as the Spearman's correlation coefficient. Interpretative Phenomenological Analysis (IPA) is used to analyse and present qualitative data from the four cases. The chapter also outlines the limitations and delimitations of the research.

Chapter 6: Discussion of the findings: A reflection on literature

This chapter discusses the findings that corroborate literature, findings that contradict literature and findings that had not been reported in literature. The chapter also presents a framework that could be used to integrate science citizenship education into the pedagogy and assessment of science practical work. The framework was developed from the research results. Recommendations for future research and lessons for developing researchers are also presented.

CHAPTER 2: REFLECTING ON CITIZENSHIP EDUCATION

2.1 Introduction

The current chapter examines the state of citizenship education in Zimbabwe as well as globally. The current chapter begins with an analysis of the definitions of citizenship education and then defines citizenship education in the context of the current research. It also focuses on the state of citizenship education globally and also the state of citizenship education in Zimbabwe. The chapter then discusses the link that should exist between the school and the society in order to improve lives of citizens. Pedagogies and assessments of science practical work that foster citizenship education are reflected upon. It also gives a justification for the development of a framework for integrating citizenship education in the pedagogy and assessment of science practical work.

2.2 Defining citizenship education

Citizenship education is a broad and contested concept and has no universally accepted meaning (Ahmad, 2017; Hoeg & Bencze, 2017; Hunt, 2011; Levinson, 2014; Matereke, 2011; Mukundu, Chineka & Madzudzo, 2017; Ramazan & Ezlam, 2017; Sigauke, 2012). Citizenship is viewed by some as one's nationality and as such is defined in a way which is consistent with the ideology and interests of a particular nation (Blades, 2015; Chen, 2013; Mukundu, Chineka & Madzudzo, 2017; Ramazan & Ezlam, 2017; Sigauke, 2011). Citizenship education thus varies from one nation to another. For example, citizenship rights depend on the type of government in place, whether it is democratic or autocratic affects the nature of citizenship education offered. Citizenship education which is advocated for by most governments speaks to the rights, responsibilities and patriotic stance of citizens (Fanghanel & Cousin, 2012; Hoeg & Bencze, 2017; Levinson, 2014; Mavhunga, Moyo & Chinyani, 2012;). The definition of citizenship education is so unclear to an extent that some scholars use it interchangeably with civic education (Russell & Quaynor, 2017; The Report of the Presidential Commission of Inquiry into Education and Training, 1999). It is also noted that some countries have resorted to using 'civic and citizenship education' in combination as a term to capture both the patriotic and the participatory approaches to citizenship education (Schulz et al., 2017, p. 3).

2.2.1 Citizenship education and civic education: the status quo

Russell and Quaynor (2017, p. 249) view citizenship education as composed of a "structural or political dimension" which teaches about citizen rights and responsibilities, a "cultural or personal dimension" which gives the citizens a sense of national pride and a social dimension which advocate for "democratic participation and active engagement." This argument portrays that citizenship education is broad and is treated from many dimensions. It has social, political, moral, cultural and religious connotations and it differs across communities and nations depending on the aspect that is emphasised. Citizenship education is thus broader than civic education which mainly has a political focus and neglects the social and economic aspects which should also be addressed.

Mavhunga, Moyo and Chinyani (2012, p. 50) define citizenship education as that which addresses "the political, civic and socio-economic matters of a nation and its citizens." Levinson (2014, p. 1) concurs with Mavhunga, Moyo and Chinyani by defining citizenship as an individual's "civil, political or social standing." These scholars advance the view that citizenship education calls for the holistic engagement of the citizen in the nation's destiny. The thrust of their argument is further buttressed by Hoeg and Bencze (2017, p. 846) who view citizenship as a "participative" and "socially-constructed" engagement that empowers citizens to make informed decisions and debate on matters which affect their lives. Özbek and Köksalan (2015, p. 220) further agree with Hoeg and Bencze (2017) when they posit that citizenship education should enhance "political literacy, critical-thinking, social attitudes and values and active participation." The definitions highlight that a balanced citizenship education is a combination of social, moral, political, cultural and economic education which all aim to produce an empowered citizen. The above definitions thus show that civic education is a component of citizenship education and the current researcher concurs with them and treat civic education as a subset of citizenship education.

To bring clarity to the meaning of civic education as a distinct subset of citizenship education, Levinson (2014, p. 10) defines it as the focus on "the specific rights and duties of legal citizens." Japar (2018, p. 30) concurs by highlighting that civic education boarders on issues of good governance as portrayed in the "constitution, rule of law, human rights, obligations of citizens, and the democratic process." Basing on the arguments presented in the preceding definitions, the current researcher views civic education as a subset or a component of citizenship education.

Citizenship education should address the political, moral, social, cultural and economic aspects of citizens and lead to better living conditions. Civic education mainly addresses the political concerns of citizens and is thus a part of citizenship education. The current researcher thus defines civic education as that which teaches citizens about their rights, responsibilities and obligations and also an education that fosters political awareness and democracy in a way that citizens actively engage with their political and civic leaders to promote good governance and accountability. Civic education is not equivalent to citizenship education but is just a component of it.

The current researcher concurs with Eurydice (2005, p. 10) who defines citizenship education as "school education for young people" which leads to improved lives of citizens and their communities. The definition of citizenship education is broader than civic education as it (citizenship education) also aims to contribute to the socio-economic status of the community. In the current research, the focus was on the development of a framework that enhances science citizenship education. The pedagogy and assessment of science practical work should promote active interaction of learners and their societies on issues that are related to science. The current researcher consents to the Eurydice theme of active engagement of learners to address the challenges they encounter in their lives. When learners find solutions to their challenges, then they improve their lives and their societies and consequently education becomes useful and relevant.

2.2.2 The politics of 'citizenship'

The purpose of education is to produce responsible citizens who are accountable to their communities (Zahabioun et al., 2013). The current researcher views Zahabioun et al.'s notion of citizenship as vague as they do not qualify what they mean by a good citizen. In the eyes of an autocratic government, a good citizen is one who is submissive and politically docile, yet in the eyes of a democratic government, a good citizen is one who engages in national debates and is politically active. In the eyes of a good science educator, a good citizen is one who actively resolves socio-scientific challenges within his/her personal life as well as those within his/her community. The current researcher views a good citizen as one who applies knowledge learnt at school to improve his/her life and also to improve his/her society.

Mavhunga, Moyo and Chinyani (2012, p. 53) posit that citizenship education, for most nations, aims to produce citizens who are patriotic, fostering a "common national identity." This definition addresses the concerns of civic education and not citizenship education per se. The current researcher notes, with concern, that most of the definitions on citizenship education give a narrow focus on civic issues, for example, Fanghanel and Cousin (2012) view the concept of citizenship as referring to the citizen's individual rights and duties, political involvement, social engagements and collective democracy. The current researcher views citizenship education in a broad sense to encompass education that leads to the social, moral, political and economic advancement of a citizen.

Citizenship education is generally biased towards civic issues and is politicised as it is designed to ideologically push for positioning those in power as the supreme (Chen, 2013; Magudu, 2012; Mukundu, Chineka & Madzudzo, 2017; Sigauke, 2011). According to Sigauke (2012, p. 215), the term citizenship has no "universal meaning" because it is defined by those in power to suit their interests and is often used to limit political openness. The same sentiments are shared by Hart (2012) who laments the dominance and imposition of government policies that are not sensitive to issues of community culture, the socio-scientific challenges and the environment. Such an imposition leads to a "theory-practice gap" which can be resolved by democratising the decision-making process as well as implementing responsive pedagogies which are "inquiry-based, action-based" and "community-oriented" (Hart, 2012, p. 104-107). Camicia and Zhu (2011) offer a solution to government dominance by assigning the mandate of citizenship education to educational curricula and schools. The current researcher embraces such an approach to education in general and to science education in particular since this gives the learners first-hand experience that enhances the construction of knowledge. The learners would be able to apply the knowledge to improve their lives.

The current researcher thus advocates for citizenship education which is approached from multi-disciplines so that each subject contributes to the production of an empowered citizen. If citizenship education is taught within each discipline, the approach could produce citizens who could be actively involved in political, social, moral and economic issues. This could also enable learners to integrate issues of good citizenship from across the disciplines. For example, science could teach learners how to produce soap and the learners could apply concepts from Business Enterprise to make a living from the soap production. This is the concept of citizenship education that the current researcher argues for. Learners should be able to apply the knowledge acquired from the study of all the subjects to improve their lives and their societies.

There is consensus that citizenship education empowers learners to engage meaningfully in the social, political, cultural, economic and environmental matters affecting their lives (Eurydice, 2005; Presidential Commission of Inquiry into Education and Training, 1999; Rudolph & Horibe, 2016; Vesterinen, Tolppanen & Aksela, 2016). However, on the contrary, many countries reduce citizenship education to only politics as they mainly focus on civic education. The current researcher prioritises citizenship education which addresses the social, political, moral, cultural and economic aspects of the citizens' lives. While acknowledging the important role of the general citizenship education given prominence by governments, the current researcher argues for the advancement of science citizenship education as well.

Science citizenship education has the potential to empower citizens to solve socio-scientific problems which may befall their day to day lives. Rudolph and Horibe (2016) stress that science education can contribute to citizenship education if the pedagogies employed enhance learners' active participation. Blackmore (2016) argues that social constructivist pedagogies are the most ideal to foster citizenship education as they promote creativity, problem-solving and critical-thinking skills. The teaching and learning process should focus on active learner participation that facilitates a good contribution to their communities in particular and their nation at large. In the same vein, Eurydice (2005) argues that citizenship education should be integrated in school programmes and activities. This enhances science learners' active interaction with the community to solve scientific challenges or implement reforms, thus putting scientific knowledge learnt at school into action. The current researcher argues that science citizenship education has the potential to propel any nation forward with regard to improving science-related areas of life like health, hygiene, diet and energy use. The learners thus become informed citizens who can contribute to the social, moral, cultural, political and economic well-being of their societies. The development of a framework which links the pedagogy and assessment of science practical work to the promotion of science citizenship education thus may address the concerns of many science scholars and researchers, Rudolph and Horibe included.

2.2.3 Science education and science citizenship education: closing the gap

The current science education agenda in many countries aims at the production of citizens who are scientifically literate, partake in debates that focus on resolving socio-scientific issues within their communities and apply science concepts in a way that enriches their lives. However, Albe (2015, p. 904) observes that generally there is a "gap between science and society." The disconnection between school science and society is undesirable since communities fail to benefit from science education. Albe (2015) argues that scientific challenges within communities and nations may only be resolved if and when science education produces learners who take an active role in scientific engagements. Albe (2015) also calls for science educators to analyse and critique the science curricula and reform them in a way that addresses the challenges faced by citizens in their communities, otherwise science education will increasingly become irrelevant to society. Bandura (1977) concurs with Albe by arguing that citizenship education should empower learners to be in charge of their real lives as learners are motivated to learn science concepts when they view the learning as important and applicable to real-life.

Dillon (2012) reiterates that authentic learning occurs when learners are actively involved in real-life projects and activities. Similarly, Zewde (2010) argues for learning that is relevant and would empower the learner socially and economically. Adidi and Irabor (2019) agree with Dillon(2012) and Zewde (2010) when they posit that education should empower citizens to make good and meaningful decisions in solving socio-economic problems within their communities. In the same vein, Chowdhury (2016) asserts that learners are stimulated by relevant science practical work such as attachment to factories and industries as well as participation in projects within their societies. The current researcher concurs with Dillon, Zewde and Chowdhury as she also argues for science education which empowers citizens to live better lives by teaching science learners using pedagogies which enable them to apply the science knowledge and concepts. This well considered argument draws the attention of science educators to implement pedagogies and assessments which enhance science citizenship education in order to produce learners who actively engage in science-related scholarly debates and projects within their communities. The development of a framework that guides science instruction towards the attainment of the science citizenship was thus of paramount importance as it directs science education towards science citizenship education.

Science learning is a process that should lead to a good understanding and interpretation of the relationship and interaction between humans and the environment. Scientific knowledge should lead to better lives for humans and a sustainable interaction with the environment and the natural resources. Tan and Kim (2012) raise the question on how science education can contribute to the integration of science knowledge and skills to citizens' daily lives and further highlight that the attributes of a good science education are the development of critical-thinking skills, problem-solving, creativity and team collaboration. Pedagogies and assessments of science practical work that practically solve the challenges of learners and their communities should be part of the solution to attainment of better lives. Learners should use science concepts to resolve challenges faces by society, for example, learners could research and provide alternatives to electrical energy. Only then would science education desirably produce citizens who are better informed and positioned to make the world a better place through the application of science knowledge to improve their lives and their societies.

Proponents of good science education justify the compulsory teaching of science to all learners by putting forward four arguments, which are, the "utilitarian," "economic," "cultural" and "democratic" arguments (Osborne, 2010, p. 48). The utilitarian advocates argue for science education which benefits learners in real-life. They argue that science education leads to the development of critical-thinking and problem-solving skills and hence the learners' lives improve (Osborne, 2010). Those who argue for the economic contribution of science posit that science-related careers need citizens who are knowledgeable to take them up for the economic benefit of a nation (Osborne, 2010). Science education would better prepare the professionals if it puts emphasis on practical science rather than factual recall, hence the current researcher's argument for science citizenship education which is skill development oriented. The cultural argument insists that science is a culture to citizens as they depend on it for their lives (Osborne, 2010). For example, the food types eaten and their preparation depend on science. Nowadays more and more people across nations are shunning sugary foods due to their negative impact on health.

The democratic argument views scholarly scientific debates as a must participate for all citizens who therefore need to be scientifically literate (Osborne, 2010). A similar argument is given by Vesterinen, Tolppanen and Aksela (2016) who insist that science education should address citizenship which focuses and takes action on matters that sustains the environmental as well as addressing socio-scientific challenges. For example, in Zimbabwe, the small scale gold miners use mercury to extract gold along river banks. Citizens should deliberate on the environmental and ecological impact of mercury from a scientifically informed position. The current researcher views the use of mercury by the small scale gold miners as an example of scientific illiteracy on their part because that is a health hazard and they risk their lives as well.

Science citizenship education should empower learners to be scientifically competent to deal with scientific issues and challenges which they may meet in real-life (European Commission, 2015; Osborne, 2010; Oxfam, 2015). Way back in 1995, Dewey described a discrepancy between practicing scientists and those interested in science in respect to "its significance in life" (1995, p. 391). Dewey (1995) attributed the disharmony to the way science was taught, which emphasised on presenting facts to learners rather than aiding to critical thinking. Recently, Tan and Kim (2012) noted that citizens generally demonstrated a low level of scientific literacy globally. Tan and Kim (2012) are supported by Hoeg and Bencze (2017) who highlight that science curricula have been silent on issues of how science education could contribute to socio-political challenges and hence to finding answers to community challenges. This implies that the position of teaching science in an irrelevant manner which was observed by Dewey still obtains in schools today. This observation should be disturbing for policy makers, science educators, science curriculum developers and science researchers. If scientific literacy remains low across nations, then the argument for compulsory science education is not bearing fruit. How then can this anomaly of low scientific literacy be corrected? Action needs to be taken to teach science in a way that leads to learner motivation and acquisition of science knowledge which can be applied to real-life situations. It is the current researcher's argument that authentic science citizenship education would go a long way in improving scientific literacy in learners. The common proverb which says 'catch them young' is relevant to the effective implementation of science citizenship education. If learners are exposed to societal challenges while still at school and become part of the citizens who find solutions, they are more likely to develop a culture of active engagement which they would most likely advance in their adulthood. The integration of school science to society is a strong base for effective scientific literacy and attainment of science citizenship education.

2.3 Science practical work and citizenship education

Dewey (1995, p. 395) advocates for science education which has learner involvement and hence inquiry based as learners are "introduced into the flux of experience." Dewey garners support from Chowdhury (2016) who also strongly believes in learner-centred and inquiry-based pedagogies to promote learner participation in a bid to resolve societal challenges. Support for this position also comes from Williams (2011) who claims that the purpose of science education is that of increasing citizens' scientific application and literacy rather than mere production of professionals in science-related careers. Williams (2011) thus advocates for science practical work which puts theory into practice and promotes critical thinking. Sigauke (2013) also sees the pedagogy suitable for citizenship education as learner-centred with maximum learner-community engagement while Komalasari and Rahmat (2019) decries the pedagogy of civic education which is content-oriented resulting in poor knowledge application by the learners. Oxfam (2015) tasks global citizenship education to develop critical-thinking skills and learners' active participation in community and global programmes and recommends argumentation, exploration, drama and inquiry as suitable pedagogies. The scholars thus argue for pedagogies which maximise the development of critical-thinking and problem-solving skills. The current researcher concurs with these scholars who are rightly advocating for science citizenship education as they view the interaction between school science and society as critical for authentic science learning and attainment of a high level of scientific literacy. The importance of a framework to guide the pedagogy and assessment of science practical work so that science education focuses on the attainment of relevant and useful scientific knowledge can, therefore, not be over emphasised.

Literature portrays that the general argument pertaining to science education is that it should improve learners' lifestyles/livelihoods. Science concepts should be applied to solve community problems as science learning should not be detached from society but be actively engaged in constructive debates and projects (Camicia & Zhu, 2011; Chowdhury, 2016; European Commission, 2015; Hoeg & Bencze, 2017; Sklad, Friedman, Park & Oomen, 2016). In the same vein, Dewey (1995) argues that laboratory work should not be a technical procedure but should be aligned to support knowledge formation which supports life. Matthews (2014, p. 1585), in support of Dewey, views science as the interaction of individuals within a society with the "objects and processes" which define the people's existence and thus defines a good science education as one which exposes learners to the worldview where they interact with the resources and challenges within their communities. The researcher stands with these scholars as they are arguing for science citizenship education. If practical science is emphasised in such a way that is connects school science to the community, then most science-related problems which besiege communities would be solved by the citizens. Science citizenship education should lead to improved lives, yet we continue to see a discrepancy between schools and communities. For instance, learners who are taught about proper use of toilets use them properly at school while public toilets remain a mercy in their communities. Such a situation is a result of the teaching of science which is detached from the learners' lives and science citizenship education offers the solution to this disconnection between school science and society.

Castro (2013) notes that although most nations acknowledge the role that should be played by civic education to develop responsible citizens, generally there is a mismatch between that position and the implementation and quality of civic education. As Witschge and van de Werfhorst (2016) argue, successful implementation of civic education requires government planning that leads to adequate allocation of resources, teacher training, good content selection, provision of relevant assessments, conducive learning environments and well-organised civic activities. The challenges that befall the implementation of civic education are most likely met during the implementation of science citizenship education as well. It is therefore imperative that a framework that guides the pedagogy and assessment of science practical work which foster citizenship education be deployed so that it guards against such challenges.

Collins (2011) reiterates that learners value science education and view science knowledge as vital for their lives and therefore science content included in the curriculum should be relevant to learners' daily lives. For example, Collins (2011) records that a group of learners who participated in a study on the importance of science appreciated the knowledge on how to maintain good body weight and fitness through a good diet and regular exercising. It becomes important and relevant science when learners connect what they learn in science classes to their lives. The learners would, for example, use the knowledge on diet and exercise to live healthier lives. That is an example of science citizenship education, a science education that is applied to real-life. The science teacher may request that each learner keeps a diary where he/she records all meals taken and exercise schedules for a month. The teacher checks the diaries and discusses improvements that may be required. The learner is then encouraged to convey the information to his/her family and that way, the community becomes scientifically literate. The science practical work enriches citizens' lives when the pedagogy used fosters citizenship education. The current researcher argues that the teaching of science practical work to foster science citizenship would be greatly improved if the teachers are guided. The development of a framework on the pedagogy and assessment of science practical work which enhances citizenship education thus aimed to improve the level of scientific literacy, which has been observed to be low for many nations (European Commission, 2015; Mukundu, Chineka & Madzudzo, 2017; Tan & Kim, 2012; Williams, 2011).

Osborne (2010) questions the purpose of science education and particularly if it imparts the competencies needed by citizens, while Dewey (1995), questions if acquiring ready-made information without practical engagement is the correct pedagogy for science education. In the Zimbabwean context, the Report of the Presidential Commission of Inquiry into Education and Training (1999) notes that school science suffers a lot of criticism emanating from it being too theoretical and abstract and for its lack of relevance to learners' real-life experiences. In the same light, Fensham, (2012) also laments that science has been taught in an abstract way as emphasis is placed on the acquisition of theoretic concepts without relating them to the learners' environment and circumstances. That, Fensham (2012) argues, resulted in science being classified as a difficult subject. Fensham, (2012) further observes that science has also been taught as a single discipline, seemingly divorced from the other subjects. Hart (2012) views the teaching of science as a stand-alone subject as the main limitation of school science because that makes its concepts appear abstract. The current researcher posits that if science education lacks subject integration, suitable pedagogies and relevant assessments, then the 'abstract nature of science' could be compounded. Science has so many concepts that are related to other subjects like Mathematics, Agriculture, Geography and Food Science. In fact, science is so interrelated to many subjects in any educational curriculum. Science applies to our everyday lives since it applies, for example, to health issues, diet, shelter, transport, energy and the environment. Science citizenship education would most likely help to make science concepts easier to understand and relevant as it would emphasise on the practical experiences of learners.

Effective global citizenship education is realised when all subjects in the curriculum contribute towards developing the learner/citizen (Oxfam, 2015). Science should, therefore, be taught using the multi-disciplinary approach. However, Fensham (2012) notes that very few science teachers are competent in implementing such a pedagogy, while Hart (2012) proposes staff-development for teachers so as to align them to the constructivist pedagogies that bring citizen participation to school science. Dillon (2012) concurs with Fensham and Hart as he sees the issue of teaching that is within the community as challenging for teachers and proposes that they be given support in terms of training. Furiwai and Singh-Pillay (2020), Yung (2012) and Sigauke (2013) all reiterate the importance of teacher training by arguing that educational policy reforms may be derailed if teachers are not trained. Teachers may fail to interpret or may misunderstand the reforms leading to misrepresentations and distortions. Teacher training should also focus on the pedagogy of citizenship education. Practicing teachers may be trained on the pedagogy of citizenship education through workshops and/or in-service training. The training of teachers is vital for the successful implementation of citizenship education as Adeyemi (2018) also adds his voice in outlining that the success of any curriculum reforms hinges on the teachers who are the key drivers at the implementation stage, otherwise the concept remains on paper. The same sentiments are aired by the Presidential Commission of Inquiry into Education and Training (1999) which emphasises that quality teachers are vital and indispensable for the delivery of quality education. The current researcher reiterates that if and when teachers are not taken on board during curriculum reforms, then the implementation process would most likely not yield the desirable outcomes. The researcher also argues that if a framework which guides the pedagogy and assessment of science practical work to foster citizenship education is available, then even the teacher staff-development and training would be better focused.

Dillon (2012) posits that most science curricula have been overloaded with content to an extent of overlooking crucial topics like environmental and health issues and proposes that there should be major reforms in science education so that learners are exposed to the science related to societal programmes and challenges. Dillon (2012) further argues that meaningful learning occurs when the lessons are relevant to learners' lives rather than the rote learning or reciting of facts. Detaching the teaching and learning of science from the learner's day to day activities or challenges defeats the whole purpose of science education. The critical question the current researcher raises here is why science education should burden learners with abstract concepts which they would not be able to understand and apply in their lives. The current researcher, therefore, concurs with Dillon (2012) on the fact that science should be taught in such a way that it adds value to the learner and his/her society. Without reference to the term 'citizenship science education', Dillon advocates for it. The kind of learner involvement in community projects and challenges Dillon would want to see is, in the current researcher's view, science citizenship education at its best.

Johnson and Morris (2010) observe that many educational curricula have been reformed in a bid to promote citizenship education which produces critical thinkers. Their position is supported by Williams (2011, p. 120) who rejects the teacher-centred "fact-based transmission" of subject content and argues for pedagogies based on argumentation and practical work which is planned and delivered in such a way that it enhances critical thinking and exposes learners to "real science" beyond the science laboratory. Japar (2018) also supports the argument by proposing that civic education should be taught based on constructivism because it employs pedagogies which promote critical thinking. When learners, teachers and society work hand in hand to solve their day to day challenges, then science education becomes both relevant and democratic (Hoeg & Bencze, 2017). The current researcher supports the argument for learner-centred, inquiry-based science education as it enhances the application of scientific knowledge. Science citizenship education should employ pedagogies and assessments that enable learners to develop into pro-active citizens when it comes to finding solutions to socio-scientific challenges.

The literature reviewed indicates that there is a consensus among science educators that science citizenship education should be prioritised for science education to give value to citizens and their communities. Science education has the potential to improve lives and livelihoods of learners if pedagogies and assessments that enhance citizenship education are employed. Learners should actively apply school science to improve their lives and their societies. If the teaching of science promotes pedagogies that remove the gap between school science and society and promotes a culture of total engagement, then science education would be relevant and useful and the argument for compulsory science education would lead to an increase in the level of scientific literacy. Science citizenship education should therefore be the focus of every science curriculum. The development of a framework which links the pedagogy and assessment of science practical work to science citizenship education is thus a necessary and welcome achievement.

2.4 The global state of citizenship education

Japar (2018) observes that civic education in Indonesia focuses on teaching citizens about their rights and responsibilities. Also commenting on the same case, Komalasari and Rahmat (2019) stipulate the role of civic education in Indonesia as that of promoting nationalism and patriotism. The citizenship education offered focuses on the civic and political aspects and is not directed at empowering citizens economically and socially. It is the current researcher's argument that the skewed type of citizenship education which does not focus on economically empowering citizens has to be augmented by subject specific citizenship education so that the learner is totally empowered.

Civic education in Liberia is taught through Social Studies and two hours per week are devoted to citizenship education; in the case of Rwanda, citizenship or civic education is allocated a maximum of two hours per week and is also taught through Social Studies at Primary level and taught as Political Education at lower Secondary level and General Paper at upper Secondary level (Russell & Quaynor, 2017). Russell and Quaynor (2017) note that although in Rwanda citizenship education is incorporated into the national curriculum, the subject is neglected since it is politicised. Civic issues are the major emphasis for both Rwanda and Liberia. In Ghana, citizenship education is delivered to learners through Social Studies and the subject lacks adequate content and does not employ suitable pedagogies (Angyagre & Quainoo, 2019). The citizenship offered is aligned to civic issues and does not focus on critical-thinking skills development (Angyagre & Quainoo, 2019). In Egypt, citizenship educations focuses on civic issues as learners are taught about their history and national identity so that they are proud of their identity, their language, culture and heritage (Waly, 2014). In Rwanda, citizenship education is taught in a way that addresses the 1994 genocide and citizenship education addresses civic issues, is taught by traditional leaders as well as schools (Nzahabwanayo & Divala, 2018). The focus is for all people living in Rwanda to be treated equally as Rwandese rather than focusing on ethnic groups like the Tutsi, the Hutu or the Twa (Nzahabwanayo & Divala, 2018).

Hunt (2011) points out that the concept of citizenship education is clearly outlined in South African policies as one of the objectives of education. South African citizenship education during apartheid was meant to maintain racial classes by instilling white supremacy through differentiated teacher training programmes and resource allocation (Hunt, 2011). At the end of apartheid, South Africa's education policy shifted to promote equitable citizenship education as enshrined in the Constitution of South Africa (Hunt, 2011). Hunt (2011, p. 56) carried out a post-apartheid multiple-site case study on citizenship education in schools and noted that the implementation of citizenship education varied within schools and "from the policy framework" and hence it "remained a rhetoric of citizenship, as opposed to a practice." The change in policy was done without changing the socio-political positions of the schools and their communities; hence, it remained on paper as it was largely ignored.

Kisby and Sloam (2012) note that in England, citizenship education aims to promote political debate as well as voluntary serving of the community. In Wales, citizenship education in Primary and Secondary schools is offered through Personal and Social Education, PSE (Kisby & Sloam, 2012). In Scotland, education programmes are run by local authorities and schools, and there is no stand-alone citizenship education subject but it is offered as topics under Modern Studies (Kisby & Sloam, 2012). However, Modern Studies is optional so a large number of learners who opt not to study it do not receive citizenship education (Kisby & Sloam, 2012). Scotland views citizenship in terms of the citizens' rights and responsibilities as well as accountability within their communities and globally (Kisby & Sloam, 2012).

Leek (2016) observes that citizenship and civic education in Poland resulted in social and political changes. In Poland, global citizenship education, which also incorporates civic issues, is taught through History, Environmental Education and Social Studies (Leek, 2016). The Polish government controls the national curriculum content and objectives but relinquishes the teaching methods and textbook selection to the schools (Leek, 2016). The national curriculum content infuses the doctrine of the ruling political party (Leek, 2016). Citizenship education is thus politicised so as to advance the doctrine of the ruling party. In the view of the current researcher, this kind of citizenship education falls short of genuinely addressing the challenges of citizens and improving their lives. It amounts to brainwashing and indoctrination and is undesirable.

Chen (2013) observes that citizenship-related topics in China are shaped by the communist ideology. China, like Poland, has also politicised the citizenship education. Citizenship education is taught through moral, political and ideological education as there is no subject called citizenship education (Chen, 2013). The Chinese government's emphasis of citizenship education is high morality and citizen responsibilities ahead of the rights of citizens (Chen, 2013). Chen (2013) proposes that the Chinese government should develop citizenship education which empowers citizens to be actively involved in political as well as community debates. Chen (2013) realises that the narrow and indoctrination kind of citizenship education offered to Chinese learners is not the best as it lacks active engagements and community involvement. Citizenship education should be broad to include the important aspects of learner engagements that would improve the lives of citizens politically, socially, morally, culturally and economically.

Citizenship education in the United States of America is mainly reflected in the Social Studies curriculum standards and is developed by the Department of Education of the state (Stuteville & Johnson, 2016). Stuteville and Johnson (2016) point out that the public education sector, which has a mandate of offering education to all citizens, suffers a lot of criticism for failing to produce good and responsible citizens. Stuteville and Johnson (2016, p. 112) also observe that citizenship education offered by some of the American states differed in thrust and attribute the differences to the "political, historic, geographic, and demographic" differences of the states. The thrust and quality of citizenship education is affected by the philosophy of a nation and in the United States of America, decentralisation of citizenship education curricula to states results in different emphasis of citizenship issues.

The International Civic and Citizenship education Study carried out in 2016 examined the state of civic and citizenship education in twenty-four countries. In their findings, 11 respondents proposed that civic and citizenship education should be taught as a stand-alone subject with specialist teachers, 22 respondents proposed that the related content be integrated in subjects related to human/social sciences, for example History, Geography, Law and Economics, 18 respondents proposed that it be integrated in all the subjects taught in a school, 9 respondents proposed that it be taught as an extra-curricular activity and 15 respondents proposed that it be a whole school experience (Schulz et al., 2017). Although all the 24 countries provided teacher empowerment through "in-service and pre-service training" on civic and citizenship education, the training programmes and activities varied across nations (Schulz et al., 2017, p. 21).

Mukundu, Chineka and Madzudzo (2017) lament the general lack of policy direction worldwide which leads to the marginalisation of citizenship issues in school curricula. Mavhunga, Moyo and Chinyani (2012) observe that although most governments accept the centrality of citizenship education, they find it difficult to implement and Schulz et al (2017) acknowledge that the content and the implementation of citizenship education is diverse across nations. This implies that citizenship education lacks uniformity and a framework on science citizenship education would assist science educators to operate from an informed position.

Literature reveals that the version of citizenship education advocated for by most countries focus on civic issues which are taught through General Paper, Social Studies and/or History. The citizenship education is generally addressed in a way which promotes political dominance by the ruling party. The citizenship content is crafted to promote the ideology of the sitting government and hence is politicised. It side-lines citizenship content which empowers learners socially and economically. The promotion of citizenship education which has a narrow focus on civic issues is a weakness of the global educational curricula which needs to be redressed. Citizenship education should be broad to allow all subjects in a curriculum to contribute to the production of a citizen who is empowered socially, morally, politically, culturally and economically. The pedagogy for enhancing citizenship education should be inquiry-based and the learning environment should be free of political victimisation.

2.5 The state of citizenship education in Zimbabwe

2.5.1 A historical perspective

During the colonial era in Zimbabwe, civic education was offered to white learners and History was offered to black learners. The content in the learning areas was meant to enhance white supremacy and relegated the black majority to "second class citizens" (Magudu, 2012, p. 179). At independence, in 1980, the Zimbabwean government was supposed to redress this situation by redefining citizenship education (Magudu, 2012). The Zimbabwean government then declared that education was "a human right for all citizens" (Report of the Presidential Commission of Inquiry into Education and Training, 1999, p. 9). This declaration is a welcome development for any nation as education enlightens citizens so that they become productive culturally, socially and economically. Consequently, the largest vote of the national budget was allocated to education as it was seen as vital to economically empower citizens (Report of the Presidential Commission of Inquiry into Education and Training, 1999).

Mukundu, Chineka and Madzudzo (2017) posit that in Zimbabwe, citizenship education was then offered within some subjects and its implementation was unsystematic across both the Primary and Secondary levels. Subjects that had topics on citizenship issues at Primary level were Environmental Science, Religious and Moral Education, Physical Education, Aids Education and Social Studies (Magudu, 2012; Mukundu, Chineka & Madzudzo, 2017). Ironically, these learning areas had very low weighting when it came to the high stakes summative examinations, so they were given low status during the teaching and learning process. At Secondary level, citizenship education was taught mainly through History, which was not a compulsory subject (Mukundu, Chineka & Madzudzo, 2017). This meant that citizenship education was marginalised as it was not offered to all learners. Magudu (2012) states that Zimbabwe has attempted to include citizenship education in the curriculum since 1980. The attempts have generally not been successful because, nineteen years later, the Report of the Presidential Commission of Inquiry into Education and Training noted that "citizenship education in the Zimbabwean curriculum was near-absent" (1999, p. 354). The observation of the Presidential Commission led to Ordinary level History being made compulsory, National and Strategic Studies being introduced in tertiary institutions and a National Youth Service being introduced, all in a bid to address issues of citizenship education (Magudu, 2012).

In the old curriculum, which was offered till 2016, citizenship education at ordinary level was mainly taught through Education with Production and History (Magudu, 2012). History emphasised civic issues while Education with Production was meant to integrate theory with real-life practice (Magudu, 2012). The concept of Education with Production was meant to apply the concepts taught in a practical way. For example, in Agriculture, if learners were to be taught about poultry rearing, then chicks were bought, and learners reared them and marketed them. The learners got the practical experience and competencies of rearing poultry as well as marketing. Learners would then be able to earn a living from rearing poultry. This is the kind of citizenship education which the current researcher advocates for as part of science education as it would make science learning relevant and improve scientific literacy.

However, citizenship issues were marginalised as many History teachers abandoned teaching them since the issues were politicised and sensitive and had consequences from politicians (Magudu, 2012; Mukundu, Chineka & Madzudzo, 2017; Sigauke, 2012). Teacher victimisation resulted in citizenship education programmes in Zimbabwe being ineffective (Mukundu, Chineka & Madzudzo, 2017; Sigauke, 2013; Magudu, 2012; The Report of the Presidential Commission of Inquiry into Education and Training, 1999). The current researcher argues for citizenship education which is democratic and citizen value-laden.

Magudu (2012) laments the fact that Zimbabwe acknowledges that citizenship education is vital for the production of responsible citizens but offers politicised citizenship education where the youth are politically manipulated. Magudu (2012, p. 185) points out that citizenship education in Zimbabwe is "associated with indoctrination" and argues for the depoliticising of citizenship education in Zimbabwe. Similarly, Sigauke (2012) recommends that Zimbabwe should develop and implement a citizenship education programme in which the youths have freedom to debate on government policies and any issues crucial to the nation. In a democracy, the citizens should have the right to air their concerns without any negative consequences. Citizenship education should be taught in a way that promotes critical thinking and hence guard against indoctrination. Citizenship education that is both politicised and imposed to learners who should be passive recipients is tantamount to indoctrination (Sigauke, 2011). The current researcher argues that indoctrination, in any educational setting, is undesirable as it defeats the whole purpose of education. Learners have to be taught in such a way that they develop their mental capabilities for critical engagements and not for conformity. Citizenship education which was implemented in Zimbabwe was not open to learner critical analysis and hence was tantamount to state indoctrination. Any citizenship content in the curriculum should be taught using pedagogies that allow learners to actively engage in debates, argumentation and critical analysis.

The Report of the Presidential Commission of Inquiry into Education and Training contends that citizenship education should be at the "centre of the education curriculum for the twenty first century" (1999, p. 349-353). The Presidential Commission of Inquiry into Education and Training (1999) is in line with the global argument for the provision of citizenship education to all learners. However, the Report of the Presidential Commission of Inquiry into Education and Training (1999, p. 24) notes that there was no clear educational philosophy in Zimbabwe and stakeholders proposed that the philosophy be based on unhu/ubuntu which is a value that illuminates "education, the family, in national building and in international relations." This philosophy guides citizens to be especially morally and socially correct for the advancement of the society in which they live. When citizens have unhu/ubuntu, they leave peacefully, respecting each other and their properties, collectively addressing societal challenges and there is a sense of belonging and security. The citizenship education agenda in Zimbabwe addresses the moral and civic issues and there is need for it to be supported by the subject specific citizenship concepts which would address the socio-economic issues as well.

The Report of the Presidential Commission of Inquiry into Education and Training (1999) proposed that the education offered should be relevant to the survival of citizens and hence should equip the learners with real-life skills. The report of the Presidential Commission of Inquiry into Education and Training (1999), while acknowledging that it was crucial for all subjects to contribute to the production of responsible citizens, goes on to propose that citizenship education be a stand-alone subject. The report of the Presidential Commission of Inquiry into Education and Training (1999, p. 354) also recommends that "citizenship (civic) education be compulsorily taught in the entire school curriculum as a matter of urgency" and that all teachers be staff-developed on the issues and the pedagogy of citizenship education. A close analysis of the observations and recommendations of the Presidential Commission reveals a contradiction with regard to the citizenship education being advocated for. For instance, the Presidential Commission recommends that the education should enable the learner to be a balanced citizen who would have acquired skills needed for survival. The current researcher views these skills as those that enhance political, social, moral, cultural and economic well-being. Then the Report of the Presidential Commission of Inquiry into Education and Training (1999) recommends that citizenship (civic) education be taught as a stand-alone subject. The subject being proposed has content which is politicised and hence the stance contradicts the argument for citizenship education which enhances citizen survival. This shows a lack of clarity on how citizenship education should be addressed and implemented. A framework for science citizenship education would assist in clarifying the route inter-discipline citizenship education could take and the suitable pedagogies and assessments to be employed.

In Zimbabwe, the competence-based educational curriculum (implemented from 2017) aims to address the educational deficiencies that were noted by the 1999 Report of the Presidential Commission of Inquiry into Education and Training, among them, the near-absent state of citizenship education. The current research focuses on the development of a framework for integrating citizenship education in the pedagogy and assessment of practical work in Combined Science in Zimbabwe. The current research, therefore, contributes to the debate on citizenship education which Zimbabwe and the global community may implement to improve science education.

At ordinary level in the Zimbabwean competence-based curriculum, almost all syllabi speak to community, national and global citizenship. The syllabi have a focus on the production of citizens who could apply the concepts learnt at school to solving real-life issues, for example, in Chemistry, Physics, Combined Science, Geography, History, Heritage Studies, Family and Religious Studies. However, the compulsory Heritage Studies Syllabus Forms 1-4 focuses more on civic education as its thrust is on the production of a citizen who is "patriotic, competent, self-reliant and has a sense of national pride" (Ministry of Primary and Secondary Education Heritage Studies Syllabus Forms 1-4, 2015, p. 1). The competence-based curriculum also has a Life Skills Orientation Programme which focuses on training post Grade 7, post Form 4 and post Form 6 on citizenship. The syllabus is yet to be implemented. The syllabus aims to develop a "patriotic and responsible citizen" who has good characteristics for "life such as punctuality, commitment, honesty, empathy, resilience and perseverance" (Ministry of Primary and Secondary Education Life Skills Orientation Programme Syllabus Post Grade 7, Form 4 and Form 6, 2015, p. 1).

2.5.2 Towards an ideal science citizenship education

Literature thus reveals that the Zimbabwean citizenship education thrust has been that which deals with civic issues. The current research focused on citizenship education which led to scientific literacy and was particularly concerned with the state of science citizenship education in Zimbabwe. Mukundu, Chineka and Madzudzo, (2017) are disturbed with the low levels of scientific literacy in Zimbabwe despite and in spite of large numbers of candidates who sit for science examinations yearly. Similarly, the Report of the Presidential Commission of Inquiry into Education and Training (1999, p. 396) observes Zimbabwe's "overwhelming level of scientific and technological deficiency" as disturbing and posits that its attainment is still a long way to go. In fact, in Zimbabwe there is always a science learning area which is compulsory for all learners to study yet scientific literacy remains low. In the current competency-based curriculum, Combined Science is the compulsory science learning area. The question for Zimbabwean science educators to answer is why there are low levels of science literacy and what has to be done to correct the anomaly. The current researcher sees the development of a framework for integrating citizenship education in the pedagogy and assessment of science practical work as a step towards improving the levels of scientific literacy in Zimbabwe and globally.

Science education should provide a link between societies, real-life projects and schools (European Commission, 2015). The argument is supported by Mukundu, Chineka and Madzudzo, (2017) who contend that science education contributes to the nation's socio-economic development and urge Zimbabwe to reform the science curriculum in a way that would benefit the nation. Recently, Mukundu, Chineka and Madzudzo, (2017) lamented that although many science curriculum reviews had been made in Zimbabwe, these had not yielded any significant scientific achievements. This position indicates that research on science education should inform policy makers on the direction to take to improve scientific literacy and enable science education to contribute to the economic development of the country. Science should be taught in a way that enhances science citizenship. The pedagogy of science practical work should be community-based so as to empower the learner to apply the concepts learnt in real-life situations. The current researcher challenges the teaching of science practical work which ends in the classroom and/or in the laboratory as it has led to learners acquiring science concepts in a way that is divorced from their application. There should be an open and active connection between school science and its application to real-life which is experienced by the learner. Science citizenship education should be the thrust of science education and should aim to improve scientific literacy and application within citizens. Science education should endeavour to solve socio-scientific challenges within communities. The practical work done in science should connect to real-life situations so that science concepts are understood by learners who would then be in a position to apply them.

Mukundu, Chineka and Madzudzo (2017) identify high stakes summative examinations and inadequate science funding as some of the challenges that led to ineffective science education reforms in Zimbabwe. High stakes examinations have a backwash effect to the curriculum as they make teachers to teach to the test and promote examination malpractice (Heng, 2015; Kamenetz, 2015; Long et al., 2011). In Zimbabwe, some teachers 'drill' learners so that they pass examinations. They make learners recite and cram information so that they pass examinations. This is undesirable for science education as rote learning leads to 'temporary' knowledge which is forgotten easily and cannot be applied to real-life situations. The current researcher argues that high stakes summative examinations lead to deliberate use of wrong pedagogies by teachers. Compounded by lack of resources, poor supervision, unclear policies, poor human resource base and poor teacher motivation, science education could continue to be taught using irrelevant pedagogies. This scenario would result in updated science curricula which would still not be beneficial to science learners and citizens. The framework for integrating citizenship education into the pedagogy and assessment of science practical work would also outline relevant assessments which promote science knowledge which can be applied in real-life.

The European Commission (2015) argues that the implementation of any educational programme cannot be successful unless teachers are trained, disciplined, well-motivated and are content, pedagogical and assessment competent. Similarly, the pedagogy and assessment of science practical work that enhances citizenship education should be made part of the science teacher training programmes. Many nations have reformed their educational curricula to include citizenship education. This is a desirable position which needs to be supported by teacher staff-development for the successful implementation process. Magudu (2012) highlights that Zimbabwean teachers lack the basic PCK to effectively deal with issues of citizenship education as they have not been trained for it and resources and textbooks are also scarce. Magudu (2012) is supported by the Report of the Presidential Commission of Inquiry into Education and Training (1999, p. 397) which also identifies "unsuitable teaching methodologies" as one of the reasons why there is generally low levels of scientific literacy in Zimbabwe. The critical question raised is whether the situation in Zimbabwean schools with regard to science pedagogies employed is now different from the one that was lamented by the Presidential Commission of Inquiry into Education and Training in 1999. The current research aimed at getting clarity on the pedagogies and assessments employed by science teachers during the teaching and learning of Combined Science practical work in Zimbabwe and how the practical work is linked to the concept of citizenship education.

Recently, Rudolph and Horibe (2016, p. 806) noted that science citizenship education "has never been defined with any real precision." The current researcher thus focuses on science citizenship education and the development of a framework that informs science educators on relevant pedagogies and assessments that enhance scientific literacy. The researcher clarifies the role of science education in the production of a balanced citizen as supported by Ahmad (2017, p. 39) who argues for an "interdisciplinary approach" to citizenship education. On the same note, the 2016 International Civic and Citizenship education Study concluded that effective civic and citizenship education should be a "cross-curricular" agenda as this position was acknowledged even by countries which offered the subject as a stand-alone (Schulz et al., 2017, p. 6).

The current researcher argues that each subject should enhance citizenship concepts which are related to it. While civic education is important and is a cross subject agenda, citizenship education should not narrowly focus on the civic issues only. Citizenship education should address the social and economic challenges as well so that citizens live better lives. The concept of multidisciplinary teaching should be integrated in teacher training programmes as well as being emphasised during the teaching and learning process. Every subject should contribute towards the citizenship agenda, for example, Geography learners could take an active role to address challenges of environmental degradation within their communities. The learners could close gullies and plant trees within their communities in order to preserve them while science learners could educate communities on the prevention of waterborne diseases such as cholera by boiling drinking water collected from unprotected water sources.

Hoeg and Bencze (2017) lament the position that pedagogies that enhance science citizenship are not practiced in schools as schools are not required to identify any community challenges to resolve with their science classes. This implies that the notion of science citizenship education remains rhetoric in many educational curricula. Unless policy makers put in place effective programmes to support science citizenship education, the concept will never bear fruit. Effective science citizenship education which is able to change and improve lives and society can be realised through compulsory science education which is taught using learner-centred, inquiry-based pedagogies.

The researcher concurs with the European Commission (2015) which highlights that authentic learning occurs when learners are exposed to actual problems for them to find solutions. The Zimbabwean curriculum has been heavily criticised for being too academic at the expense of practical exposure of learners to real-life challenges (The Report of the Presidential Commission of Inquiry into Education and Training, 1999). The learning is detached from the community and that gap leads to learners who have knowledge which they cannot apply to solve real-life challenges. An emphasis on science citizenship education could lead to the construction of "science knowledge of worthy" which could be applied to improve the lives of citizens. The development of a framework for science citizenship education is therefore a worthwhile endeavour as it informs science educators across the globe on the suitable pedagogies and assessments to employ.

2.6 Conclusion

The current chapter reviewed literature on citizenship education. This was critical since it was part on the main concepts within the theoretical framework employed in the current research. The state of citizenship education in Zimbabwe as well as globally was interrogated. It was generally noted that the concept of citizenship education emphasised globally focused on civic issues and it was not standard or uniform across nations. This position portrays the need for a framework on citizenship education that addresses scientific issues. Pedagogies and assessments that are aligned to social constructivism were proposed as most ideal to integrate citizenship education to science practical work. The next chapter reviewed literature on theories of learning, science practical work pedagogies and practical work assessments.

CHAPTER 3: PERSPECTIVES ON PEDAGOGY AND ASSESSMENT

3.1 Introduction

The previous chapter reviewed literature on the state of citizenship education in Zimbabwe as well as globally. It also focused on the pedagogies and assessments of science practical work that enhance science citizenship education. The current chapter reviews the critical literature on the pedagogies and assessments used in the teaching and learning of science practical work in ways that enhance citizenship education. The literature review was informed by the theoretical framework which was presented in Chapter 1. In this regard, the theoretical framework informed the literature 'landscape', which must be explored in order to locate the current research within existing literature. This literature will also provide a template against which the findings of the current research will be weighed in order to determine the contribution made by the current research. The chapter begins by tracing theories on the acquisition of knowledge and argues for effective pedagogical approaches and assessments. It thus begins by focusing on the major philosophical positions on knowledge acquisition, namely functionalism, structuralism, behaviourism, cognitivism, the socio-cultural theory and social constructivism with a view to analyse their potential in the teaching and learning of science practical work and eventually their capacities to contribute to science citizenship education. Pedagogies that are based on social constructivism, that is, inquiry-based pedagogies are viewed as best positioned to facilitate citizenship education. Social constructivism is presented as the basis of theoretical framework which informs the current research.

3.2 The history of knowledge acquisition

Knowledge acquisition has been at the centre of studies carried out in educational psychology. The current research's main focus is to answer the question pertaining to the pedagogical approaches and assessments which can be used to enhance citizenship education through science practical work. The question is critical since educators can only be effective in their teaching process when they have knowledge on educational theories, pedagogy, assessment as well as the pedagogical content knowledge, PCK (Akuma & Callaghan, 2018; Barak, 2017; Barak, 2014; Cooper, Loughran & Berry, 2015; Pagliaro, 2013; Yore, 2012). In a bid to answer the question pertaining to how learning occurs, many educational theories have been proposed to date, and some have been discarded while others have been modified or merged. While acknowledging that many studies on how learning takes place were carried out, the current researcher traces the argument on how learning occurs from the period of structuralism and functionalism since these have contributed immensely to current educational theories.

3.2.1 Structuralism and functionalism

Schunk (2012) identifies structuralism and functionalism as the two major schools of thought in educational psychology that existed at the beginning of the twentieth century. Structuralism and functionalism were seized with understanding how learning occurred and their positions had major implications on pedagogy and educational assessment. Wundt and Titchener spearheaded structuralism (Beenfeldt, 2013; Schunk, 2012). Wundt is generally regarded as the founder of the concept of introspection while it is generally agreed that Titchener was the leader of structuralism (Beenfeldt, 2013). Structuralists studied the mind using introspection as their method (Costall, 2006). Introspection is a form of self-analysis that focuses on one's own mental and emotional processes. The structuralists studied the mind, its structure and how mental processes were involved in the acquisition of knowledge and also how ideas were connected (Schunk, 2012). The experiments on introspection, which used trained participants, recorded verbally reporting of the immediate experiences of the participants after being exposed to events. By studying the mind, the structuralists acknowledged the centrality of the mind in the process of knowledge acquisition.

Structuralism, by carrying out experiments, acknowledged that exposing an individual to an event was important for learning to take place. Structuralism linked the experiences to the mind which would then construct some meaning from the experiences. This position augurs well with the argument for exposure of learners to practical work as a way of enhancing meaningful learning. The centrality of the mental processes to learning is acknowledged to date by educators, psychologists and philosophers, thus, this is a valuable contribution that emanated from structuralism.

The method of introspection which they used was, however, subjective to one's feelings and was greatly influenced by external factors and hence, unreliable and inappropriate. Schunk (2012, p. 9) views the verbal responses given by participants as a result of responding to the environmental factors or stimulus instead of responding to the mind which means that the method removed the focus from the mind. The method of introspection side-lined meaning and hence disregarded the involvement of the brain or the mind in explaining how learning occurs. Titchener (1912, p. 485) admits that introspection was unreliable and also that it "may be scientifically illegitimate or wholly imaginary." Titchener's admission shows that structuralism started to crumple from both the interior and the exterior. In the researcher's view, it was the method of introspection that was unreliable but the idea of experimental involvement of individuals to events for them to be able to construct their own meaning was a vital contribution to educational pedagogy. The experimental orientation of practical work in science is thus in line with structuralism.

Functionalists, on the other hand, argued that learning involved the mind as well as the response to stimuli. The link then enabled organisms to adapt to their surroundings. The functionalists were informed by Darwin's theory of evolution. William James, John Dewey and James Angell are among the founding members of functionalism (Schunk, 2012). James, who became a prominent functionalist, argues that psychology is "the science of mental life" and he gives "feelings, desires, cognitions, reasoning, decisions" as examples of the phenomena (James, 1890, p. 2). Functionalists agreed that psychological processes or the mind could not be broken into discrete parts and that consciousness was to be viewed holistically. James (1890, p.148) argues that consciousness is not "jointed" but rather "flows" like water smoothly flowing in a river.

The critical question here is the link between functionalism and the pedagogy and assessment of science practical work which promotes citizenship education. Functionalism argues that the mind is involved in learning and that a stimulus helps to enhance learning. The current researcher sees stimulus as also vital to direct practical work in science to solve societal problems. The nature of the stimuli may be different from those proposed by the functionalists, but they have the same purpose. For example, the development of a gully on the rural learners' way to school may be a stimulus for them to involve the mind in coming up with a practical solution to fill up the gully.

However, both structuralism and functionalism had problems due to the method of tedious experimentation they used as introspection was highly subjective and unreliable (Beenfeldt, 2013; Costall, 2006; Schunk, 2012). Neisser (as cited in Beenfeldt, 2013) clarified that introspection was abandoned because it lacked any clear explanation of how people related to the world. It also lacked an explanation on cognitive development and behaviour modeling. Schwitzgebel (2011) rejects introspection by arguing that it was highly unreliable as many people could just not 'introspect' their own mental processes. Schunk (2012) also criticised the use of introspection as a method to study high order cognitive skills like deductive reasoning, critical-thinking and problem-solving.

Although both functionalism and structuralism were eventually rejected, they made a vital contribution to the philosophy of knowledge acquisition through practical work. By arguing that at the centre of any learning process is some practical experience and the mind or mental processes, they are, in the researcher's view, the roots of constructivism and form the basis for the pedagogy for science practical work. Throwing away everything that functionalism and structuralism advocated for is like throwing away the baby with the dirty bath water. The centrality of mental processes is a position that is still acknowledged today and hence the fire they started then is still on. The pedagogy and assessment of practical work in science that invokes mental processes lead to long term mastering of science concepts which would then be utilised to improve citizens' lives and their communities. Functionalism and structuralism thus have a bearing on pedagogies employed during practical work which stimulate mental processes and enhance citizenship education.

3.2.2 Behaviourism

The idea of introspection became the basis of a modified theory, behaviourism, which dominated educational psychology in the 1950s. It is important that behaviourism be examined to review the potential it may have to inform the pedagogy and assessment of science practical work that may enhance science citizenship education. Prominent behaviourists include Watson, Pavlov, Skinner and Thorndike. Hohenstein and Manning (2010) posit that behaviourism is not interested on the mind and the processes that take place within it as these are not visible and hence are abstract to understand human behaviour. Behaviourism is obsessed by the view that learning is promoted by external stimuli and results in observable and measurable outcomes. The theory uses "drill and practice" to foster learning (Pagliaro, 2013, p. xiii). Thus, behaviourism focuses on external changes which can be observed and are the result of experiences or interactions with the environment. For behaviourists, the preferred mode of learning is through conditioning (Ertmer & Newby, 2013; Long, Wood, Littleton, Passenger & Sheehy, 2011; Pritchard, 2009; Yore, 2012). In the 1950s, behaviourism was widely acknowledged as the theory of education that facilitated learning. Learning under behaviourism was characterised by the use of specific terms, direct teacher instruction, and well programmed activities. Behaviourism concentrated on how the association between the stimulus and response was made, strengthened and maintained (Ertmer & Newby, 2013; Yore, 2012). Behaviourism, however, ignored the role of the mind or mental processes which cognitivists explained and hold as vital for the learning process (Bandura, 1977; Pritchard, 2009). Ignoring or rejecting the centrality of the mind or mental processes in the learning process became the huge criticism for behaviourism. Practical work which does not involve the mind and does not critique the procedure and apparatus used may be highly dangerous and unsafe.

One of the major challenges to behaviourism came from studies on observational learning conducted by Albert Bandura and his colleagues. A central finding of their research was that people could learn new actions merely by observing others perform them (Bandura, 1977). Observers did not have to perform the actions at the time of learning. Reinforcement was not necessary for learning to occur. These findings disputed central assumptions of the conditioning theories. Bandura and colleagues put forward an argument for the social cognitive theory which states that a lot of learning occurs socially as observations may result in acquisition of skills, beliefs and knowledge as well as a change in attitudes by the observer (Schunk, 2012).

The cognitivists had gathered evidence on how cognitive structures contributed to learning and ultimately to change of behaviour, hence the behaviourists' position of rejecting the mental processes began to fall apart. Research indicates that authentic learning occurs better by using cognitive processes (Bandura, 1977). This led to the rise of cognitivism in the 1960s. The history of learning reveals a shift away from environmental influences and towards cognitive factors as explanations for knowledge acquisition (Schunk, 2012). This shift began with the advent of cognitive psychology which disputed the claim of behaviourism that stimuli, responses, and consequences were adequate to explain learning.

The question now is whether pedagogies that are aligned to behaviourism are the best to use to teach science practical skills and enhance science citizenship education. The practical skills and science concepts would be learnt best when the learners are actively involved during the learning process and mental processes are involved. Behaviourism neglects the mind which the current researcher sees as crucial for both the processing and storing of knowledge or concepts. It is also dangerous to teach science practical work through an emphasis on trial and error as advocated for by behaviourism due to safety concerns. This position is further supported by Agarkar (2019) who posits that behaviourism is generally poorly positioned as the basis for pedagogies that should be employed in the teaching, learning and assessment of practical work in science due to its neglecting the involvement of the mind.

Ertmer and Newby (2013) raise a critical question on whether it is ideal to base pedagogy on a single educational learning theory or to integrate ideal principles from different educational theories. Agarkar (2019) lends support to this position by stipulating that the objective that needs to be attained during learning should focus the theoretical position that would be taken. While the current researcher acknowledges that the active involvement of the mind is vital for authentic learning to take place, she also thinks that it is a radical stance to wholly reject everything on behaviourism, for example, the drill and practice phenomenon results in marked improvements in sporting activities. Also, while intrinsic motivation is important to enable learners to set out educational targets for themselves, extrinsic motivation is also necessary for learners who lack self-determination to be driven towards set targets. Thus, the current researcher supports Pagliaro (2013) who argues that while one of the theories may be the best, it still remains important to acknowledge that all of them have sections that are relevant and contribute to learning and that the theories are not totally independent of each other but have similarities in certain aspects or principles.

3.2.3 Cognitivism

What then are the prospects of cognitivism as the basis of pedagogical approaches and assessments that may be implemented in science practical work in order to enhance citizenship education? In order to answer this question, an exploration of cognitivism is required. The main theory of cognitive development and learning was proposed by Jean Piaget and is largely based on the development of mental structures called schemas (Long et al., 2011; Pagliaro, 2013). The current researcher visualises schemas as imaginary shelves found in the brain which store related information or knowledge. Schemas are used to represent experiences, events, concepts, actions and processes. Learning occurs when the learner's schemas are adjusted or altered. Cognitivists, drawing from Piaget's argument, thus see learning as a mental process that occurs as a result internal adjustments of the mental structures, the schemas (Ertmer & Newby, 2013). This definition is also echoed by Long et al (2011), who define learning as a result of mental adjustments that occur when learners actively interrogate learning materials. Educationists of the 21st century generally accept that cognitive structures are at the centre of authentic knowledge acquisition (Çetinkaya & Özyürek, 2019).

Cognitive theories place great emphasis on learners' capacity to process information as a central cause of learning. Many educational researchers concur that the most effective knowledge acquisition occurs through active mind engagement in problem-solving situations. Cognitivism puts emphasis on the involvement of the mind in learning. Theories about cognitivism acknowledge that authentic learning occur when the learner is actively involved in the process of learning rather than being a passive recipient of information (Ertmer & Newby, 2013; Long et al., 2011; Schunk, 2012). Piaget acknowledges that the environment has a role in learning but he pays more attention to the role of the mind in the acquisition of knowledge (Long et al., 2011). Piaget argues that a learner's environment may involve the teacher who facilitates the teaching and learning process.

Piaget views learning as a process that is facilitated by information that does not exist in any of the learner's schemas. This sets in disequilibrium in the learner which leads to adjustments in the mind to accommodate the new information and hence lead to a new equilibrium. The teacher's guiding prompts and probes are very important since they help to create disequilibrium in the learner which will lead to the necessary mental or cognitive adjustments, and hence learning. The current researcher prefers to refer to the disequilibrium as the 'experiential-cognitive conflict.' In the current researcher's view, learning takes place when the knowledge acquired from a learner's experiences is challenged by peers or the teacher or a textbook or experimental work. This leads to cognitive modification and hence to learning.

The experiential-cognitive conflict which is created by peers is vital since learners are more likely to engage in an effective dialogue among themselves rather than with the teacher whom they view as an adult (Long et al., 2011). This argument is particularly relevant in the African context, where picking up an argument with an adult is viewed as being disrespectful, hence the learners may not engage the teacher to an extent they may do among themselves. The mismatch between a learner's experiences and those of peers result in the experiential-cognitive conflict which then lead to the learner modifying the existing knowledge or adopting new knowledge. Barak (2017) argues that the experiential-cognitive conflict is vital for cognitive development. This implies that an effective pedagogy should utilise the learners' experiences and the knowledge base drawn from them. The teaching process then reinforces the knowledge or modifies it or discards it in a manner that actively involves the learner. Hence, the teacher facilitates learning and the instruction employed during the teaching and learning process should reflect that role.

In the learning of science, most of the experiential-cognitive conflict emanates from the non-scientific beliefs that the learner brings to school and the social interactions with peers and the guidance offered by the teacher. Resolving the experiential-cognitive conflict is done through the knowledge modification process, which accommodates new knowledge acquired during the process and hence results in a deeper scientific understanding and hence authentic, self-directed learning. The teacher who is the facilitator in the teaching and learning process's major role is to align the content and level of difficulty to the learner's needs, skills and existing knowledge. Piaget affirms the teacher's role as that of generating disequilibrium within learners (Long et al., 2011)**.** Effective learning results in behavioural change and application of knowledge over a long period of time (Long et al., 2011; Schunk, 2012). Effective science learning should lead to the ability to solve problems which are encountered in life and hence to good citizenship.

Cognitivism, like functionalism and structuralism, argues for the involvement of mental processes in the learning process. Learning has to be challenging in a way that balances level of cognitive development to enable the learner to process the concepts, understand them and store them for future use. Practical work that is taught and assessed in such a way would help the learners to use the concepts and skills to solve real-life problems for their good as well as the good of their communities. Given the principles that guide cognitivism discussed here, the current researcher argues that integrating citizenship education in the pedagogy and assessment of science practical work could require a cognitive approach.

3.2.4 The socio-cultural theory

A critical question is also raised in relation to the possible role of the socio-cultural theory to the learning process in general and to science practical work that promotes citizenship education in particular. Vygotsky (1978) argues that learning is enhanced by social interactions between the learner and his/her peers and the teacher. He posits that there is a zone of proximal development (ZPD) that lies between a learner's individual level of development and the level a learner attains through learning while guided by a competent adult or peer (Vygosky, 1978). Thus, ZPD is the difference between what children can attain without guidance and what they can do with guidance from others. The teacher guides the learner so that he/she can attain the zone of proximal development. Learner interactions with the teacher and peers in the ZPD enhance cognitive development (Barak, 2017; Long et al., 2011).

Vygotsky (1978, p. 86) highlights that any child has cognitive developmental processes that may remain in an "embryonic state" unless collaboration with peers takes place to advance them. Vygotsky argues that authentic learning takes place when the learners' experiences are used as the basis of meaning formation and that the learners' thinking processes are informed by their experiences with other people, the environments and the resources around them (Long et al., 2011; Schunk, 2012; Vygotsky, 1978). Vygotsky thus puts forward a strong argument that experience obtained as the learner interacts with the environment contributes to authentic learning. The learner's experience is important since it leads to the experiential-cognitive conflict which is necessary for authentic learning to take place. The role of the teacher is to use instruction which facilitates collaboration so that appropriate mental development is attained.

Vygotsky (1978) also argues that learners coming from different cultures derive different meaning from even similar experiences. This reminds the current researcher of the strong contention about the causes of lightning in Zimbabwe. The current researcher went to school with the view that lightning was caused by traditional healers in an act of witchcraft. She had to make a big effort to adjust her schemas so as to accommodate the scientific explanation. Thus, social interactions may result in different mind status quo which requires different cognitive adjustments. Vygotsky (1978) concurs with Piaget when he acknowledges that learning which happens in the ZPD happens through the guidance and social interactions with the teacher (Long et al., 2011). This implies that the teaching and learning process should allow for learners to apply and modify knowledge acquired from social contexts.

Social interactions among learners would most likely lead to alterations of preconceived knowledge, mediation and learning. Peer collaboration provokes the learner to operate at a higher intellectual level, hence the learner attains the next higher cognitive level (Barak, 2017). The experiential-cognitive conflict explains learning as a process which occurs when the cognitive conflict induced by peer collaboration is resolved, hence leading to knowledge development. It helps any learner to attain his/her full academic potential. Social interactions among learners are also crucial since they facilitate good citizenry. Learners who collaborate in class are most likely going to have a shared vision for their community.

Practical work in science, especially in the developing world where resources are limited, benefits from the socio-cultural theory immensely. The sharing of social experiences when brought to the learning process is enriching. When learners collaborate during the learning process, they learn from each other. The learners are also more likely to collaborate when they are adults and are employing the concept of good citizenship to collectively solve challenges in their communities.

3.2.5 Social Constructivism

The current researcher also seeks to probe the extent to which social constructivism could enhance the integration of citizenship education in the pedagogy and assessment of science practical work, so it is crucial to interrogate it as well. Social constructivism is mostly based on the theories of Piaget and Vygotsky (Barak, 2017; Bächtold, 2013; Schunk, 2012). Social constructivism has been the major learning theory applied to learning and teaching in recent years (Beerenwinkel & von Arx, 2017; Schulz, 2014; Yore, 2012). Beerenwinkel and von Arx (2017) acknowledge that constructivism is at the centre of global science curriculum reforms. Constructivism views learning as personal and active construction of knowledge from the learner's experiences which are shaped by the environment (Beerenwinkel & von Arx, 2017).

Schulz (2014) observes that constructivism has a lot of educational controversy. The controversy is associated with its classification, by some, as a philosophy of education, and by others, as a learning theory, or a framework or as an instructional design. Beerenwinkel and von Arx (2017) argue that constructivism is not a theory and define it as a framework that integrates many educational theories. Bächtold (2013) views constructivism as a theory of learning which is effective if implemented in science education. Bächtold (2013), on another note, argues that constructivism can also be viewed as a theory of teaching if learners' conceptions on a topic are sought prior to teaching and also if a cognitive conflict is created in the learners. Toraman and Demir (2016) argue that constructivism is a philosophy of education and not a theory because it seeks to explain how the learner acquires knowledge.

The arguments surrounding constructivism require a closer analysis of the classification of whether it is a philosophy, a theory, a framework or an instructional design. Schunk (2012, p. 10) defines a theory as "a scientifically acceptable set of principles offered to explain a phenomenon." A theory stipulates a framework for analysis and interpretation of observations. Thus, a theory is broader than a framework, for example, the constructivism theory has a framework for pedagogy and a framework for assessment. Constructivism cannot be an instructional design or pedagogy because it is broader than that and it actually has many pedagogies within it. The current researcher treats constructivism as a learning theory and views the pedagogies and assessments within it as frameworks.

Social constructivism puts emphasis on the way knowledge is acquired. It argues that learning takes place when the learners use both personal and social experiences to construct their own meaning with the mentorship of the teacher. The academic modification process which results in knowledge acquisition is a result of what Healy (2013, p. 2) refers to as a "conceptual conflict" and what the current researcher refers to as an experiential-cognitive conflict. It is important that learners construct their knowledge beginning from their personal experiences and interpretations which they modify as they interact with peers and the teacher resulting in deeper understanding and hence authentic learning.

Bächtold (2013) argues that constructivism is based on the principle of mental involvement during the construction of knowledge. As such, construction of knowledge may be a result of the changes to the cognitive structures. The argument that knowledge is constructed, which is at the centre of social constructivism, has found favour with many educators and researchers over the years.

Constructivism has been widely accepted because it advocates for learner-centred instruction, thus replacing the teacher-centred instruction (Toraman & Demir, 2016). Barak (2017) suggests that instruction should be aligned to social constructivism instructional designs to be able to foster the development of the 21st century competences. The social constructivism teaching models modified the cognitive model by accommodating the learner's socio-cultural disposition (Yore, 2012). Social constructivism believes that social interactions and personal experiences lead to cognitive development and learning (Barak, 2017). The current researcher acknowledges that experiences result in authentic learning, for example, a toddler who gets slightly burnt when playing with fire learns to keep a safe distance from fire. Class discussions with peers and teachers on scientific issues enable the learners to make sense of their own experiences and ideas. The discussions lead to the experiential-cognitive conflict, reflection, adjustment, accommodation, reframing, and/or rejection, hence the end result is meaningful learning.

Social constructivism defines the role of the teacher as that of a coach who encourages talent development by applying both individual effort and social interactions (Bell, Maeng & Binns, 2013; Pagliaro, 2013). The coach guides the learners as they demonstrate what they can do and as such, the teacher guides the learners as they acquire knowledge and competences (Bell, Maeng & Binns, 2013). The teacher produces a conducive environment and guides the learners on their academic, social, moral and physical growth (Pagliaro, 2013). The teacher is thus a facilitator of learning and the learner is an active participant during the knowledge acquisition process.

Social constructivism views knowledge as being constructed by learners during the teaching and learning process. The learners use their experiences to actively construct new knowledge and social constructivism categorically rejects that knowledge is transmitted from the teacher to the learner (Pagliaro, 2013). Social constructivism rejects teacher-centred instructional designs which put emphasis on drill and memorisation, and ultimately to rote learning. Teacher-centred instructional designs lead to less effective learning while learner-centred instructional designs lead to meaningful learning. Rote learning produces knowledge of limited usability and applicability. Rote learning is undesirable for science education which has a major goal in the production of scientifically literate citizens who would address socio-scientific challenges in their communities. Healy (2013) posits that learners acquire meaningful knowledge when they are actively engaged and contributing to the learning process while the teacher facilitates. This is the position that social constructivism emphasises and it is the correct path that science education should take.

Healy (2013) laments the fact that in many educational set-ups, the teacher dictates the concepts to be learnt to the learners and expect the learners to accept his/her imposition without questioning anything. Healy (2013) notes that when teachers impose knowledge that conflict with the learners' own experiences and understanding as scientific facts, the teacher's position is most likely rejected and hence no learning takes place. It is worth noting that global citizenship principles are fighting against any form of dictatorship, be it political, moral, social, physical or religious. Teacher-centred learning environments are tantamount to academic dictatorship which is bound to face resistance from the learners. Teacher-centred instructional designs are undesirable and should be abandoned in favour of the learner-centred instructional designs.

Social constructivism is the theory of education which is most suitable for the teaching of science practical work that enhances citizenship education because it is based on active student collaboration as well as interaction with the materials that facilitate meaningful learning (Adom, Yeboah & Ankrah, 2016; Agarkar, 2019; Çetinkaya & Özyürek, 2019). It advocates for construction of knowledge through engagements which result in cognitive processing and development. The social interactions among learners are good to promote citizenship collaboration which is desirable for collectively solving community challenges. The role of the teacher as a facilitator is desirable for the knowledge construction by learners as they will not rely on the teacher for solutions. The current researcher views pedagogies and assessments which are based on social constructivism as most suitable for the teaching and learning of science practical work which promotes citizenship education. The current research is thus informed by social constructivism although the researcher observes that many authors loosely address it as just constructivism. Social constructivism is better positioned to provide effective pedagogical approaches to the teaching and learning of science practical work that enhances citizenship education. This is because it is based on both cognitivism and the social-cultural theory and being a hybrid, it addresses the process of knowledge acquisition more effectively.

Since the current researcher argues for social constructivism as the theory that most likely results in acquisition of science practical skills in a manner which promotes citizenship education, it is important to also discuss the ideal conditions that are associated with it. It is vital that as educators implement pedagogies and assessments which are based on social constructivism, they aim to have good or ideal conditions for effective teaching and learning environment. That way, the teaching and learning process or programme would most likely achieve its objective(s).

3.2.5.1 Ideal conditions for social constructivism

Social constructivist teachers should base instruction on students' experiences (Beerenwinkel & von Arx, 2017). The teacher needs to know the current level of content, experiences and needs in every learner for the effective learning process to take place. However, a critical question posed by Healy (2013) is whether science teachers practice constructivist approaches when responding to learners' errors and misconceptions. According to constructivism, a misconception indicates wrong meaning formation from an experience which the teacher can only correct when he or she first understands how it was acquired.

Stanovich and Stanovich (2010) note that teachers are supposed to teach learners critical-thinking and problem-solving skills while these skills are actually abstract to most learners. Thus, the teaching of critical-thinking and problem-solving skills requires small classes and the right frame of mind for teachers. The current researcher argues that although the teaching of critical-thinking and problem-solving skills requires special organisational skills and planning for the teacher, it is a worthwhile endeavour since critical-thinking and problem-solving skills produce learners and eventually citizens who would be rational and relevant to their communities. Development of critical-thinking and problem-solving skills in learners is also hindered by teacher restrictions during practical work. Collins (2011) observes that teachers normally restrict learners' creativeness, inventiveness and autonomy during practical work due to safety concerns. This calls for science classes to have a low teacher-learner ratio and be manageable for the teacher.

Sickel, Banilower, Carlson and Van Driel (2015) note that different countries use different teacher training programmes, for example, some countries train science teachers in a two-year programme in education colleges, while some train them in a four-year university programme, and yet others train them in a one-year postgraduate course. In Zimbabwe, teachers' training colleges have two or three year programmes while teachers' training universities have four year programmes. The question raised here is whether Zimbabwean science teachers have the same competencies in terms of the content and instructional designs.

Williams (2011) highlights that for science education to be effective, qualified science teachers and laboratory technicians/assistants are required. It has been observed that there is a general shortage of trained science teachers globally (Sickel et al., 2015). Meanwhile, Williams (2011) observes that the requirements of science departments consume bigger portions of the school budget. The science apparatus, equipment and chemicals are generally expensive. Since chemicals are consumables, they have to be frequently replaced, so even those that are relatively cheap are costly in that regard. Science education, therefore, requires well-staffed and well-resourced schools for successful implementation of pedagogies that are based on social constructivism.

Pagliaro (2013) advocates for educators who have knowledge on educational theories so that they make correct decisions on their teaching practice. The current researcher views Pagliaro's argument as very important and relevant since she (the researcher) believes that one runs well on a path that he/she knows well. In the same spirit, a good educator should know the theories and instructional designs so that even if he/she decides to fuse them, possible challenges are addressed. The teaching process requires teachers who have Pedagogical Content Knowledge. PCK (Cobern et al., 2014; Cooper, Loughran & Berry, 2015). Cooper, Loughran and Berry (2015) define PCK as the knowledge about effective lesson delivery which depends on the subject matter which a teacher acquires due to experience. PCK gives the teacher his/her professionalism and subject content expertise. It also informs the teaching process by enabling teachers to use the correct or most effective pedagogies. Cooper, Loughran and Berry (2015) thus argue that teaching is a complicated, challenging and delicate process that requires specialised skills and lament that it is not viewed as such by members of the public.

Barak (2014, p. 1-2) notes that many teachers use traditional teaching methods such as “lectures, textbook reading, and exercise drills” with their classes as either they are not competent with constructivist pedagogies, have limited lesson and preparation time or are unaware of the advantages of the social constructivist pedagogies. Barak (2014) thus argues that teachers are comfortable with instructional designs that are based on their PCK and teaching experience. Teachers are not comfortable to venture where they have never been especially those deemed to be producing good results in high stakes national examinations. Barak (2014) also argues that for any curriculum reform to be a success, teachers have to be staff-developed so that they appreciate the proposed change(s). While also acknowledging the centrality of inquiry-based teaching and learning pedagogies, Crawford (2012) observes that the majority of teachers do not employ social constructivist pedagogies citing lack of support for teachers, both in terms of staff-development and material resources. Staff-development should be carried out where teacher gaps on social constructivism are noted.

Teachers have to change their dispositions with regard to their role during the teaching and learning process for them to effectively facilitate the acquisition of the 21st century competences by the learners (Barak, 2014). The instructional designs employed by the teacher should foster active, learner-centred, exploratory learning in a supportive environment. Barak (2014) raises a critical discourse by arguing that teachers cling to traditional teaching methods because that is what they were exposed to when they were learners and hence were not prepared to depart from what they knew.

In Zimbabwe, the Integrated Science which was offered to most learners who would in turn feed the Teachers’ Colleges had ‘dilute’ Biology, Chemistry and Physics content. The syllabus also lacked an emphasis on the practical aspect of science education by having a pen and paper alternative to practical examination instead of a real practical examination. Most of the science teachers never carried out practical work when they were learners and are most likely going to resist the centrality of practical work in their pedagogies and assessments. The science teachers were mostly exposed to the traditional teaching methods yet they are now expected to apply constructivist pedagogies and assessments in their teaching. They have known the teacher to be the source of knowledge and hence the 'authority', yet they are now expected to be facilitators. Most of the science teachers studied Integrated Science and would most likely have content challenges when they teach the Combined Science which requires a deep understanding of concepts in Biology, Chemistry and Physics. Science teachers who have degree qualifications have either specialised in Biology, Chemistry or Physics and so have limitations when they teach Combined Science which combines all the three disciplines.

What then are the mitigations required for the Zimbabwean science teachers to be effective Combined Science teachers? Barak (2014) sees teacher training institutions as critical partners to enhance the transformation required in the education system by them introducing the required skills and teaching methods to teacher trainees. The current researcher views good coordination between the Ministry of Primary and Secondary Education and the Ministry of Higher and Tertiary Education as critical for teacher training programmes to align to the intended educational philosophy of the competence-based curriculum. Teacher in-service training programmes should also be carried out to facilitate the effective implementation of the competence-based curriculum. This would lead to well-informed and capacitated teachers who would be better positioned to change the instructional designs to align them to the new philosophy. The teachers need to be roped in instead of just imposing the philosophical innovations. Teamwork among teachers may go a long way in alleviating the challenges of teacher specialisation. A team of teachers may assist each other by arranging that teachers teach content which is in their area of specialisation. Teacher workshops and seminars may be held so that teachers are staff-developed on social constructivist pedagogies and assessments that enhance citizenship education. The staff-development would most likely empower the teachers to deliver on the citizenship education agenda effectively. Staff-development would also most likely lead to changes in attitudes and perceptions for the teachers. The current researcher views the development of a framework for integrating citizenship education to the pedagogy and assessment of science practical work as an opportunity for science teachers to be guided towards delivering of a useful science education which enables learners to apply science concepts in real-life.

3.3 Social constructivist pedagogies

Corrigan et al (2013) view pedagogy as the interconnectivity between instruction and learning that results in authentic knowledge construction. Black (2014) notes that pedagogy is a broad term that encompasses all processes employed during the teaching and learning process and defines instruction is a domain of pedagogy. Corrigan et al (2013) view pedagogy as inclusive of assessments used during instruction. Leighton (2013) questions the availability of suitable pedagogies and assessments that would enhance the acquisition of high order cognitive skills, and hence address the issue of low levels of scientific literacy. The current researcher defines pedagogy as the theories and practices that are involved during the teaching and learning process but without incorporating assessment.

Toraman and Demir (2016) carried out a meta-analysis research on the impact of constructivist pedagogies on learner attitudes to the learning process and they concluded that constructivist instructional designs result in desirable attitudes compared to traditional teaching and learning methods. Positive learner attitudes and motivation are crucial to set the educational targets and achievement standards. The current researcher agrees with Toraman and Demir (2016) who argue that the education agenda is that of producing learners who can apply the knowledge acquired during the teaching and learning process. Science education should aim to produce citizens who apply the scientific knowledge to improve or enrich their lives. The science knowledge should make this world a better place for all. For example, science knowledge should be used to find solutions to environmental challenges, socio-scientific challenges, health challenges and diet challenges.

Educational researchers propose that pedagogy and assessment "should be reformed" to enhance the acquisition of high cognitive skills (Barak, 2017, p. 286). It is also important to note that global trends have moved away from mastery of theory only to the ability to demonstrate the acquisition of skills (Barak, 2017). The current researcher views well planned social constructivist pedagogies as the tool to be used for fostering the 21st century competencies, therefore she advocates for the use of pedagogies which are informed by social constructivism to design learner-centred teaching and learning activities. She took this position after realising that the experiences of the learners and their knowledge construction processes are vital for effective learning.

There is a general consensus among science educators and researchers that inquiry-based instructional approaches lead to authentic science learning. Inquiry-based approaches are constructivist in nature and are learner-centred (Bächtold, 2013; Crawford, 2012). Cheng (2013) agrees with many science educators and researchers by putting across the argument that science pedagogy has to be learner-centred and employing instructional methods that promote practical work and problem-solving skills which are vital for scientific literacy. Yore (2012) also argues that inquiry-based pedagogies are most suitable for the acquisition of knowledge that can be applied in life. Thus, inquiry-based pedagogies have found favour with many educators. In the current researcher's view, they lead to meaningful learning since they are informed by social constructivism. This allows the learner to use personal experiences to construct his/her own meaning. The learner also constructs meaning from his/her own experiences by interacting with the teacher and peers. This position is also supported by Barak (2017, p. 295) who argues that the active engagement of learners by "investigating, experiencing, and discovering" lead to acquisition of authentic knowledge.

Educational success can be increased by well-planned lessons which in turn lead to learner motivation, interest and positive attitudes (Anderson, 2015; Toraman & Demir, 2016). Mnguni (2019) questions whether the teacher is well equipped and positioned to act as a facilitator and not a source of knowledge. Mnguni (2019) also critically questions whether the teacher could be an effective agent of curriculum reform. Demirhan İşcan and Keleşoğlu (2017) describe a constructivist teacher as one who does not have monopoly over knowledge but directs learners towards a variety of sources so that they can construct their own meaning. Social constructivist teachers encourage learners to be independent, creative and encourage learners to actively engage in discussions with the teacher as well as among themselves. The constructivist teacher also provides prompt feedback to learners (Demirhan İşcan & Keleşoğlu, 2017). When the teacher has to guide the learner towards the acquisition of a new scientific concept, he/she should consider the learner's prior conceptions and should guide the transformation or accommodation process (Bächtold, 2013; Demirhan İşcan & Keleşoğlu, 2017). The teacher guides the learning process by providing resources, the correct learning environment and correcting misconceptions. When social interactions are used in education, the learners are supposed to provide feedback to their fellow learners in a way that is friendly and encouraging (Barak, 2017). This is an important role for the teacher. A good learning environment should accommodate all learners in a manner that gives them confidence and allows them to freely participate during lessons. The teacher should therefore facilitate a culture of tolerance, respect and collaboration among the learners.

Beerenwinkel and von Arx (2017) carried out a research on teaching methods used in Physics classes in Finland, Switzerland and Germany and they concluded that granting learner autonomy during the teaching and learning process increased learner motivation. A constructivist teacher should accommodate learners' interest and guide them appropriately, as they set their educational targets and achievement standards.

3.3.1 Inquiry-based learning

Many curriculum developers, educational philosophers, educational researchers and teachers acknowledge the centrality of social constructivism in enhancing authentic learning. They believe in inquiry-based and problem-solving learning approaches, a perspective also supported by the current researcher. Inquiry-based learning can be traced back to the educational philosophy of John Dewey whose argument was that inquiry led to better concept mastery (Krajcik & Blumenfeld, 2006). Quinton (2010) concurs with Krajcik and Blumenfeld by positing that Dewey was the one who proposed the theory of inquiry-based learning. Inquiry-based pedagogies include practical work, project-based learning (PBL), argumentation, discussion and collaborative learning. However, the current researcher does not treat collaborative learning as pedagogy since she argues that it is infused in all the other pedagogies.

3.3.2 Practical Work

Collins (2011) defines science practical work as a broad term that meant all activities that could be actively carried out by learners. Toplis (2012) concurs with Collins (2011) by defining practical work as activities carried out by learners through their active engagement. In the current research, practical work refers to any procedure that is carried out by learners which enables them to construct knowledge including laboratory experiments, field tours and learner demonstrations.

Abrahams, Reiss and Sharpe (2013) argue that practical work in science enhances the development of practical skills which are crucial for the study of science at university and for training in science related careers. Collins (2011) has no doubt that learners value practical work since it leads to effective science learning while Williams (2011) cites the ability of practical work to arouse interest in learners, to promote learning for learners who are visualisers and enhance learning in learners who learn better by doing as some of the advantages of practical work in science. Students effectively learn from experiences and active engagements. They remember things they have seen and handled better compared to things they are informed. Wei, Chen and Chen (2019) see practical work as essential for learners to master the subject matter. Therefore, science education should promote practical experiences since they are better positioned to result in meaningful learning.

Cowie (2015) states that practical activities carried out by learners are highly esteemed and rewarding in science education. Meanwhile, Millar (2009) points out that many science educators view practical work carried out by learners as vital for knowledge construction and Williams (2011) sees practical work as crucial to promote good science education and edges science teachers to incorporate it in their pedagogies. In support of this position, Barak (2017) advocates for science practical work which foster knowledge construction. While Barak (2017) focuses on practical work which helps in the acquisition of new knowledge, the current researcher views it as also vital for learners to consolidate on knowledge already acquired from social experiences. Practical work is effective to aid learners in knowledge construction especially if teachers promptly give learners feedback on any errors encountered in the carrying out of the practical work (Healy, 2013). Social constructivist pedagogies lead to authentic learning as learners are actively involved in the learning process by relating to their daily experiences. Good science education should lead to long lasting and active science knowledge. Active science knowledge is that which is applied to enhance the lives of citizens and resolve community challenges. Practical work should be a pedagogical approach which is used in every science class to assist learners to attain science knowledge which they can apply to improve their lives and their communities.

Even though practical work in science is at the core of science pedagogies, Collins (2011) and Furiwai and Singh-Pillay (2020), observe that science researchers and educators still have to tackle challenges associated with teacher skills in practical work, instructional deficiencies linked to specialisation, resource availability, and also challenges associated with assessment. Millar (2013) argues that the inquiry-based science teaching has been largely unsuccessful because it failed to enhance the intended competencies as practical work was carried out just as a routine. Krajcik and Blumenfeld (2006, p. 319) discredit practical work done by the majority of science teachers which specifies the procedure to be applied, the "cookbook procedures" since these do not lead to meaningful learning or development of the critical-thinking skills. Millar (2009, p. 10) concurs with Krajcik and Blumenfeld (2006) by also criticising science practical work for its "cookbook or recipe following" instructions which made it ineffective as a tool that was meant to assist learners to develop scientific concepts and knowledge. The same sentiments are shared by Cowie (2015, p. 69) who argues that practical work in science should move away from "teacher-prescribed confirmatory experiments." The science teacher should generate and maintain active learner participation which both motivates the learners and results in cognitive engagement that is necessary for knowledge construction (Dawes, 2015). When using practical work, teachers should balance the physical participation and the cognitive engagement of learners (Bennett, 2015). Millar (2009) proposes the use of The Practical Activity Analysis Inventory (PAAI), a checklist to keep teachers focused on what the practical activity should achieve. Towndrow, Tan, Yung and Cohen (2010) agree with Millar (2009) when they state that the teacher should record the skills that should be mastered by the learners during any practical work that is carried out. The purpose of an inventory like the PAAI is to enable a teacher to align practical work to the aims and objectives of the syllabus.

The scholars cited above criticise the pedagogies employed in the teaching of science practical work which do not lead to application of science knowledge in real-life situations. The current researcher, by developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work, would make a contribution towards science practical work that could be relevant, applicable and useful to learners. The teachers would also be empowered to teach science practical work using pedagogies and assessments which lead to applicable life-long learning.

3.3.3 Discussion, argumentation and debate

The current researcher presents discussion, argumentation and debate under one heading as these feed into each other and she views them as deeply interrelated. There is a lot of learner social engagement and collaboration in all of them. Jiménez-Aleixandre and Erduran (2015) define scientific argumentation as a process of supporting or rejecting arguments or theories basing on empirical scientific facts or evidence. The learners apply reasoning that is related to both the subject matter and the method used. The learner who is engaged in argumentation develops critical-thinking skills, analysis skills, problem-solving skills and collaboration skills. Dawes (2015) believes that new knowledge is constructed through collaboration and academic engagement and the science related discussions produce learners who are unbiased, cooperative and tolerant. Argumentation gives learners the opportunity to partake in problem-solving deliberations which are high order cognitive skills (Jiménez-Aleixandre & Erduran, 2015).

Science education programmes should make use of discussions, scholarly debate or argumentation since these aid learners to master the scientific language which is needed for effective scientific communications (Dawes, 2015). Science education aims to improve levels of scientific literacy and application of scientific skills through inquiry-based knowledge construction (Anderson, 2015). When the learner is actively involved in the learning process, the active part is the mind and not necessarily the physical involvement (Bächtold, 2013). This argument helps to dispel misconceptions that hinge on believing that physical activity is a must for an inquiry-based pedagogy. The cognitive activity is the central concept in inquiry-based learning. Scientific argumentation, discussions, debates and evaluations enhance knowledge construction, scientific reasoning, collaboration and scientific communication skills. Collaborative learning develops learners' social skills like tolerance, patience, sharing, respect, courtesy and these skills are important for good citizenship.

3.3.4 Project-based learning (PBL)

Project-based learning is a pedagogy which is based on constructivism where learning takes place as learners are actively involved in problem-solving which is related to real-life (Krajcik & Blumenfeld, 2006). Mayes and Shader (2015) argue that PBL pedagogy results in learners acquiring knowledge that can be applied and hence meaningful learning. In a project-based teaching and learning environment, the teacher may use probing questions and learners can respond in unique ways depending on their needs, experiences, challenges or interests (Anderson, 2015). PBL emphasises on the learners resolving real-life challenges and developing gargets or artifacts that offer solutions to the challenges (Krajcik & Blumenfeld, 2006). In PBL, learners investigate problems faced in the community and propose solutions. For example, the corona virus pandemic led schools and universities in Zimbabwe to carry out practical work that was aligned to offer solutions to the COVID-19 challenges. Schools and universities produced sanitisers and face masks in a bid to resolve the shortages of these basic items within their communities. That is an example of useful science practical work that promotes the concept of citizenship education. The current researcher argues for science practical work or PBL that is aligned to the needs of the community.

Krajcik and Blumenfeld (2006) highlight five major characteristics of PBL. The pedagogy starts by the task or problem which could be presented as a question, followed by carrying out an inquiry. Collaboration and use of information technologies support the learning process. The learners produce artifacts that demonstrate meaningful learning. For example, the learner may be interested in community health and poses a question on the common diet for the community. The inquiry gathers data about the food consumed within the community. The inquiry employs collaboration between the learner and the community members and information technology systems may be used to record interviews. Graphs and notes may be used as artifacts for meaningful learning. The learner may then analyse the data and come up with recommendations. Suppose the learner concludes that the diet generally lacks vitamins and minerals, a recommendation may be that the members of the community plant fruit frees. This is a real-life problem that leads to situated learning and the information is used to improve the lives of community members. This is a practical example of a pedagogy which enhances citizenship education as the members would benefit from the learning process and the learner is most likely to have an orchard in his/her home.

Having discussed pedagogies aligned to social constructivism, it is also imperative that the current researcher explores assessments that are aligned to social constructivism as well. The next section presents a discussion on educational assessment.

3.4 Educational assessment

Educational assessments are tools that are used to obtain information pertaining to learners' academic progress, challenges, misconceptions, interests, beliefs and attitudes (Black, 2013). Walvoord and Anderson (2010) define assessment as a well-designed and planned way of collecting data concerning learning programmes and learners' progress. Most scholars define assessment in terms of the purpose it serves, that is, either as formative or summative. Millar (2013) defines formative assessment as the assessment that informs the learning process and summative assessment as the one that is used for grading purposes. Many educators and researchers concur that a formative assessment is one that is used to gather information which informs the teaching and learning process while a summative assessment is one that is used to assess the knowledge and skills acquired by learners at the end of a course (Abrahams, Reiss & Sharpe, 2013; Black, 2014; Dixson & Worrell, 2016; Long et al., 2011). Black (2014) stresses that the difference between a formative assessment and a summative assessment is based on the role of the assessment, that is, whether it is used to provide feedback for the teaching and learning process or it is used for certification purposes at the end of an educational programme.

An assessment is thus classified by the purpose it serves. Formative assessments, which are mostly diagnostic in nature, are used to inform the teaching and learning process as feedback gathered from them informs and gives direction to instruction. From an analysis of the formative assessment data, the teacher may modify instruction, or revise a topic with the class or move on to the next topic. Formative assessments thus aim to clarify the aims and objectives of the curriculum, evaluate the teaching and learning process and use the data collected to improve instruction. Summative assessments are judgmental in nature since they are used for certification which either opens or closes further educational and career opportunities for the learners.

Formative assessments are further classified into two categories, that is, assessment as learning and assessment for learning. Summative assessments are referred to as assessment of learning. Assessment as learning is the assessment that monitors the learning process and enables learners to be responsible for the learning process (Corrigan et al., 2013; Cowie, Moreland & Otrel-Cass, 2013). For example, the teacher may give learners a question as an assignment which they focus on as they research. While this would be a task, the learners use it to acquire knowledge.

Assessment for learning is embedded in pedagogy and is a tool teachers use to gather data about the learning process, including their instruction (Abrahams, Reiss & Sharpe, 2013; Corrigan et al., 2013; Murugiah, 2020). Assessment for learning enables the teacher to modify the teaching methods as he or she is informed by the frequent feedback that comes from the assessment(s). For instance, the teacher delivers a lesson through a discussion and checks for learners' understanding by using probing and prompting questions. The teacher realises that the learners have not mastered the concepts well. The teacher, basing on that assessment, changes the instruction from a discussion to practical work. This type of assessment is vital for authentic learning as it also allows the teacher to timeously assess the pedagogies used as well as addressing students' misconceptions.

Assessment of learning informs both the teacher and the learner of the knowledge acquired at the end of a topic or term or course. Summative examinations are an example of assessment of learning. Summative assessments are those assessments that are external and often formal high stakes (Gunstone, 2013; Long et al., 2011; Miller, Linn & Gronlund, 2009; Umami, 2018; World Bank, 2008). Summative assessments determine placement for learners in further educational or career opportunities and are also used to evaluate schools and teachers (Elmore, 2019; Long et al., 2011; McLawhon & Phillips, 2013; Millar, 2013; Miller, Linn & Gronlund, 2009). Educational researchers argue that summative assessments inform learning as many teachers refer to questions from past high stakes national examinations to focus the content and skills they prioritise and the pedagogies suitable (Corrigan et al., 2013; Millar, 2013; Murugiah, 2020). Content that is frequently assessed is bound to be emphasised in the teaching and learning process. The teachers and learners tend to analyse the high stakes summative assessments to identify content and concepts that are frequently assessed and hence concentrating on those (Corrigan et al., 2013).

The pertinent question here is whether assessments can be treated separately by highlighting these classifications. The current researcher concurs with Corrigan et al (2013) when they say that all educational assessments are closely related and should be integrated to enhance effective science learning. Black (2013) points out that teachers generally have poor knowledge on assessments and they also have confusion which emanates from defining assessments as either formative or summative and argues that the information obtained from any assessment can then be used as deemed fit by the teacher. In other words, the argument is that both formative and summative assessments should be embedded amongst themselves as well as in the pedagogy. Barak (2017) defines an embedded assessment as the integration of feedback from both formative and summative assessments in the teaching and learning process. Decristan, Klieme, Kunter, Hochweber, Büttner, Fauth, Hondrich, Rieser, Hertel and Hardy (2015) argue for the use of embedded formative assessments to keep the learners mentally engaged as this enables the acquisition of the 21st century competencies. Heng (2015) actually decries the separation between formative and summative assessments. Assessments used by teachers during instruction should be comparable to the summative national examinations. Such practice results in learners who are confident to tackle examinations and so would not be disoriented by them. Educators should strive at least to blur the bold line that separates formative and summative assessment for the betterment of learners' acquisition of meaningful learning.

Educational assessment has stirred debate among its proponents and its detractors for a long time. Long et al (2011) argue for assessment as they note that without it the teaching and learning process would lack direction and focus and teachers would have no information on learners' capabilities and challenges and also no information on the effective pedagogy to use. Black (2013) ascertains that assessment is an integral and vital process that keeps the teaching and learning process focused and laments that it is often side-lined in researches on pedagogy which has led to its marginalisation. Millar (2013) posits that the curriculum interpretation by teachers and learners is never uniform and assessments reduce these variations. Assessment is a critical issue for education in general and the science education agenda in particular (Corrigan et al., 2013). Yore (2012) also observes the critical role taken by assessment by proposing that assessment should be integrated to pedagogy as well as to objectives of the educational programme. In this way, assessment informs both the teacher and the learner on the teaching and learning process. The proponents of assessment value it for the role it plays in assisting educators to operate within the confinements of the curriculum, improvement of pedagogy, evaluating learners' educational attainment and learner certification.

Detractors of assessment in general and examinations in particular argue that tests lack content validity, de-motivate learners, limit creativity, narrow the curriculum, promote cheating, are expensive, time consuming and have no educational value (Adey & Serret, 2010; Bennett, 2018; Dolezalek, 2009; Harris, Smith & Harris, 2011; Kamenetz, 2015; Long et al., 2011). Millar (2013, p. 67) observes that assessment instruments like tests and external examinations are criticised in an "endemic" way as it is almost impossible to develop a perfect assessment. Similarly, Black (2014) contends that the development of a national assessment is cumbersome as setting valid test items is a difficult task. The examiners who set the test items should be very competent with the learning area, knowledgeable with respect to the content, aims and objectives of the learning area, should be creative, racially, socially and religiously sensitive and should also accommodate learners with special needs.

It is generally agreed that the content, skills and procedures assessed by the high stakes examinations are emphasised in the teaching and learning process and this leads to curriculum backwash (Black, 2014; Cobern et al., 2014; Corrigan et al., 2013; Dixson & Worrell, 2016; Kamenetz, 2015; Long et al., 2011; Millar, 2013). The item setters should strive to eliminate the backwash effect by setting items from the whole syllabus in such a way that it becomes difficult for teachers and learners to come up with an examination trend. The curriculum backwash effect is the greatest challenge that educators, educational assessors and educational researchers should seriously ponder on. It is undesirable for education to produce learners who are limited to passing examinations and have no role in the well-being of their families and society. The narrowing of the curriculum defeats the big educational agenda of producing learners who are scientifically competent and relevant global citizens.

In the current researcher's view, educational assessment is an indispensable component of any educational programme that should keep the teaching and learning process focused for the attainment of the intended curriculum. Assessments are used to fairly evaluate learners, to inform instruction and educational reforms on the course they take and also inform policy makers about the curriculum implementation process. However, it is the implementation of educational assessment which is generally problematic. It has been observed that in most cases the curriculum development or review process does not align the content and pedagogy to the assessment instruments. Assessment is treated as a separate entity. In fact, Black (2014) wonders why there is limited literature on educational assessment as compared to literature on pedagogy. Black's observation has been lamented recently by Fadzil and Saat (2019) who notice that there is still very little research that has been carried out to explore effective assessments that can be used to assess science practical skills. Millar (2013) also concurs with Black arguing that the critical purpose saved by assessment in focusing the curriculum is often neglected. Black (2013) argues that it is vital to develop a framework that clearly defines the pedagogy and the role of assessment. The current researcher concurs with Black and aims to produce a framework that clearly defines the roles of the teachers and learners in integrating citizenship education in the pedagogy and assessment of science practical work.

Hussain, Shah, Syeda, and Sarwar (2018) report that a research they carried out on the causes of anxiety during science practical skills examinations indicated that lack of practice was one of the major causes and suggested individual learner science practical work as a solution to the challenge. Hussain et al (2018) thus argue for the alignment of science practical work pedagogy and assessment. If learners would be carrying out the practical work individually during examinations, then the teaching and learning process should put that into consideration. Collins (2011) reports that learners who participated in a research found the revision exercises intensively carried out during the examination year unbeneficial as the learners did not understand them and the exercises did not lead to knowledge construction. Millar (2013, p. 65-66) decries that suitable assessments "for assessing specific aspects of science learning" have not been developed yet and so urges science educators and researchers to prioritise the development of assessments that improve science learning. Literature thus shows that there is a gap between curriculum, pedagogy and assessment that is detrimental to the attainment of the 21st century skills and the enhancement of citizenship education. The current research, by developing a framework which integrates citizenship education to the pedagogies and assessments of science practical work, has relevance to science education. Thus, the current research aimed to reduce the gap observed to exist between curriculum, pedagogy and assessment.

Summative assessments greatly define the teaching and learning processes within classrooms (Towndrow et al., 2010). It is an accepted position that high stakes assessments denote the curriculum that is implemented, hence side-lining the intended curriculum (Black, 2014; Cobern et al., 2014; Corrigan et al., 2013; Dixson & Worrell, 2016; Kamenetz, 2015; Millar, 2013; Yung, 2012). When the current researcher was a practicing science teacher, she realised that many teachers who produced good results were stating that they were good at 'spotting' the topics or content which would be covered in examinations. The question that the current researcher poses is whether spotting of content in an examination is good for science education. Spotting narrows the curriculum and many concepts that are part of the syllabus are side-lined during the teaching and learning process. Spotting reduces education to examination passing rather than knowledge acquisition. This becomes a typical case of the backwash effect of assessment. How then could this weakness of summative assessment be mitigated?

It is of paramount importance that assessment is aligned to the national curriculum so that the teaching and learning process promotes the intended curriculum. Assessment thus influences the content taught and the pedagogies employed. An effective teaching and learning process can be achieved by putting in place assessment processes that are aligned to the intended curriculum. National curriculum should clearly define the knowledge and competencies which are considered of value and assessments used should address these concepts and skills adequately. Heng (2015) observes that there is an alignment among curriculum, instruction and educational assessments in Chinese schools and this has gone a long way in improving learner understanding. Heng (2015, p. 7) appraises the alignment which he refers to as the "synergy of teaching, assessment, and curriculum making." It is important to observe that "assessment and examinations may cripple a curriculum, or they may drive and steer it" (World Bank, 2008, p. 58). Assessment that focuses on recalling of facts leads to "rote learning and memorisation of facts" and defeats what the curriculum aims to address and achieve (World Bank, 2008, p. 58). The success of any educational reform programme is to a large extent based on the nature of the examinations associated with it (World Bank, 2008). Assessment should therefore be used to improve the teaching and learning process by focusing both teachers and learners towards the intended content, competencies and pedagogies. It is also important that the teacher employs a wide range of assessments so that both the teacher and the learners get adequate feedback on the teaching and learning process (Demirhan İşcan, & Keleşoğlu, 2017).

Isaacs, Zara, Herbert, Coombs and Smith (2013) view the development of relevant assessment instruments as vital in aiding meaningful learning. Appropriate assessments have to be carried out before, during and after the teaching of any content if any meaningful learning is targeted. Fadzil and Saat (2019) argue that science practical skills assessment is hindered by lack of guidelines that could be used by teachers to score the science practical skills and posit that such guidelines are important for effective practical skills assessment. This is a position supported by Healy (2013) who highlights that the implementation of constructivist pedagogies should be accompanied with suitable assessments. This implies that assessment should monitor the processes of disequilibrium and accommodation which lead to authentic learning. The teacher should give realistic positive feedback regularly. The feedback should aim to address the knowledge gap from the learners' understanding. Positive feedback which is promptly given reinforces correct conceptual change and learners are more likely to welcome it (Healy, 2013). Black (2014, p. 498) proposes the use of "peer- and self-assessment" by learners. This has the potential of turning some summative assessments into formative uses.

Teachers have different backgrounds in terms of training and PCK. Science teachers also have different competencies with regard to the assessment of science practical work. The current research aimed to focus the teachers' science practical work pedagogies and assessments by proposing a framework which integrates citizenship education to science instruction. The teachers would therefore be empowered to teach science practical work in a way that makes it relevant to learners' real-life situations and challenges. Constructivist assessments of science practical work should be based on learner practical skills demonstrations.

A critical question raised now is about the ideal connection that should exist among the curriculum, pedagogy and assessment for the attainment of any intended educational programme. The next section explores the ideal relationship that should exist among the curriculum, pedagogy and educational assessment.

3.5 The curriculum, pedagogy and educational assessment: The ideal

The World Bank (2008) observes that in some Sub-Sahara African countries, there is a discrepancy between assessment documents and practice. The documents indicate that varied assessment practices are used to assess learners' academic progress and skills yet that is not done in the actual practice (World Bank, 2008). The assessments focus on only a section of the curriculum and this emanates from the implementation process as well as the impact of the high stakes examinations (World Bank, 2008). African education systems are dominated by rote learning and the acquisition of 21st century skills in learners can only be promoted when suitable assessments are developed (World Bank, 2008). The observation is not good for Education Ministries in Africa since they are not realising the 21st century goals. Successful educational reforms require the coming together of all stakeholders like policymakers, curriculum developers, funders and teachers to work hand-in-glove to reform pedagogies and assessments (Towndrow et al., 2010). The use of inquiry-based pedagogies which are informed by social constructivism as advocated for by the current researcher would be sensitive to classroom dynamics and diversity.

Corrigan et al (2013) pose a question pertaining to the links between science curriculum, science pedagogy and science assessment. Millar (2013, p. 60) observes that there is a general consensus among educators on the "interrelated triad of curriculum, pedagogy and assessment" but laments the lack of coordination that exists during the syllabus development as the three are generally not addressed simultaneous but one after the other. The interwoven relationship between curriculum, pedagogy and educational assessment requires that a review of the curriculum should also result in a review of the pedagogy and educational assessments. A discord among the three is undesirable since it fails the educational agenda. Thus, the development of a framework which integrates citizenship education in the pedagogy and assessment of science practical work could enhance the link between curriculum, pedagogy and assessment.

Meaningful learning is a product of contextualised learning since the learners would be exposed to real-life challenges (Anderson, 2015). Curriculum, pedagogy and educational assessment should be aligned with the aim of developing learners into scientifically literate citizens who would improve their societies (Cowie, 2015; McLawhon & Phillips, 2013). Science education should produce citizens who use science knowledge and skills to improve their lives and their communities (Towndrow et al., 2010). The current research aimed to promote the teaching and learning of science practical work in a way which enhances science citizenship education through the development of a framework which links the pedagogy and assessment of science practical work to the science citizenship education agenda.

3.6. Conclusion

The current chapter explored literature on educational theories with the view for the current researcher to adopt the most suitable theory from an informed position. The chapter also reviewed pedagogies and assessments that are most suitable for the effective teaching and learning of science practical work. The current chapter reviewed critical literature which is based on the theoretical framework employed in the current research. Based on the above theoretical discourse, the current researcher argues that social constructivism is the ideal educational theory that can be used to inform the integration of citizenship education to science practical work pedagogy and assessment. The next chapter examines the research methods that would be most suitable to collect data and analyse it in order to address the research questions.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction

The previous chapter reviewed literature on the pedagogies and assessments that enhance the learning of practical work in science. The gist of the current chapter is to give a detailed account of the educational research approaches, namely quantitative, qualitative and mixed methods, so that the current researcher appreciates them and therefore justifies the method that was used in the current research. The research approach employed was informed by both the theoretical framework and the literature reviewed to ensure that the research adhered to science principles of knowledge generation. The research designs which were used for the current research, that is, the multiple-case study and the cross-sectional survey are then outlined. Sampling strategies and samples are stipulated. Validity, reliability, trustworthiness, credibility and ethics are also discussed.

4.2 Location of the study

The study was located in Zimbabwe, a developing African country. Given the need to enhance science education in the developing world, Zimbabwe was chosen in the current research as a case study, through which the integration of citizenship education in science practical work could be explored. This could have a significant impact on other developing countries both scientifically and economically. Zimbabwe has ten administrative provinces. These are Matabeleland South, Matabeleland North, Midlands, Mashonaland West, Mashonaland Central, Mashonaland East, Manicaland, Masvingo, Harare and Bulawayo. The Midlands province is in the middle and more central position of Zimbabwe. The four research cases were secondary schools in four districts in the Midlands province namely Kwekwe, Gweru, Chirumanzu and Shurugwi districts. The cross-sectional survey sample was comprised of Combined Science teachers from all the ten administrative provinces of Zimbabwe. The Combined Science teachers who were sampled were also Combined Science examiners with the Zimbabwe School Examinations Council (ZIMSEC) in 2019.

4.3 Educational research methods

The current section addressed the three research approaches, namely qualitative, quantitative and mixed methods, to provide background to the research approach, and research designs employed in the current research. To do this, the current researcher first reflected on the research methods that inform these approaches. The reflection on all research methods was important to demonstrate how the current research was located in the broader research methodologies. Newby (2014) identifies praxis, policy and intellectual enquiry as the major drivers of educational research. Educational research aims to improve, test, shape, judge policy, as well as to change or improve practice. It is therefore important that the current researcher appreciates all the methods that can be applied to enable a good choice of research designs which would then yield rich data. Education is a "contested area" and parents, learners, politicians, policy makers, educators, educational assessors and educational researchers are all stakeholders (Newby, 2014, p. 25). Any educational research undertaken should therefore be properly constituted so that all the stakeholders are satisfied with the rigour and transparency of all the processes for the research findings to be accepted. Research in science education can employ any designs from quantitative research, qualitative research or mixed methods research depending on the focus of the research question(s).

Quantitative, qualitative and mixed methods research approaches are differentiated on the basis of their paradigms. A research paradigm is informed by four principles, that is, epistemology, ontology, methodology and axiology (Kivunja & Kuyini, 2017; Poni, 2014). Newby (2014) defines a paradigm as a philosophical position that agrees to principles or values that govern the purposes and procedures operational in a particular discipline and constitute a way of viewing reality. Kivunja and Kuyini (2017), on the other hand, describe a paradigm as the philosophy which guides the research methodology, research methods and the process of data gathering, analysis and discussion. A paradigm thus gives the philosophy of the research as defined by the epistemology, ontology, methodology and axiology.

Epistemology is a concept which defines the innate characteristics of knowledge (Kivunja & Kuyini, 2017). Willig (2013) defines epistemology as a branch of philosophy which deals with the theory of the acquisition of knowledge, and this position is supported by Hesse-Biber (2010) who also defines epistemology as the philosophy that governs how knowledge is acquired. This implies that in research, epistemology refers to the position of defining whether knowledge is acquired or is experientially produced or is socially constructed. Meanwhile, ontology is the philosophy about the nature of reality (Hesse-Biber, 2010; Kivunja & Kuyini, 2017; Taylor & Medina, 2013; Willig, 2013). Therefore, ontology helps the researcher to make sense of the data gathered and hence be able to interpret it. Methodology is the research framework that includes the research approaches, methods, research designs, procedures as well as the data collecting instruments and data analysis processes (Kivunja & Kuyini, 2017). Axiology is concerned with the research ethics that should be addressed before and during the research process so that the research does not harm the participants (Kivunja & Kuyini, 2017). In light of the above discourse, the current researcher acknowledges the need to adopt a research paradigm which informs her ontology, epistemology, methodology and axiology. This is addressed in detail in section 4.3.3 of the current Chapter, where the preferred research approach is also discussed.

4.3.1 Quantitative research

The research paradigm generally associated with quantitative research is positivism. Within the positivist paradigm, the epistemology is objective reasoning, the ontology is naive realism which is based on the use of senses to understand the material world, the methodology is experimental as variables are controlled and the axiology is beneficence or no harm to participants (Kivunja & Kuyini, 2017). Positivism is a position which views knowledge acquisition as objective, "impartial and unbiased" (Willig, 2013, p. 40). As Hesse-Biber (2010, p. 14) puts it, positivism believes that "an objective reality exists" and this has nothing to do with social experiences and context. This paradigm therefore views the researcher's background and dispositions as unimportant to the research findings and his/her influence on research findings as negligible. Positivism views a research as a scientific way of investigating a phenomenon in which there is deductive reasoning, hypothesis formulation and testing; experiments are carried out, observations are recorded and the data statistically analysed (Buckley, 2018; Gay, Mills & Airasian, 2012; Hesse-Biber, 2010; Kivunja & Kuyini, 2017; Newby, 2014; Poni, 2014; Taylor & Medina, 2013; Tracy, 2013). Creswell (2014, p. 6) concurs with these scholars as he sees positivism (also referred to as post-positivism) as the paradigm employed in quantitative research and depends on "empirical observation and measurement" to verify theory.

Experimental research designs, quasi-experimental designs and non-experimental designs such as surveys are identified as quantitative designs (Creswell, 2014; Taylor & Medina, 2013). Random sampling is employed in quantitative research to enable the samples to be statistically representative for the generalisation of results (Gay, Mills & Airasian, 2012; Yin, 2011). Onwuegbuzie and Collin (2007) identify five random sampling techniques as simple, stratified, cluster, systematic and multi-stage random sampling. The positivist paradigm is checked for validity, reliability and objectivity which are enhanced through triangulation (Kivunja & Kuyini, 2017; Taylor & Medina, 2013). Quantitative research designs are generally favoured for their ability to use representative samples and hence research findings which can be generalised. Thus, the current researcher employed a cross-sectional survey to complement the multiple-case study used. A detailed explanation and justification of the choice of the research approach and the research design is discussed under sections 4.4.1 to 4.4.3 of the current chapter.

4.3.2 Qualitative research

Qualitative research methods are based on the interpretative or constructivist paradigm where knowledge is believed to be socially constructed in the process of theory generation (Adom, Yeboah & Ankrah, 2016; Creswell, 2014; Hesse-Biber, 2010; Newby, 2014; Simons, 2014; Starman, 2013; Thanh & Thanh, 2015; Taylor & Medina, 2013; Tracy, 2013). The interpretivist/constructivist paradigm views its epistemology as subjective as the researcher socially constructs meaning from the data, its ontology as relativist due to existence of many realities, its methodology as naturalist since observations are done in the participants' natural settings and its axiology as balanced as ethical issues are addressed (Kivunja & Kuyini, 2017).

The paradigm is based on the principle that "reality is socially constructed" and that knowledge acquisition is based on "subjective meaning" (Hesse-Biber, 2010, p. 63). The subjective meaning eventually leads to an inductive theory generation (Creswell, 2014; Gay, Mills & Airasian, 2012; Thanh & Thanh, 2015). The researcher's background impacts on the data capturing methods used and the interpretation of the research findings (Adom, Yeboah & Ankrah, 2016; Hesse-Biber, 2010; Willig, 2013). This implies that the researcher's and participants' experiences and social context have a bearing on the research design used, the process of knowledge construction and hence on the research findings and conclusions. It is paramount, therefore, that the researcher declares his/her areas of interest that are likely to impact on the research process and proposes how he/she intends to minimise his/her subjectivity. The declaration helps to give credibility to the research process and hence, to the research findings and conclusions.

Purposive sampling is employed in many qualitative researches as it is vital to select samples that will be data-rich with respect to the phenomenon under study (Gay, Mills & Airasian, 2012; Shaban, Considine, Fry & Curtis, 2017; Njie & Asimiran, 2014; Yin, 2011). Tracy (2013, p. 134) qualifies a good qualitative researcher as one who uses "purposive sampling" so as to collect data that best answers the research question(s).

It is generally recommended that a researcher should spend extensive time collecting qualitative data so that he/she has more time to observe the participants in their natural environment as limited time may result in unrealistic and unauthentic data (Adom, Yeboah & Ankrah, 2016). The data are analysed and sorted repeatedly to enhance an understanding of the phenomenon under study (Castleberry & Nolen, 2018; Neuman, 2014; Simons, 2014). Researcher reflexivity should enable the researcher to record and analyse data in an unbiased way. Qualitative data analysis begins on the onset of data collection and is continuous through the research period so the process of data collection and analysis is concurrent (Belotto, 2018; Castleberry & Nolen, 2018; Chenail, 2012; Saldaña, 2011; Shaban et al., 2017). Qualitative data analysis aims to illuminate, in context, the "patterns, trends, and relationships" of a phenomenon under study (Albers, 2017, p. 215). The intensity of the coding process depends on the research aims, the research question(s) and the richness of the collected data (Neuman, 2014).

Creswell (2014) identifies narrative research, phenomenology, grounded theory, ethnographies and case studies as the qualitative research designs. Qualitative designs are mainly checked for trustworthiness, credibility, dependability, transferability and fairness (Taylor & Medina, 2013). The current researcher employed the multiple-case study research design so that she could understand the phenomenon under study from the position of the participants within their contexts.

4.3.3 Mixed methods research

Mixed methods research combine quantitative and qualitative research methods to gather both types of data or convert quantitative data to qualitative data at the data gathering stage or vice versa. Mixed methods research may 'mix' the quantitative and qualitative data gathering procedures or the data analysis. The concept of mixed methods research was born on the realisation that neither quantitative research methods nor qualitative research methods could collect data as effectively as when they are combined or mixed (Almpanis, 2016; Creswell, 2012; Hollstein, 2014; Saldaña, 2011; Turpin, Asano & Finlayson, 2017).

When quantitative and qualitative research methods are mixed in the same research, which is a form of triangulation, it gives credibility, reliability and validity to the research findings (Buckley, 2018; Mirhosseini, 2018). Poni (2014) emphasises that research questions are well and exhaustively answered when a mixed methods research approach is used instead of a single one since diverse data are gathered. Mixed methods research combines data saturation from the qualitative approach and representative sampling from the quantitative approach (Buckley, 2018).

Mixed methods research designs are classified according to the order of the quantitative and qualitative data collection processes in relation to time as well as the participants (Creswell, 2012; Creswell, 2014; Hollstein, 2014; Gay, Mills & Airasian, 2012; Onwuegbuzie & Collin, 2007). When data are collected independently and approximately at the same time, then the research design is concurrent or convergent. When qualitative data and quantitative data are collected at different times, with one set being used to inform the next stage in the research, then the design is sequential. When the participants in the qualitative and quantitative designs are different but both samples are drawn from the population of interest, the design is parallel (Onwuegbuzie & Collin, 2007).

Hollstein (2014) identifies five mixed methods research designs as parallel designs, sequential designs (exploratory, explanatory), embedded designs, fully integrated designs and conversion designs. Sequential designs make use of the quantitative and qualitative research methods in a sequential manner. Depending on the method that is undertaken first, sequential designs may be further classified as exploratory or explanatory (Hollstein, 2014). A sequential exploratory design begins with the qualitative data capturing process, followed by a quantitative data capturing process and the converse is true for a sequential explanatory design (Creswell, 2014; Hollstein, 2012).

In a quantitative-qualitative equal weighting (QUAN-QUAL) concurrent triangulation research design, which Creswell (2014) also refers to as the convergent or parallel research design, quantitative and qualitative data are collected at the same time, independently analysed and then compared (Creswell, 2009; Creswell, 2012; Creswell, 2014; Gray, 2014; Hollstein, 2014; Punch & Oancea, 2014). Inferences are made after separate data analysis has been completed. Hollstein, (2014) argues that parallel designs are employed to answer confirmatory research questions as well as exploratory research questions. The parallel designs are also effective in data triangulation (Creswell, 2012; Hollstein, 2014). The QUAN–QUAL model, which is also referred to as the triangulation mixed methods design, is a good example of a parallel/concurrent design (Creswell 2012, Creswell, 2014; Hesse-Biber, 2010; Gay, Mills & Airasian, 2012). A concurrent design is suitable if mixed methods are complementary and are used to triangulate data to give validity to the research findings (Creswell, 2012; Onwuegbuzie & Collin, 2007, Wald, 2014). Methods triangulation, which increases the credibility of the research data, refers to the deployment of two or more methods to collect data to answer the same research question (Hesse-Biber, 2010).

Mixed methods are underpinned by the pragmatism paradigm (Creswell, 2012; Creswell, 2014; Mirhosseini, 2018; Turpin, Asano & Finlayson, 2015). Within pragmatism, a research should employ any practical procedures which address the research question(s) rather than sticking to an ideological position (Creswell, 2012; Creswell, 2014; Kivunja & Kuyini, 2017; Newby, 2014). Pragmatism stipulates that research methods should be based on the problem to be addressed and the research questions to be addressed. Pragmatism thus empowers the researcher to use any research designs, procedures and data analysis processes which assist to address the research agenda without dichotomising anything. This leads to more thorough research procedures and hence to more valid research findings.

The pragmatic paradigm views its epistemology as relational since the researcher is free to make any suitable decisions, the ontology as non-singular reality as interpretations vary according to individuals, the methodology as mixed methods since both quantitative and qualitative research approaches are used in a single research and the axiology as value-laden since it benefits the participants and the community (Kivunja & Kuyini, 2017).

Onwuegbuzie and Collin (2007) argue that any sampling procedure can be employed in mixed methods research. Onwuegbuzie and Collin (2007) highlight that a valid mixed methods research has to continue to adapt samples and data capturing processes to effectively answer the research question(s). This implies that researchers should not be bogged down by the classifications but rather be guided by the research goal and choose any sampling procedure that leads to in-depth and rich data collection.

Challenges of mixed methods research include the extensive specialisation of the researcher who should be competent in both qualitative and quantitative research designs, and also the fact that it is more expensive and the researcher needs more time to collect and analyse data (Caruth, 2013; Creswell, 2012; Gay, Mills & Airasian, 2012). The mixed methods research designs adopted in the current research are strenuous when carried out by a single researcher since specialisation in both qualitative and quantitative research designs it required. The concurrent data collection and analysis also gives a lot of pressure to the researcher since it is also intensive. However, the current researcher still preferred the mixed methods research approach because of the advantages of triangulation of both the methods and data sources which increased the potential of collecting rich data. In the next sub-sections, a detailed justification for the preferred research approach is discussed.

4.4 Justification for using mixed methods, cross-sectional survey and multiple-case study

The current researcher adopted a mixed methods research approach for reasons discussed in the current section. Mixed methods research approached employed is underpinned by the pragmatism (Mirhosseini, 2018).This entailed combining a cross-sectional survey (quantitative research) and a multiple-case study (qualitative research), making the current research a mixed methods research. It is important that a justification of the choice of methods be given as it contributes to the credibility of the research.

4.4.1 Justification for employing mixed methods in the current research

The main research question of the current research explored how a framework for integrating citizenship education in the pedagogy and assessment of science practical work could be developed, using Combined Science in Zimbabwe as a case study. The research also explored the extent to which citizenship education was integrated in the pedagogy and assessment of Combined Science practical work. The current research also questioned how citizenship education could be integrated in the pedagogy and assessment of science practical work. The research sub-questions could be best answered when data was collected through class observations, document analysis, interviews and focus group discussions with Combined Science teachers which justified the use of the multiple-case study. The interviews and focus group discussions, however, were possible with a small sample of the Combined Science teachers within the four sampled schools. The challenge of a small sample was addressed through the use of a cross-sectional survey where a questionnaire addressing the same research questions was administered to a larger sample.

The use of quantitative and qualitative research designs in the same research improved the rigour of the research since the strengths of the designs complemented each other (Albers, 2017; Johnson & Christensen, 2017; Poni, 2014). The strengths of both quantitative and qualitative research approaches were most likely combined in the current research and their weaknesses could be neutralised and the research findings could thus be validated (Caruth, 2013; Creswell, 2014; Gay, Mills & Airasian, 2012; Hesse-Biber, 2010; Hollstein, 2014; Saldaña, 2011; Wald, 2014).

The use of the mixed methods research approach was viable and desirable given the fact that a number of other researchers successfully adopted the same approach in their researches. It was therefore necessary to ensure that the current research is founded on existing science in order to ensure its relevance and credibility. For example, Galliot and Graham (2016) described how they effectively carried out a sequential mixed methods research to determine students' carrier choices. In their educational research, Galliot and Graham (2016) used a quantitative cross-sectional survey and qualitative focus group discussions with students and they reported that the mixed methods research approach was effective in data collection. As such, the current researcher also carrying out an educational research posits that the mixed methods research approach would also enable her to collect rich data. Murphy and Murphy (2016) used the QUAN- QUAL concurrent mixed methods design to study the benefits of culturally relevant instruction on Latino students' writing skills. They pointed out that the use of a mixed methods research approach is both feasible and data enriching. Almpanis (2016) used the quantitative survey/online questionnaire and the qualitative semi-structured interviews in a research which investigated the Heads of e-learning’s perspectives towards technology enhanced learning and reported that the use of a mixed methods research approach was effective in data collection and analysis due to its complimentary nature. These were examples of researches which were carried out in the field of education using mixed methods research approaches. The current research is also in the field of education. Thus, the mixed methods research approach would most likely contribute to effective knowledge creation as demonstrated by these prior researches.

Kozleski (2017) argues that qualitative research helps researchers to learn about the teaching and learning process in a classroom and relates it to other similar set-ups. The qualitative research results, therefore, aimed to give insights into the teaching and learning of science practical skills and citizenship education in the sampled schools. The multiple-case study research design’s main advantage was thus the fact that it led to an in-depth analysis of the case (Creswell, 2014; Pearson, Albon & Hubball, 2015). The cross-sectional survey research design employed in the current research enabled the quantitative data to be collected using a big sample which was representative and could enable the findings to be generalised to the population (Creswell, 2009). Thus, the research findings could be used to inform educators, curriculum designers and policy makers on the state of science citizenship education. The use of the mixed methods research approach resulted in the triangulation of both data collection methods and sources and thus the research findings were validated and more reliable.

Hesse-Biber (2010) laments the common dominance of quantitative research methods over qualitative research methods in mixed methods researches since it might undermine qualitative methods. In the current research, the QUAN-QUAL design used gave equal weighting to quantitative and qualitative data to get the full complementary advantage of the mixed methods research approach.

Although Simons (2014) argues that generalisation of data may be done from a single exemplar case or multiple exemplar cases, and Willig (2013) concurs by arguing that findings from a multiple-case study may be generalised, the current researcher understood that four cases were too few to authenticate generalisation, hence the need for the cross-sectional survey to complement the cases' findings. A cross-sectional survey was therefore a suitable research design to combine with the multiple-case study because of its ability to collect data on many aspects of the research from a representative sample. The current research thus combined the multiple-case study research design and the cross-sectional survey research design so that they complemented each other. The qualitative multiple-case study gave an in-depth study of the pedagogy and assessment of Combined Science practical work in relation to fostering citizenship education while the quantitative cross-sectional survey gathered data which was representative.

4.4.2 Justification for a cross-sectional survey

Creswell (2014, p. 13) describes survey research as a quantitative, non-experimental research design which gives "numeric description of trends, attitudes, or opinions of a population by studying a sample of that population." Abbott and McKinney (2013) concur with Creswell as they define a survey as a non-experimental design which uses a questionnaire or an interview guide to get information from respondents. As Neuman (2014, p. 317) posits, a survey is a source of quality research data which can be "accurate, reliable, and valid" provided the data collecting instrument has been constructed well and a representative sample has been used. The sample of 700 Combined Science teachers used in the current research's cross-sectional survey design was representative enough to allow for generalisation of the findings. Details of the sample, sampling method and sample description are discussed is section 4.8.1 of the current chapter.

Surveys may be longitudinal or cross-sectional depending on the frequency of data collection. When the data is collected on a single occasion, then it is a cross-sectional design and when data is collected on two or more occasions, then it is longitudinal. A cross-sectional survey was used in the quantitative research approach as the questionnaire was administered to the respondents at a single occasion (Gay, Mills & Airasian, 2012). The cross-sectional survey was implemented in the current research because it reduced the time required for data collection and enabled the current researcher to spend more time analysing the data. It was also a good way of increasing the return rate for the completed questionnaires. For example, in the current research, of the seven hundred (700) questionnaires distributed to the sample, six hundred and three were returned, which is an eighty-six percent (86%) return.

In a survey research, structured questionnaires or structured interview schedules are the main instruments used for data collection (Abbott & McKinney, 2013; Gay, Mills & Airasian, 2012). Information from survey research can only be useful and generalised if the questionnaire used is valid and reliable and the sample is representative of the population (Abbott & McKinney, 2013). In other words, the researcher should avoid making errors which might arise from sampling procedures, designing of the questionnaire and data analysis (Neuman, 2014). Designing a survey questionnaire is a challenging task as the items should not be biased since that impact negatively on validity and reliability (Abbott & McKinney, 2013). A valid and reliable questionnaire should not contain unexplained or unfamiliar abbreviations, slang, vague language, double-barreled questions, leading questions and ambiguous questions (Gay, Mills & Airasian, 2012; Neuman, 2014). These are areas of concern which the current researcher addressed when she compiled the questionnaire. Reliability, in this case, is the extent to which the questionnaire produces similar outcomes whenever it is reused. It is about reproducibility of similar results and consistency of the questionnaire. The validity of the questionnaire is the extent to which it measures what it is intended to measure (Abbott & McKinney, 2013).

A questionnaire should be pilot tested using a small sample which is similar to the sample (Gay, Mills & Airasian, 2012; Neuman, 2014). In this regard, the questionnaire was pilot tested by asking sixteen (16) Combined Science teachers who were Combined Science examiners with the Zimbabwe School Examinations Council (ZIMSEC) to respond to it before the actual data capturing process. Purposive sampling was done to select examiners who were in leadership positions. The sixteen Combined Science teachers also took part in the cross-sectional survey. Adjustments were then effected to items that were unclear or ambiguous. Piloting the questionnaire helped to improve on face validity and content validity.

When conducting the survey, the respondents should be given clear instructions on how to complete the questionnaire (Neuman, 2014). The questionnaire used in the survey had twenty seven (27) structured items. Advantages of close-ended items or structured items include the ability to collect rich accurate data from respondents who would most likely understand the questions or concepts raised better and also easier replication of the questionnaire (Neuman, 2014). The current researcher, however, notes that the use of close-ended items or structured items may result in lack of originality in responses, missing of desired choices and the fact that complex responses cannot be clearly outlined (Neuman, 2014). Since a multiple-case study research design was also conducted, it gave an in-depth understanding, hence compensating for the above stated shortcoming. The current researcher used a questionnaire which had structured items because the in-depth views from the participants were obtained from the interviews and focus group discussions employed in the multiple-case study.

4.4.3 Justification for a multiple-case study

Njie and Asimiran (2014, p. 37) define a case study as a "demarcation of a group, area or a situation" which is studied to obtain insights from it while it is in its natural settings. Similarly, Saldaña (2011) defines a case study as a research that focuses on a single phenomenon. Case study design is commonly used in research because it examines a research phenomenon in great depth. Shaban et al. (2017, p. 18) argue that case study is defined by the "case …, the context, and the issue." Shaban et al.'s definition clarifies the parameters of the case study in a more vivid way. The critical question to answer here pertains to what the case, the context and the issue meant in the current research. In the multiple-case study design employed, the case was the educational programme of teaching and learning Combined Science practical work, the context was represented by the sampled schools and the issue was whether the pedagogy and assessment of Combined Science practical work fostered citizenship education. The multiple-case study research design facilitated an in-depth analysis and insights to the science practical skills teaching and learning process using multiple data collecting procedures from multiple sites. It also explored the teaching and learning process in the real classroom environments.

Case studies have a long history of being applied to represent similar phenomena in educational research (Simons, 2014). Yin (2009) and Njie and Asimiran (2014) argue that a case study research design is suitable when a research aims to address a how and/or why question. The qualitative research approach enabled the collection of data while the participants were in their natural settings. In education, a case study aims to give an in-depth understanding of the quality of educational programmes or policies as they are implemented in unique contexts (Saldaña, 2011; Newby, 2014). Case studies are qualitative in nature due to their emphasis on personal and subjective knowledge acquisition (Newby, 2014; Simons, 2014). The multiple-case study research design used in the current research thus captured the experiences of the participants in their own words by using documents, interviews, focus group discussions and lesson observations.

A case may be purposively sampled if it's unique or may be conveniently sampled if it is convenient to the researcher (Saldaña, 2011). The schools sampled in the current research were instrumental sites since they were exemplars of common schools that offered Combined Science in Zimbabwe. A multiple-case study was used to obtain an in-depth perspective on the pedagogy and assessment of science practical work in relation to the concept of citizenship education. The current researcher acknowledges that each school had a unique context which led to unique characteristics even though they had many similarities with other schools.

In literature, the case study's criticism emanates from its use of a small sample and the subjectivity of both the researcher and the participants (Simons, 2014; Willig, 2013). The current researcher employed the multiple-case study research design to gather diverse data on the state of citizenship education in the pedagogy and assessment of Combined Science which gave an advantage over studying a single case. The multiple-case study research design was chosen so as to get an in-depth understanding of the Combined Science practical work pedagogy and assessment situation and its link to citizenship education (Creswell, 2014; Taylor & Medina, 2013; Willig, 2013; Woodside, 2010; Zhou & Creswell, 2012). The multiple-case study better positioned the current researcher to appreciate the schools' economic, political and social backgrounds that impacted on the pedagogies and assessments of science practical work. When using a multiple-case study or multi-site case study research design, it is important to bear in mind that each case is explored on its own to gather data, determine themes and results comparisons are then made (Simons, 2014). In light of this position, the current researcher studied each case separately and only compared the results in the discussion section (Chapter 6).

Subjective knowledge construction in qualitative research is a weakness that has to be addressed through rigour of research designs as well as the rigour in data capturing and sampling procedures (Saldaña, 2014). That was addressed through gathering quantitative data using a cross-sectional survey to give the current research the rigour. The current researcher also gathered data through document analysis, focus group discussions and lesson observations as they were a means of triangulating interview data as participant subjectivity tend to be high in interviews (Simons, 2014).

4.5 Strategies adopted to ensure validity and reliability in the current research

Newby (2014) describes reliability and validity as of paramount importance to a good research. Reliability and validity are terms that are often associated with quantitative research (Saldaña, 2014). Reliability and validity may be enhanced by the process of triangulation (Newby, 2014; Creswell, 2014). Johnson and Christensen (2017) define validity as correct and unbiased analysis and reporting that emanates from the research data collected while Wald (2014) defines validity as the extent to which data collecting instruments are able to gather data correctly.

Taherdoost (2016) classifies validity as face validity, content validity, construct validity and criterion validity. Creswell (2014) classifies validity as content validity, predictive or concurrent validity and construct validity. Taherdoost (2016) defines face validity as an analysis of a research instrument with regard to the clarity and quality of the items. Content validity examines whether the items are aligned to the intended content; criterion validity (which Creswell (2014) refers to as predictive or concurrent validity) examines whether items are aligned to the intended criterion and construct validity examines whether the results obtained from the items are relevant and useful (Creswell, 2014; Taherdoost, 2016).

Validity is generally affected by the method and/or procedures used in the research, the researcher's bias and/or the population to which the results are reported (Creswell, 2014; Newby, 2014). Validity of a research is achieved by using appropriate research procedures which result in comprehensive data capturing (Yin, 2011). Research validity is generally strengthened by data collection triangulation, methodological triangulation and data analysis triangulation (Yin, 2011;

Wald, 2014). On the other hand, reliability refers to the consistency of the research design. A research that is reliable would give the same results when it is repeated. As Creswell (2014, p. 177) puts it, reliability means that "scores from an instrument are stable and consistent." How then were issues of validity and reliability addressed in the current research?

The mixing of two research designs, that is, the cross-sectional survey and the multiple-case study to collect parallel data resulted in the current research having methodological triangulation, data source triangulation and data analysis triangulation which enhanced validity. The collection of parallel data from three schools within the qualitative multiple-case study research design was also a second data source triangulation. The gathering of qualitative data using interviews, focus group discussions and class observations also resulted in a third data source triangulation. The multiple data triangulation increased the validity of the current research. Figure 4.1 shows the levels of the methodological data triangulation and data source triangulation employed in the current research.

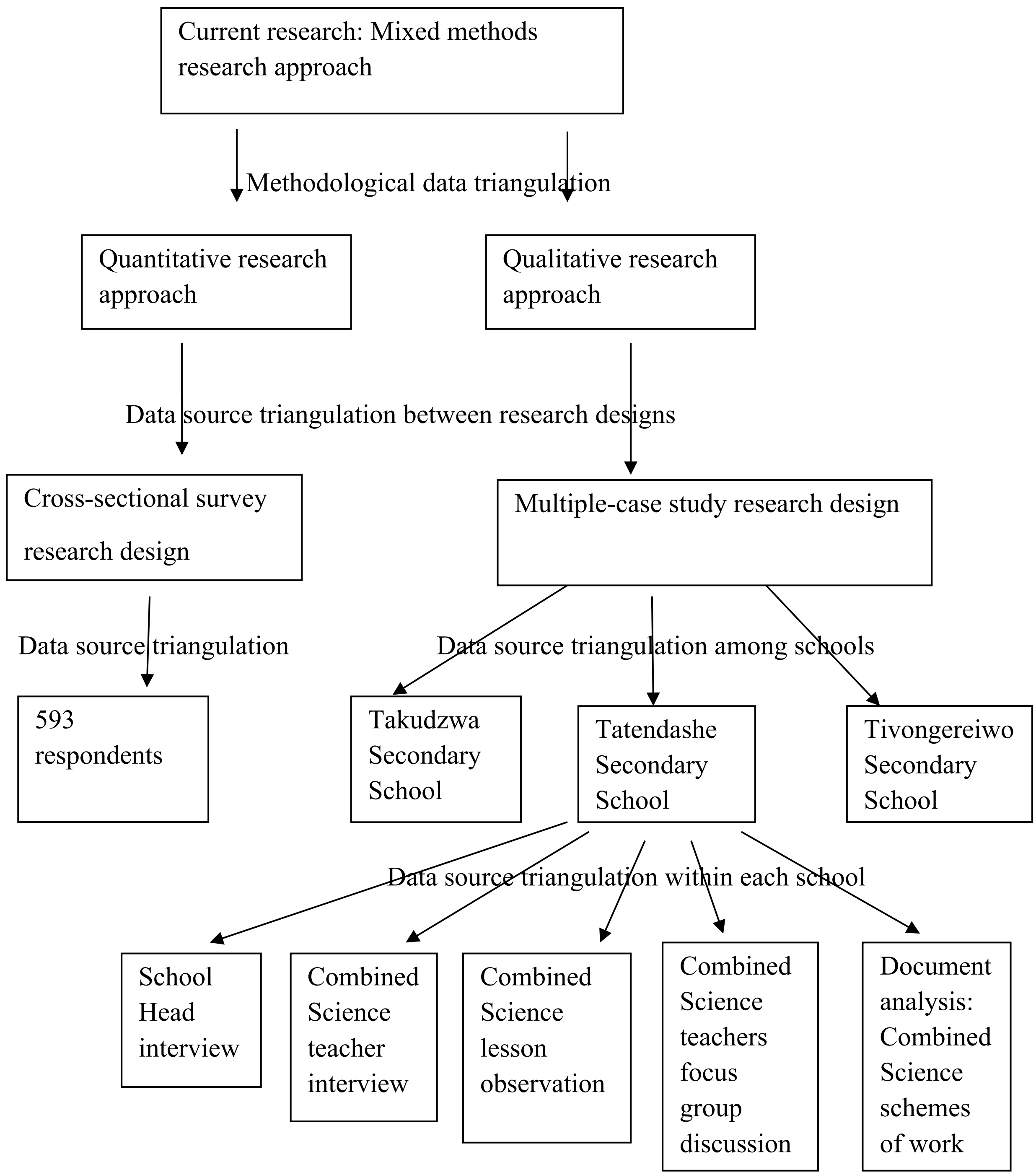

Figure 4.1 *A flow diagram of the methodological data triangulation and data source triangulation*

In the quantitative cross-sectional survey research design, content validity and face validity of the questionnaire (Appendix R) were enhanced through administering it to a pilot group of sixteen Combined Science teachers who were experts in the area of the research. The items were then modified according to their recommendations.

Internal consistency reliability of the items in the questionnaire was analysed using the Cronbach's alpha coefficient. The analysis was done using the SPSS software. The Cronbach's alpha coefficient is a measure of the interrelatedness of the items (Johnson & Christensen, 2017; Taherdoost, 2016). The general rule is that the acceptable reliability of Cronbach's alpha coefficient is 70% (i.e., $r \geq .7$) for research purposes (Johnson & Christensen, 2017; Taherdoost, 2016). The Cronbach's alpha coefficient for the current research was 82.5% ($r = .825$) when nineteen (19) items were analysed. The analysis excluded general items like the sex of the respondents and focused on the items that gathered data which answered the research questions. The r value was greater than .7 and that indicated that the items were reliable.

4.6 Credibility and trustworthiness in the current research

Credibility and trustworthiness are often associated with qualitative research (Saldaña, 2014). Data source and data type triangulation give trustworthiness and credibility to a research (Gaya, 2016; Shaban et al., 2017; Tracy, 2013). Woodside (2010, p. 117) defines credibility of a research as "representing multiple realities" emanating from the research methodology, data sources, researcher's data interpretation and getting feedback from participants on reports generated. Credibility, in qualitative research, is enhanced by thick description, integrity, transparency, honesty, reflexivity and good research ethics (Buckley, 2018; Saldaña, 2014; Tracy, 2013). Any researcher should strive to carry out a research which has trustworthiness and credibility (Yin, 2011). In the current research, trustworthiness and credibility were achieved through the current researcher's transparency and data source triangulation and data verification done by the participants. Research participants and Ministry of Primary and Secondary Education officials and the ZIMSEC Director had access to the research procedures, data collection instruments, findings and conclusions. That transparency reflected on the integrity, honesty and professionalism of the current researcher and these are good attributes of a good research process (Yin, 2011).

A good researcher should be methodical and use a research procedure which is rigorous, unbiased and could be replicated (Pearson, Albon & Hubball, 2015; Yin, 2011). The current researcher clearly outlined and articulated the current research procedures in a bid for them to be understood by other people who can then judge them. The current researcher presented justifications for the samples and sampling procedures (see section 4.8.1 of the current chapter). The research results were thoroughly reported as recommended by Newby (2014) who states that in a good research, the procedure and reporting of findings should be robust.

A researcher should also be transparent about the challenges faced during the data collecting stages and the method should be void of unexplained bias or planned distortions of events or findings (Newby, 2014). In the same vein, the current researcher stated that she failed to hold an interview with one School Head because he was not available when the researcher collected data at that school and also stated that she did not collect data from the fourth school that was in her sample as schools in Zimbabwe were closed prematurely due to the COVID-19 pandemic. That disturbed the data capturing programme for the fourth school. The current researcher thus declared the challenges faced during the data collecting stage.

Triangulation is also a way of according the research credibility and trustworthiness. Newby (2014) points out that the process of triangulation is critical since it validates research designs, research data and research results. The current research had methodological triangulation, data collection triangulation as well as data analysis triangulation as illustrated in Figure 4.1 under section 4.5 of the current chapter. In the current research, the data summaries transcribed from interviews and focus group discussions were presented to participants and they validated it. There was also thorough analysis of data and valid interpretations of the findings which Kozleski (2017) acknowledges as practical and possible when there is rigour in the process of collecting research data. The current researcher maintained professionalism and integrity during the data collection and interpretation stages. The researcher constantly reflected on her reflexivity to minimise possible distortions to the data. Raw data was kept safely, and it would be kept for five years after the research process. The researcher also addressed ethics issues as stipulated in section 4.7 of the current chapter.

4.7 Research ethics employed in the current research

The mixed methods research approach addressed ethical issues that are prevalent in both qualitative and qualitative research approaches. Ethical clearance has to be obtained from Institutional Review Boards (IRBs) located at research institutions before any research is undertaken (Abbott & McKinney, 2013; Creswell, 2014). In this regard, the current researcher also applied for an ethics approval certificate from the College of Education at the University of South Africa with the assistance of her supervisor. An ethics approval certificate was issued under reference number 2019/06/12/63506610/38/MC (see Appendix T). The current researcher also applied for permission to carry out the research at the selected schools from the Permanent Secretary in Zimbabwe's Ministry of Primary and Secondary Education and permission was granted (see Appendix U). The current researcher also applied for permission to carry out the research at the four secondary schools in the Midlands Province from the Provincial Education Director (Midlands Province) and permission was granted (see Appendix V). Permission was also sort from the School Heads (see Appendix B). The current researcher also applied for permission to carry out the current research's cross-sectional survey from the Zimbabwe School Examinations Council (ZIMSEC) Director and permission was granted (see Appendix W).

As the research had human participants, ethical considerations were of paramount importance so that the participants were protected from any potential damage that might arise due to the information they supplied during the research (Galliott & Graham, 2016). Willig (2013) points out that any researcher needs to uphold research ethics with regard to the protection of participants' confidential information and anonymity. Traianou (2014) notes that it is a requirement that any research should minimise harm to participants and any stakeholders, preserve people's autonomy and preserve their privacy. The current researcher thus used pseudonyms for the sampled schools, sampled classes and the participants so that they remained anonymous. The purpose of the research was explained to all the participants and all stakeholders. Further to that, the stakeholders and participants were given assurance on the issues of confidentiality and anonymity.

The current researcher also protected confidential personal information, communicated the aim of the research, was respectful, fair, just, trustworthy and addressed potential power dynamics during data collection as advocated for by many scholars (Abbott & McKinney, 2013; Creswell, 2012; Pearson, Albon & Hubball, 2015; Traianou, 2014; Tracy, 2013; Turpin, Asano & Finlayson, 2015; Willig, 2013). The participants were informed that they were free to withdraw from the study at any time without any consequences (Abbott & McKinney, 2013).

The current researcher collected data as an overt researcher. The main advantage was that she dealt with ethical issues in a more effective way and minimised possible suspicion which participants could have in relation to the researcher. The major disadvantage, however, was the possibility of the Hawthorne effect (Abbott & McKinney, 2013; Newby, 2014). Participants could have behaved in an artificial manner when they were aware that they were being observed.

Willig (2013) identifies two types of reflexivity, that is, personal/self and epistemological. Personal or self reflexivity involves the researcher's reflection on how his or her personal background, interests, values and experiences may impact on the research (Starman, 2013; Tracy, 2013; Willig, 2013). The current researcher consciously checked herself constantly to avoid bias during data capturing, analysis, interpretation and reporting. Epistemological reflexivity involves the researcher's research competencies which greatly influences the research design, procedures and data analysis (Starman, 2013; Tracy, 2013). The current researcher constantly checked for any possible improvements that could be done to the research methods employed, the research designs, the data collection procedures and the data analysis and interpretations made.

All the sources used in the current research were acknowledged to satisfy ethical requirements on dealing with intellectual property. A Turnitin report was obtained to guard against issues of plagiarism. The principle of honesty was observed and findings were not falsified in the reporting. Also, a deliberate effort to capture the verstehen, that is, to present the participant's meaning so that the research is credible, was made (Poni, 2014; Tracy, 2013).

4.8 Research designs used in the current research

The current research was conducted using the QUAN-QUAL concurrent parallel triangulation research design which falls under the mixed methods research approach. QUAN-QUAL means that the quantitative and qualitative data were given the same weighting. Concurrent means that data were collected at almost the same time. Parallel means that participants were different but drawn from the same population of interest. Triangulation means that the research also used different data collecting methods, data sources and data analysis methods. The data were collected separately, analysed separately and were only compared in the discussion section (Chapter 6).

The research designs which were mixed in the current research were the cross-sectional survey from quantitative research and multiple-case study from the qualitative research, with concurrent parallel data collection. The research was thus carried out using a multiple-case study design, which collected qualitative data as well as a cross-sectional survey research design, which collected quantitative data. Surveys and multiple-case studies, when used hand in hand, provided both representative samples and an in-depth understanding of the research phenomena (Hesse-Biber, 2010).

Table 4.1 summaries the processes that the current researcher used to collect data to answer each of the research sub-questions. The research approaches, sampling techniques, sources of data, data collection procedures and data analysis processes are outlined in relation to each of the research sub-questions.

Table 4.1

Summary of the research approach, sampling techniques, sources of data, data collection and data analysis that address the research sub-questions

Research sub-question	Research approach	Sampling techniques	Sources of data	data collection procedure	Data analysis and interpretation
1. To what extent is citizenship education integrated in the pedagogy of science practical work in Combined Science in Zimbabwe?	Multiple-case study (qualitative research method)	Purposive sampling of data-rich schools in the Midlands province	-Combined Science teachers -School Heads -Combined Science Teachers' schemes of work and practical skills assessments	-lesson observations -teacher and School Heads interviews -focus group discussions -audio/video recording during class observations, interviews, focus group discussions -document analysis	IPA system was used. Step 1: read and re-read data from a single case focusing on general comments Step 2: identified and labeled themes Step 3: related themes were put together to form clusters which were given relevant labels. Step 4: a summary table was produced from the themes
	Cross-sectional survey (quantitative research method)	Purposive, maximum variation of ZIMSEC Combined Science examiners	Combined Science teachers who were examiners with ZIMSEC	self-administered questionnaire	Data were analysed using the SPSS software to give tables and graphs of the data categories. The data were then interpreted
2. To what extent is citizenship education integrated in the assessment of science practical	Multiple-case study (qualitative research method)	Purposive sampling of data-rich schools in the Midlands province	-Combined Science teachers -School Heads -Combined Science	-lesson observations -teacher and School Heads interviews	IPA system was used. Step 1: read and re-read data from a single case focusing on general comments Step 2: identified and labeled themes

work in Combined Science in Zimbabwe?			Teachers' schemes of work and practical skills assessments	-focus group discussions -audio/video recording during class observations, interviews, focus group discussions -document analysis	Step 3: related themes were put together to form clusters which were given relevant labels. Step 4: a summary table was produced from the themes
	Cross-sectional survey (quantitative research method)	Purposive, maximum variation of ZIMSEC Combined Science examiners	Combined Science teachers who were examiners with ZIMSEC	self-administered questionnaire	Data were analysed using the SPSS software to give tables and graphs of the data categories. The data were then interpreted
3. How could citizenship education be integrated in the pedagogy of science practical work?	Multiple-case study (qualitative research method)	Purposive sampling of data-rich schools in the Midlands province	-Combined Science teachers -School Heads -Combined Science Teachers' schemes of work and practical skills assessments	-lesson observations -teacher and School Heads interviews -focus group discussions -audio/video recording during class observations, interviews, focus group discussions -document analysis	IPA system was used. Step 1: read and re-read data from a single case focusing on general comments Step 2: identified and labeled themes Step 3: related themes were put together to form clusters which were given relevant labels. Step 4: a summary table was produced from the themes
	Cross-sectional survey	Purposive, maximum variation of	Combined Science teachers who were	self-administered questionnaire	Data were analysed using the SPSS software to give tables and graphs of the data

	(quantitative research method)	ZIMSEC Combined Science examiners	examiners with ZIMSEC		categories. The data were then interpreted
4. How could citizenship education be integrated in the assessment of science practical work?	Multiple-case study (qualitative research method)	Purposive sampling of data-rich schools in the Midlands province	-Combined Science teachers -School Heads -Combined Science Teachers' schemes of work and practical skills assessments	-lesson observations -teacher and School Heads interviews -focus group discussions -audio/video recording during class observations, interviews, focus group discussions -document analysis	IPA system was used. Step 1: read and re-read data from a single case focusing on general comments Step 2: identified and labeled themes Step 3: related themes were put together to form clusters which were given relevant labels. Step 4: a summary table was produced from the themes
	Cross-sectional survey (quantitative research method)	Purposive, maximum variation of ZIMSEC Combined Science examiners	Combined Science teachers who were examiners with ZIMSEC	self-administered questionnaire	Data were analysed using the SPSS software to give tables and graphs of the data categories. The data were then interpreted

The current research was carried out in two independent phases using a mixed methods research approach which employed a cross-sectional survey and a multiple-case study. Details of the sampling techniques, data collection procedures and data analysis employed for the cross-sectional survey and the multiple-case study are discussed in the sections 4.8.1 and 4.8.2 respectively.

4.8.1 Phase 1: Cross-sectional survey

(a) Sampling

Zimbabwe has two thousand seven hundred and nineteen (2719) secondary schools which all offer the compulsory Combined Science (Curriculum Framework for Primary and Secondary Education, 2015-2022). The Zimbabwe School Examinations Council (ZIMSEC) trains and invites Combined Science teachers to mark the Combined Science examinations. Combined Science is a learning area (a subject) which has content which is drawn from Biology, Chemistry and Physics. The Combined Science teachers who were Combined Science examiners with ZIMSEC in 2019 when data for the current research was collected were approximately one thousand (1000). Combined Science examiners were invited from all the ten Zimbabwean provinces. The current researcher sampled seven hundred (700) of the Combined Science teachers from the pool of the Combined Science examiners.

The sampling was based on the Combined Science examiners' professional qualifications as well as their school provinces. The current researcher first put the Combined Science examiners who had consented to take part in the current research into ten groups according to the provinces of their schools. Within each province, the current researcher then put the respondents into sub-groups according to their qualifications. The current researcher intended to sample seventy (70) examiners from each of the ten provinces for a fair representation. She then observed that some provinces had less than seventy examiners who had consented to take part in the current research. That resulted in the current researcher sampling all the examiners who had consented from Bulawayo, Matabeleland South, Matabeleland North, Mashonaland Central and Mashonaland West since each of these provinces had less than seventy examiners. The fact that all the examiners from the five provinces were sampled implied that the criterion of also sampling basing on qualifications was no longer applicable. More than seventy examiners were then sampled from the other five provinces, which were, Harare, Masvingo, Mashonaland East, Midlands and Manicaland to make up for the low numbers for the provinces which had fewer examiners. When sampling from the five provinces which had many examiners, the current researcher put the examiners from each province into groups basing on their professional qualifications, that is, those with Certificate in Education, Diploma in Education, Bachelor of Education, Bachelor of Science degree, Master of Education and Doctor of Philosophy in Education and purposively drew samples from each category. The current researcher realised that there were few examiners with the Master of Education degree and the Doctor of Philosophy degree and she sampled all the examiners with these qualifications. Thus the maximum variation purposive sampling was employed in the cross-sectional survey so as to have a representative sample that includes the usually "marginalized data" (Tracy, 2013 p. 135). The number of Combined Science examiners who were sampled as per province and qualifications are summarised in Table 4.2.

Table 4.2

Summary of the Combined Science examiners who were sampled as per province and qualifications

	Qualifications					
Province	CE/Dip Ed	B Ed	B Sc	M Ed	PhD	Total
Bulawayo	16	17	7	4	0	44
Matabeleland North	12	11	0	1	0	24
Matabeleland South	11	12	1	2	0	26
Harare	36	42	5	7	0	90
Mashonaland Central	21	19	6	3	0	49
Mashonaland East	31	33	4	8	0	76
Mashonaland West	25	24	11	6	0	66
Midlands	32	36	6	5	1	80
Masvingo	50	52	14	14	0	130
Manicaland	45	46	14	10	0	115
Total	279	292	68	60	1	700

A group of Combined Science teachers who were examiners with ZIMSEC in 2019 were therefore purposively sampled because the group was teaching the Combined Science. As such, the teachers had information on the processes which they deployed during the teaching and learning process. They had information on the pedagogy, assessment and state of citizenship education and its implementation in the Combined Science learning area. The sample was ideal to enhance collection of rich data to answer the research questions. The information on sex of respondents and their teaching experience was presented in Chapter 5. After the sampling was done, the Combined Science teachers/examiners were then called respondents.

(b) Data collection procedure

In the cross-sectional survey research design, data were collected using a structured questionnaire (Appendix R) which was administered to the respondents. The questionnaire used in the cross-sectional survey had close-ended/structured items. The structured items aligned well to the research sub-questions. They most likely enabled collection of more relevant data from the respondents. Structured questions also presented good comparison of responses and data analysis. The researcher developed the items of the questionnaire based on the concepts that were presented in the theoretical framework as well as on the concepts which were addressed by the research questions so that they addressed the main concerns of the research. The research question and the research sub-questions were also presented in Chapter 1. The main research question was:

How could a framework for integrating citizenship education in the pedagogy and assessment of science practical work be developed, using Combined Science in Zimbabwe as a case study?

The four research sub-questions were:

1. To what extent is citizenship education integrated in the pedagogy of science practical work in Combined Science in Zimbabwe?
2. To what extent is citizenship education integrated in the assessment of science practical work in Combined Science in Zimbabwe?
3. How could citizenship education be integrated in the pedagogy of science practical work?
4. How could citizenship education be integrated in the assessment of science practical work?

The questionnaire (Appendix R) had six sections, A to F. Section A collected general information pertaining to a respondent, for example, sex, professional qualification(s) and the province of the school. Sections B to E addressed the four research sub-questions respectively. Section F collected general information pertaining to citizenship education and science practical work. Although

Creswell (2014) states that data in a survey research may be collected using a questionnaire and/or interviews, the current researcher only used a self-administered structured questionnaire since interviews were done in the multiple-case study. The questionnaire was administered on a single occasion to all the respondents so a cross-sectional survey was employed.

The questionnaire was administered on the 7th of December 2019 to a total of 700 respondents at Teacher's College A and University A which were ZIMSEC marking venues for the Combined Science examinations. Teacher's College A accommodated Combined Science Paper 2 examiners while University A accommodated Combined Science Paper 3 examiners. The current researcher explained the research aim and design to the respondents and outlined how any possible harm to respondents was addressed. The researcher also explained that participation in the research was voluntary. A general information sheet (Appendix D) and a cover letter for a questionnaire (Appendix H) were issued to each of the respondents. The current researcher then sampled the respondents as described in section 4.8.1(a) of the current chapter and issued out the consent forms (Appendix I) and the questionnaires (Appendix R) to the respondents. The respondents were given up to two weeks to submit the completed questionnaires to the current researcher. Out of the seven hundred (700) questionnaires issued, six hundred and three (603) were completed and returned. This represented eighty-six (86 %) return. The current researcher noted that ten (10) of the returned questionnaires were incomplete with very small sections having been completed so those were not captured and analysed. The current researcher, therefore, captured and analysed data from five hundred and ninety-three (593) respondents. That represented 84.7% of the sample.

(c) Data analysis and interpretation

Quantitative data were collected from respondents through the use of a questionnaire (Appendix R). The data analysis and presentation was based on the theoretical framework. The concepts presented in the theoretical framework, that is, the pedagogy of science practical work, the assessment of science practical work and science citizenship education were the main concepts used in the data analysis and presentation. Since data collecting instruments were developed basing on the theoretical framework, the themes that emerged from the data analysis were closely aligned to the theoretical framework. The data were analysed so that the current researcher could then condense the data and be able to discuss them. The quantitative data were analysed using the SPSS software. The SPSS software was a good choice to use for the analysis of data since it is a "versatile and responsive program" due to its ability to analyse data using "many statistical procedures" (Abbott & McKinney, 2013, p. 84). SPSS software is presented as a spreadsheet which enables a variety of data to be entered and analysed (Abbott & McKinney, 2013). The SPSS software could produce data summaries of categories derived from the questionnaire in form of tables, pie charts and/graphs. The current researcher computed frequency, percentages and correlation data summaries in form of tables (see Chapter 5). The SPSS software was also used to calculate the Cronbach's alpha coefficient (see section 4.5 of the current chapter). The data were then analysed and interpreted. The data were then compared to the qualitative data in the results discussions (see Chapter 6).

4.8.2 Phase 2: The multiple-case study

(a) Sampling

The Ministry of Primary and Secondary Education classified Zimbabwean schools into categories according to their location, whether they are mixed sex or single sex as well as whether they are boarding schools or day schools. Schools were also classified according to the responsible authority, that is, government schools, church/mission schools, council schools and private schools. The majority of schools in Zimbabwe were government mixed sex. There were four common secondary school categories in Zimbabwe. These were urban day mixed schools, rural day mixed schools, satellite/farm mixed schools and boarding mixed schools. The different categories usually had conditions, cultures and challenges that were peculiar to them. One school was purposively sampled from each of the four categories. A list of secondary schools, obtained from the Ministry of Primary and Secondary Education, which gave a summary of the characteristics of the schools was used for the selection process. The four schools were purposively sampled, each one representing the four general categories of the Zimbabwean schools. The four schools sampled were government mixed sex schools as it is important that the cases selected be "emblematic of a larger population of cases" (Elman, Gerring & Mahoney, 2016, p. 375). This was maximum variation purposive sampling so as to obtain maximum information on all the categories identified, and hence to obtain rich data (Tracy, 2013). The teachers that participated in the research were the Combined Science Forms 1-4 teachers were taught at the sampled schools.

The multiple-case study design enabled the current researcher to report on the results on each of the four categories, a position which informed policy accordingly. The Midlands province was selected ahead of the other nine provinces as it was central in Zimbabwe and as such had good representation of most of the Zimbabwean ethnic groups. This position further makes the current research more representative. The schools sampled were within a hundred kilometre radius from Gweru, which is the capital of the Midlands province, but falling under four different educational districts of the province. The districts sampled were Shurugwi, Gweru, Chirumhanzu and Kwekwe. This resulted in collection of adequate data from each of the cases as the current researcher afforded to visit each of the schools five times. A summary of the sampled schools and their characteristics is presented in Table 4.3.

Table 4.3

A description of the sampled schools

Sampled Secondary school	District	Category	Number of Combined Science teachers
Takudzwa	Kwekwe	Mixed sex boarding	Six qualified Two student
Nothando	Shurugwi	Mixed sex rural-day	Data not collected
Tivongereiwo	Gweru	Mixed sex satellite day	One qualified
Tatendashe	Chirumhanzu	Mixed sex urban-day	Six qualified Two student

(b) Data collection procedure

In the multiple-case study, data were captured through administering semi-structured interviews with Combined Science teachers and School Heads. Data were also collected through Combined Science lesson observations and focus group discussions with Combined Science teachers. Data were also collected through an analysis of the Combined Science schemes of work. Audio recording, photographs and videos as well as note-taking were also used to record data. A single interview with the Combined Science teacher of the sampled class, a single interview with the School Head, a single focus group discussion with Combined Science teachers and a single Combined Science class observation was carried out at each of the sampled school. Photographs and videos taken focused on equipment used in the teaching and learning of practical skills and not on participants in order to protect their identities and hence maintain the cases anonymous. Document analysis focused on the Combined Science schemes of work and was guided by the use of the document analysis form (Appendix Q). The current researcher had intended to do document analysis of formative practical skills assessments but did not do it as none of the sampled schools had given practical skills assessments when the data were collected. Audio tapes were used for recording the interviews, focus group discussions as well as the discussions during the teaching and learning process. Focus group discussions were also recorded as minutes.

In the current research, semi-structured interviews were used and they were based on semi-structured questions that formed the interview schedule (Appendix N). The questions addressed the concerns of the research sub-questions. The use of a semi-structured interview schedule enabled the current researcher to elicit for similar information from all participants (Belotto, 2018). The current researcher maintained a constant role of talking less and listening more when conducting the interviews in a bid to collect the data uniformly. However, during an interview or focus group discussion, the current researcher created new verbal questions, where necessary, to "probe" the participants to give more details about the phenomenon under study (Adom, Yeboah & Ankrah, 2016, p. 5). When an interview is held with a panel, it is led by a moderator (current researcher) as in the case of focus group discussions. The focus group discussions were guided by semi-structured questions which were in the focus group moderation schedule (Appendix P). The items were similar to those in the interview schedule in order to capture complementary data. Lesson observations were guided by using the lesson observation checklist (Appendix O). The lesson observation checklist focused on gathering data that addressed the concerns of the current research as presented in the theoretical framework as well as the research questions. Before data collection using any of the procedures, the current researcher explained the rationale of the research as well as the rights of the participants. The current researcher also explained how any possible harm to participants was mitigated in the current research and allowed the participants to raise their concerns. The current researcher also kindly requested for participants' voluntary consent. Pseudonyms were used for the schools, classes and all participants to protect their identities.

Data capturing at Takudzwa Secondary School commenced from Monday the 9th of March to Friday the 13th of March. On Monday, the researcher met the School Head around 8.35 am. The researcher introduced herself and the current research and also presented all the supporting documents. The current researcher then kindly requested for access to carry out the research and permission was granted. The School Head then handed the researcher over to the Head of the Science Department at 8.50 am. The researcher was assisted by the Head of Department (HOD) to sample a Form 3 class, Form 3 Dove. Mrs. Rudo was the Combined Science teacher for Form 3 Dove. The HOD called the science teachers to her office so that the current researcher could explain the research to them, distribute the general information sheets and request for their consent to participate in the research. The current researcher distributed the general information sheets, explained the current research and responded to questions the Combined Science teachers raised. The Combined Science teachers consented to participating in the focus group discussion. Mrs. Rudo consented to the document analysis, lesson observation and Combined Science teacher interview.

The current researcher then kindly requested Mrs. Rudo for documents that she (the researcher) would need to analyse before the lesson observation. These were the schemes of work, worksheet(s) of practical assessment(s) carried out and the class timetable. Mrs. Rudo gave the current researcher the schemes of work and the timetable but indicated that she had not given the class any practical assessment yet. The current researcher then carried out document analysis of the schemes of work between 11.45 am and 3.00 pm. The current researcher was allowed to make a copy of the schemes of work for further analysis.

Form 3 Dove had three Combined Science double lessons per week. The current researcher observed the Tuesday lesson which was carried out between periods 5 and 6, from 10.30 am to11.40 am. The current researcher arrived at the school about fifteen minutes before the lesson so that she could settle down and also inform Mrs. Rudo of her presence.

The Tuesday lesson started on time in a science laboratory as scheduled. The current researcher sat at the back of the laboratory. The laboratory was clean and well ventilated. Mrs. Rudo and the learners showed a good professional relationship. Mrs. Rudo greeted the learners and asked one learner to give the class a verse from the Bible. Another learner prayed. She introduced the current researcher to the learners and briefly outlined her (the researcher) role. She then introduced the lesson. Details of the lesson were reported in Chapter 5.

The interview with Mrs. Rudo was held on Tuesday 10 March between 2.15 pm and 3.00 pm in her office. The data gathered were reported in Chapter 5. The focus group discussion with the Combined Science teachers was held on Wednesday 11 March. The discussion was held between 10.00 am and 11.00 am in the HOD's office. The current researcher brought the teachers some drinks and snacks. Five teachers and one laboratory assistant attended. The focus group discussion took 45 minutes. The data gathered were reported in Chapter 5.

The interview with Mr. Smart, the Takudzwa Secondary School Head, was held on Thursday 12 March between 11.20 am and 11.45 am. The interview was held in Mr Smart's office and it took about 15 minutes. Mr. Smart indicated that he had a very busy schedule that week and requested the current researcher to raise only critical issues with him. The data gathered were reported in Chapter 5.

The current researcher visited the second school, Tatendashe Secondary School, on Monday the 16th of March. The current researcher arrived at the school around 8.15 am. The School Head was not in office so the current researcher introduced herself to the Deputy Head, explained the current research and also presented all the supporting documents. The current researcher then requested for permission to carry out the research. The Deputy Head granted the permission and handed the researcher over to the HOD Science around 8.30 am. The HOD took the current researcher to her (HOD) office and assisted in sampling a Form 4 class, Form 4 Sheep. The HOD called in the Combined Science teachers so that the current researcher could explain her research and request for their participation. The current researcher distributed the general information sheets, explained the current research and responded to the teachers' concerns. All the Combined Science teachers consented to taking part in the focus group discussion. The Form 4 Sheep teacher, Mr. Rufaro, also consented to the document analysis, lesson observation and interview. The current researcher requested for the schemes of work, the class timetable and worksheet(s) of practical assessment(s). Mr. Rufaro indicated that his schemes of work were in soft copy on a computer he had left at home. He could only give the current researcher the soft copy the following day. He indicated that he had not given the class any practical assessment and gave only a copy of the class timetable to the researcher.

Mr. Rufaro indicated that he was ready to be interviewed that Monday. The current researcher gave him the interview schedule, requested him to have a look at the questions and then advise the current researcher when he was ready. Mr. Rufaro took the interview schedule to his office. He returned after about 15 minutes. The interview was carried out in a science laboratory. The interview was held between 10.10 am and 11.00 am and took about 47 minutes. The data gathered were reported in Chapter 5.

The class timetable was a six day cycle so the class would have only two double lessons within the data capturing week. The lessons were on Tuesday, periods 1 and 2, 7.20 am to 8.20 am and Thursday, periods 6 and 7, 10.20 am to 11.20 am. The lesson observation was scheduled for the Tuesday lesson. The HOD told the current researcher that she (the HOD) had scheduled the focus group discussion for Wednesday between 10.00 am and 11.00 am. The current researcher left Tatendashe Secondary School at 12.20 pm. The current researcher decided to go to the third school, Tivongereiwo Secondary School, and assess whether it was possible to collect data from the two schools within the same week. The current researcher arrived at Tivongereiwo Secondary School at 1.40 pm and waited to see the School Head at 2.00 pm. The current researcher introduced herself to the School Head, explained the current research and also presented all the supporting documents. The School Head was Mr. Bruce. The current researcher then requested for permission to carry out the current research and Mr. Bruce granted it. The current researcher also requested to have an interview with Mr. Bruce who consented and slotted the interview for Thursday the 19th, between 8.00 am and 9.00 am. Mr. Bruce then handed the current researcher over to the only Combined Science teacher at the school, Mrs. Budiriro. The current researcher issued her with the general information sheet and explained the current research. Mrs. Budiriro consented to the document analysis of her schemes of work, class observation and interview. The current researcher was assisted by Mrs. Budiriro to sample a Form 1 class, Form 1 Camel. The current researcher requested for Mrs. Budiriro's schemes of work, the timetable and worksheets of practical skills assessments. She gave the current researcher the schemes of work and the timetable and indicated that she had not given the Form 1 Camel class any practical skills assessment. The current researcher was allowed to make a copy of the schemes of work so that she (the researcher) could analyse them later.

The current researcher checked the Form 1 Camel timetable and realised that she (the researcher) could capture data from Tatendashe and Tivongereiwo Secondary Schools within that same week. The schools were about one hour ten minutes' drive apart when one was driving at an average speed of 90 km/hr. The researcher drew a timetable which indicated the general time frames within which data was collected from Tatendashe and Tivongereiwo Secondary Schools. Table 4.4 shows the timetable used by the current researcher.

Table 4.4

Data collection timetable for Tatendashe Secondary School and Tivongereiwo Secondary School (from 16 March 2020 to 20 March 2020)

Time	7.20-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4
Monday			Tatendashe Secondary School Teacher interview					
Tuesday	Tatendashe Secondary School lesson observation						Tivongereiwo Secondary School lesson observation	
Wednesday		Tatendashe Secondary School focus group discussion				Tivongereiwo Secondary School Teacher interview		
Thursday	Tivongereiwo Secondary School Head interview							
Friday								

The lesson observation at Tatendashe Secondary School was held on Tuesday 17 March from 7.20 am to 8.20 am. The current researcher arrived at the school at 7.10 am and waited for Mr. Rufaro who arrived at 7.15 am. Form 4 Sheep learners were already settled in a science laboratory. Mr. Rufaro and the current researcher got to the laboratory at 7.20 am. The laboratory was clean and well ventilated. The teacher greeted the learners, introduced the current researcher and introduced the lesson. The data collected were reported in Chapter 5.

After the lesson, Mr. Rufaro gave the current researcher a soft copy of his schemes of work. The current researcher talked to the HOD to confirm the schedule for the focus group discussion. The current researcher left focus group schedules with the HOD and she distributed them to the Combined Science teachers. The current researcher left Tatendashe Secondary School around 10.20 am and headed for Tivongereiwo Secondary School.

The current researcher arrived at Tivongereiwo Secondary School around 1.45 pm and informed Mrs. Budiriro of her (the researcher) presence. Mrs. Budiriro invited the current researcher to the Form 1 Camel classroom at 2.10 pm. The classroom was generally crowded as it had sixty-seven (67) learners but it was clean and well ventilated. The teacher greeted the learners, introduced the current researcher and introduced the lesson. The lesson ended at 3.20 pm. The data gathered were reported in Chapter 5. The current researcher left the school at 3.40 pm.

On Wednesday the 18th, the current researcher arrived at Tatendashe Secondary School at 09.40 am for the focus group discussion which was scheduled for 10.00 am to 11.00 am. The focus group discussion was held as scheduled. The current researcher brought some drinks and snacks for the participants. Six Combined Science teachers attended. The discussion took one hour five minutes. The data gathered were recorded in Chapter 5.

The current researcher left the school at 11.30 am and drove to Tivongereiwo Secondary School. The current researcher arrived at the school at around 12.50 pm. Mrs. Budiriro had explained that since her office was small and she shared it with two other teachers, she preferred that the interview be conducted in the Form 1 Camel class over lunch time. The interview was conducted between 1.00 pm and 1.30 pm. The interview took about 20 minutes. The data collected were recorded in Chapter 5. The current researcher left the school at 1.55 pm.

On Thursday the 18th, the current researcher arrived at Tivongereiwo Secondary School at 7.40 am for the interview with Mr. Bruce, the School Head. He arrived at the school around 7.50 am and since he shared the office with the school clerk, the interview was conducted while standing outside. The interview was conducted between 8.05 am and 8.40 am. The interview took 30 minutes. The data captured were reported in Chapter 5. The current researcher left the school around 8.50 am.

In all the three schools, the School Heads, the Deputy Heads, the HODs Science, the Combined Science teachers, laboratory assistant, learners and all staff members were very welcoming, friendly, cooperative, professional and willing to help in whatever way possible. Those who participated in the current research did so willingly and were excited to be part of the current research.

The current researcher had scheduled to visit the fourth and last school from Monday the 23rd to Friday the 27th of March 2020 but all schools in Zimbabwe were ordered to close on Tuesday the 24th of March as a measure to fight the spread of the corona virus which caused the disease COVID-19, a pandemic that claimed thousands of lives globally. It was not possible to reschedule the program for data capturing at Nothando Secondary School (the fourth school) as schools were closed indefinitely. The fourth school was thus dropped from the research and data analysis was done for data gathered at the three schools.

(c) Data analysis and interpretation

The qualitative data gathered from the multiple-case study were analysed according to the Interpretative Phenomenological Analysis (IPA) system. IPA aims at capturing and interpreting the experiences of the participants with no or minimum distortions (Willig, 2013). IPA analyses data which is mostly captured from samples which are purposively sampled. The participants shared similar experiences since they were sampled because of their ability to answer the research question(s) (Neuman, 2014; Willig, 2013). IPA advocates for analysis of data from each case or participant separately, making comparisons at the end and it also accommodates the identification of themes throughout the data analysis period (Taylor, 2015). Thus in the current research data analysis was done in four steps per school. The first step involved the current researcher's reading and re-reading of data from a single case focusing on general comments. The second step identified and labeled themes. In the third step, related themes were put together to form clusters which were given relevant labels. In the fourth step, a summary table was produced from the themes. The summary tables from each case were then integrated to reflect the experience of the group participants as a whole during results discussions (Willig, 2013). The themes from the schools were then compared in what Shaban et al calls “cross-case analysis” (2017, p. 22).

4.9 Conclusion

This chapter discussed the quantitative, qualitative and mixed methods research approaches first before choosing the current research approach and research designs which were employed in the current research. The current researcher opted to use a mixed methods research approach as it had the best chances of capturing extensive data to answer the research questions. The research designs employed were a cross-sectional survey and a multiple-case study. A detailed account of the data collecting procedures employed was given. The sampling strategies adopted in the current research were outlined and issues of reliability, validity, credibility, trustworthiness and research ethics were discussed. The next chapter outlines the results obtained from the cross-sectional survey and the multiple-case study.

CHAPTER 5: THE ANALYSIS AND PRESENTATION OF DATA

5.1 Introduction

The focus of the current research was to develop a framework for integrating citizenship education in the pedagogy and assessment of science practical work in the Combined Science learning area in Zimbabwe. The current chapter presents the results obtained from both the quantitative cross-sectional survey and the qualitative multiple-case study. The main research question was:

How could a framework for integrating citizenship education in the pedagogy and assessment of science practical work be developed, using Combined Science in Zimbabwe as a case study?

The current research sought to explore the main research question through answering four sub-questions which were used to collect data. The sub-questions which were also presented in Chapter 1 were:

1. To what extent is citizenship education integrated in the pedagogy of science practical work in Combined Science in Zimbabwe?
2. To what extent is citizenship education integrated in the assessment of science practical work in Combined Science in Zimbabwe?
3. How could citizenship education be integrated in the pedagogy of science practical work?
4. How could citizenship education be integrated in the assessment of science practical work?

The current research was conducted using the QUAN-QUAL concurrent parallel triangulation research design. Quantitative data were collected in December 2019 and qualitative data were collected in March 2020. The data were collected and analysed separately and were only compared in the discussion. The results were presented in line with the research sub-questions they were addressing so the sub-question was quoted first followed by the related results. General results were summarised before the results that answer each of the four sub-questions were outlined.

5.2 Quantitative data analysis and presentation

The quantitative data were presented in three main data sets. Biographical results on the current research were presented first, followed by data that addressed the research sub-questions, followed by other important results. The data were presented in sub-headings that were aligned to the questionnaire which was administered. The development of the questionnaire items was based on the theoretical framework (except for the items that solicited for biographical information) as the items were aligned to the main concepts presented in the theoretical framework. This implied that data analysis was informed by the theoretical framework.

5.2.1 Biographical information on the cross-sectional survey sample

The background information on the sample did not relate directly to the research sub-questions but it is important that it was captured as it could possibly indicate additional results. For example, the data on sex indicated the general trend of Combined Science teachers with regard to gender. Although that was not the focus of the current research, the results were worth noting.

(a) Self-reported gender orientation of respondents

Five hundred and ninety-three (593) completed questionnaires were analysed using the SPSS software. The sample was seven hundred (700) and seven hundred questionnaires were distributed. Six hundred and three were returned but ten of the returned questionnaires were not complete so the current researcher did not capture them as outlined in Chapter 4. Four hundred respondents (67.5%) classified themselves as male and one hundred and ninety-three respondents (32.5%) as female. The discrepancy on sex reflected a general trend observed in science departments in the country where the majority of science teachers were male.

(b) School provinces of the respondents

Harare, Masvingo and Manicaland had more respondents than other provinces. More respondents were sampled from the three provinces when the examiners from Bulawayo, Matabeleland North, Matabeleland South and Mashonaland Central were fewer than the intended sample of seventy examiners per each of the ten provinces. The justification of the different numbers in the province samples was presented in Chapter 4. The respondents were drawn from all the ten provinces as shown in Table 5.1.

Table 5.1

School provinces of the respondents

	frequency	percent
Bulawayo	35	5.9
Harare	82	13.8
Matabeleland South	16	2.7
Matabeleland North	19	3.2
Midlands	62	10.5
Masvingo	122	20.6
Mashonaland Central	35	5.9
Mashonaland West	58	9.8
Mashonaland East	65	11.0
Manicaland	99	16.7
Total	593	100.0

(c) Teaching experience of the respondents

The respondents were of varied teaching experience as shown in Table 5.2. The majority of the respondents, however, had teaching experience of between 16 and 30 years.

Table 5.2

Teaching experience of the respondents

	frequency	percent
1-5 years	9	1.5
6-10 years	45	7.6
11-15 years	58	9.8
16-20 years	122	20.6
21-25 years	144	24.3
26-30 years	154	26.0
31-35 years	41	6.9
36+ years	20	3.4
Total	593	100.0

(d) Professional qualifications of the respondents

Most of the respondents had professional qualifications which were relevant to science teaching as illustrated in Table 5.3. Two hundred and sixty (43.8%) respondents had a Bachelor in Education degree and two hundred and eighteen (36.8%) had either a Certificate in Education or a Diploma in Education majoring in science. There were few respondents with higher professional qualifications, that is, with Master of Education degree or Doctor of Philosophy in Education degree (see Table 5.3). In Zimbabwe, a Bachelor of Science degree was not regarded as a qualification for science teaching. However, due to a shortage of science teachers, they were enrolled to teach science.

Table 5.3

Professional qualifications of the respondents

	frequency	percent
Certificate in Education/ Diploma in Education (Science)	218	36.8
Bachelor of Education (a science subject)	260	43.8
Master of Education (a science subject)	54	9.1
PhD (Education)	1	.2
Bachelor of Science	49	8.3
Other	11	1.9
Total	593	100.0

(e) Types of secondary schools

The respondents were science teachers who taught at different types of schools as shown in Table 5.4. In Zimbabwe, schools fell into different categories, for example, a mixed sex rural secondary school, or mixed sex urban secondary school. The majority of the respondents were teaching at mixed sex rural day schools and mixed sex urban day schools (see Table 5.4). These two categories represented most of the Zimbabwean schools.

Table 5.4

Types of secondary schools

	frequency	percent
Mixed sex rural day	236	39.8
Mixed sex urban day	207	34.9
Mixed sex boarding	104	17.5
Mixed sex farm/satellite day	24	4.0
Single sex urban day	18	3.0
Other	4	.7
Total	593	100.0

(f) Science subject(s) taught

Five hundred and eighty one (581) respondents were Combined Science teachers and that represented ninety eight percent (98%) of the total respondents. The sample was suitable to participate in the cross-sectional survey since most of the respondents were Combined Science teachers. The information pertaining to the subjects taught by the respondents was summarised in Table 5.5.

Table 5.5

Science subject(s) taught

	frequency	percent
Combined Science	201	33.9
Biology	4	.7
Chemistry	4	.7
Physics	2	.3
Combined Science and other science subject(s)	380	64.1
Other	2	.3
Total	593	100.0

(g) State of science equipment

Most of the respondents, (70.3%), indicated that the state of science equipment in their schools was average or better. Twenty-three-point four percent (23.4%) indicated that the state of science equipment in their schools was poor while six-point two percent (6.2%) indicated that the state of the science equipment was very poor. The information was summarised in Table 5.6.

Table 5.6

State of science equipment

	frequency	percent
Very good	33	5.6
Good	105	17.7
Average	279	47.0
Poor	139	23.4
Very poor	37	6.2
Total	593	100.0

(h) Time allocation

The Combined Science Syllabus recommended "a time allocation of 8 periods of 35 minutes per week" for an effective teaching and learning process (Combined Science Syllabus Forms 1-4, 2015, p. 2). The results showed that five hundred and twelve (86.3%) respondents stated that they were allocated six periods per class per week and only thirty-three (5.6%) were allocated the recommended eight periods. The time allocations were summarised in Table 5.7.

Table 5.7

Time allocation

Number of lessons per week	frequency	percent
5 lessons	40	6.7
6 lessons	512	86.3
7 lessons	5	.8
8 lessons	33	5.6
Other	3	.5
Total	593	100.0

(i) Frequency of practical work

The frequency of practical work that was carried out during the teaching and learning process was summarised in Table 5.8. The responses represented by "other" included those who stated they never carried out experiments or rarely or when resources were available. A total of two hundred and seventy-seven (46.7%) respondents indicated that science practical work was done every week. One hundred and fifty-six (26.3%) respondents stated that practical work was carried out once in two weeks and one hundred and nineteen (20.1%) respondents said that practical work was done once a month (see Table 5.8). The results showed that limited practical work was carried out by most schools.

Table 5.8

Frequency of practical work

	frequency	percent
Every lesson	14	2.4
Twice a week	75	12.6
Once a week	188	31.7
Once in two weeks	156	26.3
Once a month	119	20.1
Once a term	10	1.7
Other	31	5.2
Total	593	100.0

5.2.2 The extent to which citizenship education was integrated in the pedagogy of science practical work in Combined Science in Zimbabwe

The current researcher gathered data on whether teachers had received staff-development on science citizenship education. She also gathered data on the teaching methods the teachers used during the teaching and learning process. The first research sub-question was also answered when the teacher activities carried out during practical work were analysed. The roles of learners during practical work, the state of science citizenship education in schools and how citizenship education was linked to science practical work also contributed to understanding the extent to which citizenship education was integrated in the pedagogy of science practical work. The results were presented under sections 5.2.2.1 to 5.2.2.6.

5.2.2.1 Staff-development of teachers on science citizenship education

Two hundred respondents (33.7%) stated that they had been trained on citizenship education with some qualifying that the training took place long ago. Three hundred and forty-one respondents (57.5%) stated that they had not received any staff-development on the promotion of citizenship education and fifty-two (8.8%) indicated that they were not sure if they had been trained or not. The results could be interpreted to mean that there was no major teacher staff-development which was carried out in preparation of the implementation of the competence-based curriculum that focussed on science citizenship education. The current researcher interpreted the trend as suggesting that science citizenship education was implemented to a limited extent as the teachers were supposed to be empowered to be able to effectively implement it.

5.2.2.2 Teaching methods used during the teaching of Combined Science

The general teaching methods were presented as the teacher-centred/lecture method, learner-centred/inquiry-based method and project-based method. Three hundred and seventy-one respondents (62.6%) indicated that they used the lecture method as well as inquiry-based methods. One hundred and fifty one (25.5%) used the inquiry-based method. Fifty-three (8.9%) mainly used the lecture method. Two (0.3%) used the project-based method. Some respondents indicated two or more responses, for example, eight (8) respondents indicated that they combined 2 (which is the learner-centred/inquiry-based method) and 4 (which is the project-based method). Other method combinations were presented in Table 5.9. The results showed that the lecture method was still being preferred and used by many teachers. That position meant that learners were still exposed to rote learning and some teachers had not shifted to the role of being facilitators.

Table 5.9

Teaching methods used

	frequency	percent
1. Teacher-centred/lecture method	53	8.9
2. Learner-centred/inquiry- based method	151	25.5
3. Lecture method and inquiry-based method	371	62.6
4. Project-based method	2	.3
2 and 4	8	1.3
3 and 4	8	1.3
Total	593	100.0

5.2.2.3 Teacher activity during science practical work

Three hundred and twenty-two respondents (54.3%) gave written instructions to learners and guided the learners as they carried out the practical work. Seventeen (2.9%) gave oral instructions and guided learners as they carried out the practical work. One hundred and twenty-six (21.2%) carried out teacher demonstrations. Eighty-eight (14.8%) combined teacher demonstrations and written instructions as learners carried out practical work. The current researcher interpreted the results as showing that the teacher had a prominent role during practical work in Combined Science. The majority of learners followed prescribed instructions during science practical work. The results were summarised in Table 5.10.

Table 5.10

Teacher activity during science practical work

	frequency	percent
1. Give written instructions and guide learners	322	54.3
2. Give oral instructions and guide learners	17	2.9
3. Carry out teacher demonstrations	126	21.2
1 and 3	88	14.8
2 and 3	12	2.0
1, 2 and 3	28	4.7
Total	593	100.0

5.2.2.4 Roles of learners during science practical work

One hundred and forty-nine (25.1%) respondents reported that learners wrote notes and made observations as the teacher demonstrated the practical work. Two hundred and twenty-three (37.6%) respondents stated that learners carried out the practical work while working in groups. Ninety-eight (16.5%) respondents indicated that the learners were exposed to a combination of either writing notes and making observations as the teacher demonstrated the practical work or carrying out the practical work while working in groups. Forty-six (7.8%) respondents reported that learners carried out individual practical work. The results showed that the pedagogy of practical work was mainly as group work by learners or through teacher demonstrations. Very little practical work was done by learners individually. Other combinations were summarised in Table 5.11.

Table 5.11

Roles of learners during science practical work

	frequency	percent
1. Writing notes and making observations from teacher demonstrations	149	25.1
2. Carrying out individual practical work	46	7.8
3. Group Practical work	223	37.6
4. Organising and cleaning apparatus	6	1.0
1 and 3	98	16.5
2 and 3	24	4.0
1 and 2	10	1.7
1, 3 and 4	11	1.9
1, 2, 3 and 4	16	2.7
Other	10	1.7
Total	593	100.0

5.2.2.5 State of science citizenship education

Three hundred and twenty-eight (55.3%) respondents pointed out that science citizenship issues were included in the Combined Science Syllabus Forms 1-4. Seventy-four (12.5%) said the concept of science citizenship was not addressed in the Combined Science Syllabus Forms 1-4.

Seventy-seven (13.0%) stated that the concept of citizenship education was integrated in other subjects. Eighty-two (13.8%) indicated that they did not know how the concept of science citizenship was presented in the competence-based curriculum which they were implementing. Thirty (5.1%) respondents said that the issue of science citizenship education was addressed in the Combined Science Syllabus Forms 1-4 as well as in other learning areas. While very few issues of science citizenship education were included in the Combined Science Syllabus Forms 1-4, the philosophy was not clearly spelt out hence some teachers missed the concept completely. That hindered effective and wide implementation of citizenship education since the teachers lacked a common position with regard to citizenship education. The summary on the state of Combined Science citizenship education in the Zimbabwean competence-based curriculum is given in Table 5.12.

Table 5.12

State of science citizenship education

	frequency	percent
1. Not addressed	74	12.5
2. Integrated in Combined Science	328	55.3
3. Integrated in other Learning areas	77	13.0
4. I don't know	82	13.8
2 and 3	30	5.1
Other	2	.3
Total	593	100.0

5.2.2.6 How science citizenship education was linked to science practical work

One hundred and ninety-six (33.1%) respondents reported that they used science practical work to solve science related community problems. One hundred and ninety-five (32.9%) respondents stated that science practical work was linked to the learners' everyday lives. Sixty-nine (11.6%) said that they did not emphasise on science citizenship education during their teaching. Nineteen (3.2%) respondents stated that they linked science practical work to school projects. Seventy (11.8%) reported that science practical work had a dual function, that of, solving science related community problems as well as being linked to the learners' everyday lives. The results showed a laissez faire approach to citizenship education where teachers may fail to apply it with no consequences. The laissez faire approach to linking practical work to citizenship education would most likely produce learners who do not apply scientific concepts and science practical skills to enrich their lives. Other combinations were also presented in Table 5.13.

Table 5.13

How science citizenship education was linked to science practical work

	frequency	percent
1. Science practical work linked to learner's everyday life	195	32.9
2. Used practical work to solve science related community problems	196	33.1
3. Linked science practical work to school projects	19	3.2
4. Did not emphasise on science citizenship education	69	11.6
1 and 2	70	11.8
I don't know	3	.5
2 and 3	10	1.7
1, 2 and 3	19	3.2
Other	12	2.0
Total	593	100.0

5.2.3 The extent to which citizenship education was integrated in the assessment of science practical work in Combined Science in Zimbabwe

The second research sub-question was answered through an analysis of data that were related to the integration of citizenship education to practical work assessment. Data on the methods used to assess practical work and how citizenship education was linked to practical assessments were analysed (see sections 5.2.3.1 and 5.2.3.2).

5.2.3.1 Methods used to assess science practical skills

Four hundred and two (67.8%) respondents indicated that practical skills were assessed through the use of practical tests and practical examinations. One hundred and fifteen (19.4%) respondents stated that they assessed practical skills using alternative to practical tests and examinations. Five (0.8%) stated that they used science projects to assess practical skills. Forty-two (7.1%) indicated that they combined the use of alternative to practical tests and examinations as well as practical tests and examinations. The general results showed that teachers valued practical tests and examinations when assessing learners for practical skills. The critical question raised is whether the learners would have acquired the relevant skills when they were generally exposed to practical work through group work and teacher demonstrations (see Table 5.11). Other combinations stated were included in Table 5.14.

Table 5.14

Methods used to assess science practical skills

	frequency	percent
1. Use of alternative to practical tests and examinations	115	19.4
2. Use of practical tests and examinations	402	67.8
3. Use of science projects	5	.8
1 and 2	42	7.1
1, 2 and 3	7	1.2
2 and 3	17	2.9
Other	5	.8
Total	593	100.0

5.2.3.2 How citizenship education was linked to science practical assessments

Two hundred and seven (34.9%) respondents indicated that they linked practical work assessments to learners' everyday lives. One hundred and thirty-eight (23.3%) used practical assessments to solve science related problems. One hundred and twenty-four (20.9%) used practical tasks or assessments to arouse learners' interest in science. Eight (1.3%) stated that they did not know how citizenship education was integrated in the assessment of practical work. A total of one hundred and sixteen (19.6%) stated that they combined responses 1, 2 and 3 as shown in Table 5.15.

Table 5.15

How citizenship education was linked to science practical assessments

	frequency	percent
1. Linked practical work to everyday life	207	34.9
2. Used practical knowledge to solve science related problems	138	23.3
3. Used practical tasks to arouse interest in science	124	20.9
1 and 2	43	7.3
I don't know	8	1.3
1, 2 and 3	40	6.7
1 and 3	20	3.4
Other	13	2.2
Total	593	100.0

5.2.4 How citizenship education could be integrated in the pedagogy of science practical work

The third research sub-question was answered through an analysis of the data gathered on ways that could be used to integrate citizenship education to science pedagogy and the ways to promote science citizenship education as presented under sections 5.2.4.1 to 5.2.4.3.

5.2.4.1 Ways to integrate citizenship education to science pedagogy

Two hundred and fifty-nine respondents (43.7%) proposed that citizenship education should be integrated to the science content and objectives. One hundred and twenty-three (20.7%) suggested that science pedagogies should promote citizenship education. One hundred (16.9%) were of the view that citizenship education should be highlighted in educational policies. A total of one hundred and eleven (18.7%) proposed different combinations of responses 1, 2 and 3 as shown in Table 5.16. While the majority of respondents proposed the integration of citizenship education to the science content and objectives, the frequencies for those who proposed that science pedagogies should promote citizenship education and view that citizenship education should be highlighted in educational policies were also significant.

Table 5.16

Ways to integrate citizenship education to science pedagogy

	frequency	percent
1. Highlight science citizenship education in educational policies	100	16.9
2. Link pedagogies to citizenship promotion	123	20.7
3. Integrate citizenship to science content and objectives	259	43.7
1 and 3	31	5.2
2 and 3	24	4.0
1, 2 and 3	43	7.3
1 and 2	11	1.9
Other	2	.3
Total	593	100.0

5.2.4.2 Ways to promote science citizenship education

Two hundred and seventy respondents (45.5%) stated that staff-development of teachers on pedagogies that promoted science citizenship education was critical for the promotion of citizenship education in the teaching and learning of Combined Science. That response was the most common as it was proposed in all the other combinations given. Eighty-nine (15.0%) indicated that science citizenship education would be promoted when practical work was used to solve science related community challenges. Sixty-eight (11.5%) wanted the philosophy of science citizenship education to be included in the Combined Science Syllabus Forms 1-4. The researcher views the suggestions as relevant to the promotion of science citizenship education.

5.2.4.3 Ways to enhance citizenship education

One hundred and fifty-three (25.8%) respondents indicated that staff-development of teachers was critical to promote science citizenship education in the teaching and learning of Combined Science. That response also featured in combinations. A total of one hundred and seventy-four respondents had response 2 (staff-developing teachers on citizenship education) in different combinations. That implied that three hundred and twenty-seven gave response 2 as a way for enhancing science citizenship education, and that was the response with the highest frequency (see Table 5.17). Seventy (11.8) pointed to a clear policy direction as a way to enhance science citizenship education. Sixty-two (10.5%) stated that having content and objectives on citizenship education in the Combined Science syllabus was important to promote science citizenship education. Forty-one (6.9%) said that using science practical work to solve socio-scientific problems in the local communities was necessary to enhance science citizenship education. Twenty (3.4%) respondents advocated for project-based learning for the promotion of science citizenship education. Some of the respondents indicated that combinations of 1, 2, 3, 4 and 5 were necessary to enhance science citizenship education. The combinations were summarised in Table 5.17.

Table 5.17

Ways to enhance citizenship education

	frequency	percent
1. Having clear policy direction	70	11.8
2. Staff-developing teachers on citizenship education	153	25.8
3. Having content and objectives on citizenship education in the syllabus	62	10.5
4. Solving socio-scientific problems in the local Community	41	6.9
5. Having project-based learning	20	3.4
1, 2 and 3	42	7.1
1, 2, 3 and 4	21	3.5
1, 2, 3, 4 and 5	46	7.8
2 and 3	34	5.7
1 and 2	31	5.2
Other	73	12.3
Total	593	100.0

5.2.5 How citizenship education could be integrated in the assessment of science practical work

The fourth research sub-question was answered through an analysis of the data gathered on methods to effectively assess practical skills as well as ways to enhance citizenship education during the assessment of practical work (see sections 5.2.5.1 and 5.2.5.2).

5.2.5.1 Methods to effectively assess science practical skills

Four hundred and twenty (70.8%) respondents stated that practical skills could be effectively assessed through a practical test. Fifty-five (9.3%) indicated that practical skills were best assessed through a project. Fifteen (2.5%) said that the practical skills could be effectively assessed through the use of a theory test. Seventy-nine (13.3%) stated that a combination of the use of a practical test and a project would be an effective way of the assessment of practical skills. Fourteen (2.4%) indicated that a combination of a practical test and a theory test would be effective while ten (1.7%) proposed other combinations.

5.2.5.2 Ways to enhance citizenship education through assessments

Two hundred and eighty-six (48.2%) respondents indicated that citizenship education could be enhanced through the staff-development of teachers on assessments that promote citizenship education. That proposal was also part of most of the combinations suggested which even increased its frequency to three hundred and ninety-four (see Table 5.18). One hundred and nine (18.4%) stated that citizenship education should be linked to practical work assessment. Eighty-three (14.0%) wanted the concept of science citizenship education to be highlighted in educational assessment policy. Some of the respondents combined responses 1, 2 and 3 as shown in Table 5.18.

Table 5.18

Ways to enhance citizenship education through assessments

	frequency	percent
1. Highlight science citizenship education in educational assessment policy	83	14.0
2. Link assessment to science citizenship	109	18.4
3. Staff-develop teachers on assessments that promote citizenship education	286	48.2
1 and 3	33	5.6
2 and 3	39	6.6
1, 2 and 3	36	6.1
1 and 2	5	.8
Other	2	.3
Total	593	100.0

5.2.6 Other important results from the cross-sectional survey

There were other data collected on the possible benefits of science citizenship education, the challenges which militated against its effective implementation, challenges which hindered science practical work, challenges which hindered the assessment of practical skills and the respondents' general views on the concept of science citizenship education (see sections 5.2.6.1 to 5.2.6.5).

5.2.6.1 Possible benefits of science citizenship education

Two hundred and five (34.6%) respondents stated that science citizenship education would produce learners who were able to solve socio-scientific problems. One hundred and two (17.2%) indicated that science citizenship education would produce learners who were sensitive to issues of environmental sustainability. Sixty-seven (11.3%) said that citizenship education would produce learners who would live science-enriched lives. Some respondents gave combinations of 1, 2 and 3 as shown in Table 5.19. The results showed that the citizenship education had the potential to produce learners who could solve socio-scientific problems and that would be desirable.

Table 5.19

Possible benefits of science citizenship education

	frequency	percent
1. Producing learners who could solve socio-scientific problems	205	34.6
2. Producing learners who would live science enriched lives	67	11.3
3. Producing learners who would be sensitive to environmental sustainability issues	102	17.2
1 and 2	28	4.7
1 and 3	98	16.5
1, 2 and 3	84	14.2
I don't know	1	.2
2 and 3	6	1.0
Other	2	.3
Total	593	100.0

5.2.6.2. Challenges which hindered science citizenship education

The results indicated that lack of teacher staff-development on citizenship education was the main challenge that militated against science citizenship education as one hundred and seventy-nine (30.2%) respondents pointed it out and that response was also part of most of the combinations given. Seventy-one (12.0%) pointed to lack of a clear policy as the challenge. Fifty-eight (9.8%) viewed the lack of objectives on citizenship education in the Combined Science syllabus as the challenge while fifty-one (8.6%) pointed to lack of adequate time for promoting citizenship education as the challenge. Some respondents gave combinations of 1, 2, 3 and 4 as shown in Table 5.20 as they stated that effective science citizenship education was hindered by a combination of factors. Table 5.20 summarised the results.

Table 5.20

Challenges which hindered science citizenship education

	frequency	percent
1. Lack of clear policy	71	12.0
2. Lack of teacher staff-development on citizenship education	179	30.2
3. Lack of objectives on citizenship education in the Syllabus	58	9.8
4. Lack of adequate time for promoting citizenship education	51	8.6
1 and 3	14	2.4
2 and 4	50	8.4
1, 2, 3 and 4	47	7.9
2 and 3	23	3.9
1 and 2	35	5.9
1, 2 and 3	30	5.1
Other	35	5.9
Total	593	100.0

5.2.6.3 Challenges which hindered science practical work

The respondents indicated that science practical work was not offered adequately due to a wide range of challenges experienced by schools. Most of the respondents viewed the challenges that hindered practical work as a combination of factors. Large classes, lack of apparatus and lack of chemicals were the most common reasons stated. In the combinations of challenges, a total of two hundred and ninety-eight (50.3%) respondents mentioned large classes, lack of apparatus and lack of chemicals. That percentage increased when those who mentioned one challenge were also included. For example, a total of three hundred and fifty-six (60.0%) indicated that large classes hindered science practical work. Two hundred and fifty (42.2%) respondents indicated that a heavy workload also inhibited science practical work. A total of one hundred and forty-four (24.3%) respondents stated that inadequate teaching time also hindered the carrying out of science practical work. There were many combinations that were given by the respondents and those that were not very popular were captured under ‘other’. Some respondents gave combinations of 1 and 2; 1 and 3; 2, 4 and 7 and these were captured as ‘other’. A summary of the results was presented in Table 5.21.

Table 5.21

Challenges which hindered science practical work

	frequency	percent
1. Large classes	58	9.8
2. Lack of apparatus	56	9.4
3. Lack of chemicals	19	3.2
4. Heavy workloads	27	4.6
5. Inadequate teaching time	21	3.5
6. Poor teaching methods	2	.3
7. Inadequate trained science teachers	8	1.3
1, 2, 3 and 4	100	16.9
2 and 3	25	4.2
1, 2, 3, 4, 5, and 7	48	8.1
1, 2 and 3	75	12.6
1, 2, 3, 4 and 5	75	12.6
Other	79	13.3
Total	593	100.0

5.2.6.4 Challenges which hindered the assessment of science practical skills

Most of the respondents indicated a combination of factors as challenges which hindered the assessment of science practical skills. Large classes, lack of apparatus and lack of chemicals were the most common responses in the combinations. Two hundred and seventy-seven (46.7%) indicated these three in their combinations. A total of three hundred and fifty-seven (60.2%) stated that large classes were a challenge to effective assessment of practical skills. Three hundred and seventy (62.4%) pointed to lack of apparatus as a challenge to practical skills assessment. Three hundred and sixteen (53.5%) respondents said that lack of chemicals hindered the assessment of practical skills in learners, while one hundred and ninety-six (33.1%) blamed a heavy teacher workload for limiting effective practical skills assessment. The results were summarised in Table 5.22.

Table 5.22
Challenges which hindered the assessment of science practical skills

	frequency	percent
1. Large classes	80	13.5
2. Lack of apparatus	70	11.8
3. Lack of chemicals	16	2.7
4. A heavy teacher workload	22	3.7
5. Inadequate time	21	3.5
6. Poor question setting	1	.2
7. Inadequate trained science teachers	6	1.0
1, 2, 3 and 4	80	13.5
2 and 3	23	3.9
1, 2, 3, 4, 5 and 7	41	6.9
1, 2 and 3	103	17.4
1, 2, 3, 4 and 5	53	8.9
Other	77	13.0
Total	593	100.0

5.2.6.5 General views of respondents

Item 27 on the questionnaire (see Appendix R) was an open-ended item where the respondents were invited to give their views on the concept of science citizenship education, practical work pedagogies and practical work assessments. The respondents generally commented on twelve items that were numbered 1-12 in Table 5.23. Some respondents were stating two or more responses and all their contributions were captured in the data capturing process. This item, therefore, had one thousand and seventy-one (1071) responses although the respondents were five hundred and ninety-three (593). On calculating the percent of the response, the current researcher used the number of respondents and not the number of responses so the cumulative percent was then greater than 100 percent. In other words, the current researcher was interested in finding out how many respondents gave a particular response. For example, two hundred and seventy respondents stated that practical work was hindered by lack of laboratory technicians, large classes and limited resources and that represented 45.5% of the total respondents. General comments with high frequencies were that practical work was hindered by lack of laboratory technicians, large classes and limited resources; government and industry were supposed to fund science practical work in schools; teachers were supposed to be staff-developed on the concept of science citizenship education and that the Combined Science syllabus was too long, so time was not adequate to carry out frequent practical work. Table 5.23 summarised the general views of the respondents with regard to science citizenship education and practical work in science.

Table 5.23

General views of respondents

	frequency	percent
1. Government and Industry should fund science practical work	125	21.1
2. Teachers should be staff-developed on the concept of science citizenship education	124	20.9
3. Teachers should have good working conditions so that they are motivated	37	6.2
4. Untrained science teachers are not competent on practical work	60	10.1
5. Government should have a clear policy with regard to science citizenship education	53	8.9
6. Lack of laboratory technicians, large classes and limited resources hinder practical work	270	45.5
7. Lack of financial support from school administrators limits practical work	42	7.1
8. Linking science citizenship education to practical work is vital	17	2.9
9. Learners should do projects which benefit the community	35	5.9
10. Practical work should be done frequently since it motivates learners	74	12.5
11. Lack of textbooks hinders practical work	18	3.0
12. Combined Science Syllabus is too long	79	13.3
13. No comment given	137	23.1
Total	1071	

5.2.7 The relationship between variables

The critical position to establish in the current section is whether there are variables that are closely related to such an extent that they affect each other. Spearman's rank correlation coefficient was calculated on the data which was gathered in the cross-sectional survey. The data were non-parametric and hence Spearman's correlation was used. The Spearman's rank correlation coefficient analysis was carried out to compare the data pertaining to the tested variables (listed as A to T under Table 5.24(b)). The tested variables were supposed to be included in Table 5.24 (a) and Table 5.24 (b) but they were presented outside the tables due to limited space. The tested variables, A to T, have been described in a key which is below Table 5.24 (b). Table 5.24 (b) is a continuation of Table 5.24 (a) and it was extracted to enable the data to be readable since a composite table would be too crowded.

Data interpretation on the Spearman's rank coefficient

The results indicated that there was a strong correlation between challenges faced when teaching science practical work (J) and challenges faced during the assessment of practical skills (K). The Spearman's rank correlation coefficient was .657 at 99% level of significance. The positive value indicated that the more the challenges are faced during the teaching of practical work (J), the more the challenges which are faced during the assessment of practical skills (K). There is also a strong positive correlation between challenges against science citizenship promotion (Q) and ways to enhance science citizenship education (P). The Spearman's rank correlation coefficient was .614 at 99% level of significance. A correlation value of about .30 indicates a moderate correlation. For example, there was a positive moderate correlation between ways to integrate citizenship education to science pedagogy (T) and ways to enhance science citizenship education (P). The Spearman's rank correlation coefficient was .353 at 99% level of significance. The same applied to challenges faced when teaching science practical work (J) and challenges which militated against science citizenship promotion (Q), with a correlation coefficient of .340 at 99% significance level. There was a weak negative correlation between the state of science equipment in schools (B) and the roles of learners during practical work (F) with a correlation coefficient of -.123 at 99% significance level. There was also a weak correlation between state of science equipment in schools (B) and teacher activity during practical work (E), with a Spearman's rank correlation coefficient of .094 at 95% significance level. The rest of the results were presented in Table 5.24 (a) and Table 5.24 (b). The tested variables A to T were described in a key which is below Table 5.24 (b).

Table 5.24 (a)

A representation of correlation between the tested variables (A to T)

	A	B	C	D	E	F	G	H	I	J	K
B	-.126**	-									
	.002										
C	-.026	-.006	-								
	.534	.881									
D	.024	.170**	.018	-							
	.555	.000	.653								
E	-.014	.094*	.111**	.111**	-						
	.740	.022	.007	.007							
F	.005	-.123**	.160**	-.134**	.140**	-					
	.904	.003	.000	.001	.001						
G	-.005	-.051	.066	.087*	.044	-.022	-				
	.904	.211	.107	.034	.280	.599					
H	.055	-.062	.062	.000	.195**	.258**	.123**	-			
	.181	.132	.131	.991	.000	.000	.003				
I	.082*	-.201**	.098*	-.169**	-.022	.335**	.004	.241**	-		
	.045	.000	.018	.000	.591	.000	.914	.000			
J	.087*	.022	.131**	.111**	.212**	.220**	-.013	.212**	.101*	-	
	.034	.597	.001	.007	.000	.000	.749	.000	.014		
K	.068	-.002	.092*	.073	.204**	.207**	-.009	.195**	.156**	.657**	-
	.099	.956	.025	.074	.000	.000	.823	.000	.000	.000	
L	.047	-.048	.112**	.014	.162**	.228**	.089*	.201**	.245**	.137**	.195**
	.249	.245	.006	.725	.000	.000	.030	.000	.000	.001	.000
M	.010	-.039	.088*	.009	.185**	.196**	.060	.274**	.144**	.255**	.264**
	.803	.346	.032	.819	.000	.000	.146	.000	.000	.000	.000
N	-.012	-.036	.079	.066	.195**	.271**	.049	.337**	.238**	.311**	.339**
	.769	.384	.053	.109	.000	.000	.231	.000	.000	.000	.000
O	.011	-.033	.108**	.033	.216**	.288**	-.007	.263**	.168**	.206**	.307**
	.794	.430	.008	.418	.000	.000	.872	.000	.000	.000	.000
P	-.016	-.031	.093*	.029	.226**	.285**	.025	.226**	.167**	.332**	.357**
	.690	.449	.024	.477	.000	.000	.542	.000	.000	.000	.000
Q	.014	-.038	.042	.072	.219**	.262**	.031	.261**	.184**	.340**	.342**
	.736	.361	.311	.081	.000	.000	.447	.000	.000	.000	.000
R	-.005	-.012	.102*	.039	.175**	.200**	.079	.403**	.204**	.244**	.236**
	.898	.763	.013	.348	.000	.000	.056	.000	.000	.000	.000
S	-.013	.020	.026	.111**	-.020	.059	-.044	.040	-.005	-.002	.108**
	.757	.627	.530	.007	.628	.152	.282	.329	.910	.961	.009
T	.037	.004	.107**	.011	.194**	.215**	-.004	.193**	.167**	.217**	.207**
	.366	.932	.009	.787	.000	.000	.927	.000	.000	.000	.000

** Correlation at 0.01 (2-tailed)   * Correlation at 0.05 (2-tailed)

Table 5.24 (b)

A representation of correlation between the tested variables (A to T) (continued)

	L	M	N	O	P	Q	R	S
M	.300**	-						
	.000	.						
N	.276**	.396**	-					
	.000	.000	.					
O	.290**	.380**	.468**	-				
	.000	.000	.000	.				
P	.274**	.350**	.476**	.432**	-			
	.000	.000	.000	.000	.			
Q	.222**	.335**	.529**	.409**	.614**	-		
	.000	.000	.000	.000	.000	.		
R	.229**	.343**	.295**	.264**	.252**	.230**	-	
	.000	.000	.000	.000	.000	.000	.	
S	.004	.012	.085*	.006	.005	.065	.058	-
	.921	.762	.039	.892	.908	.111	.159	.
T	.221**	.397**	.399**	.401**	.353**	.347**	.227**	-.032
	.000	.000	.000	.000	.000	.000	.000	.435

** Correlation at 0.01 (2-tailed)   * Correlation at 0.05 (2-tailed)

Key: Tested variables (A to T) presented in Table 5.24 (a) and Table 5.24 (b)

A. Professional qualifications

B. State of science equipment

C. Teaching methods used

D. Frequency of practical work

E. Teacher activity during practical work

F. Roles of learners during practical work

G. State of science citizenship education

H. How citizenship education was linked to science practical work

I. Methods used to assess practical skills

J. Challenges which hinder science practical work

K. Challenges which hinder the assessment of practical skills

L. Methods to effectively assess practical skills

M. Ways to enhance citizenship education during assessments

N. Possible benefits of science citizenship education

O. Ways to promote science citizenship education

P. Ways to enhance science citizenship education

Q. Challenges which hinder science citizenship education

R. How citizenship education was linked to practical assessments

S. Staff-development of teachers on science citizenship education

T. Ways to integrate citizenship education to science pedagogy

5.3 Qualitative data analysis and presentation

The qualitative data presented in the current chapter pertained to the Combined Science Syllabus Forms 1-4 reviewed as well as data collected from each of the three cases. The current researcher carried out document analysis of the Combined Science Syllabus Forms 1-4. The current researcher also collected data on the pedagogies and assessments employed in the teaching and learning of practical work in Combined Science. Informed by the theoretical framework, the current researcher also collected data on the state of science citizenship education in relation to science practical work. From each school, data were collected through an interview with the Combined Science teacher of the sampled class, a focus group discussion with Combined Science teachers within the school, an interview with the School Head, a Combined Science lesson observation as well as document analysis of the Combined Science teacher's schemes of work for the sampled class. The data collection instruments used, that is, the interview schedule (Appendix N), the focus group moderation schedule (Appendix P), the lesson observation checklist (Appendix O) and the document analysis form (Appendix Q) were developed from the concepts presented in the theoretical framework which were also raised in the research questions. The data collection instruments thus focused on the pedagogy of science practical work, the assessment of science practical work and citizenship education (as discussed in the theoretical framework). The three schools from where data were collected were Takudzwa Secondary School, Tatendashe Secondary School and Tivongereiwo Secondary School A. detailed account of the data collection process was presented in Chapter 4.

5.3.1 General information on qualitative results

Qualitative data were collected from three schools. The data were collected through five data collecting instruments. The processes used at each sampled school were outlined in Chapter 4. The processes used to collect data were:

- document analysis of the schemes of work prepared by the Combined Science teacher of the sampled class (Appendix Q)
- non-participant lesson observation for the sampled class carried out by the current researcher (Appendix O)
- the use of a semi-structured interview with the Combined Science teacher of the sampled class (Appendix N)
- a focus group discussion with the Combined Science teachers at the sampled school (Appendix P)
- the use of a semi-structured interview with the sampled school's Head (Appendix N)

The data analysis and presentation for the multiple-case study were based on the Interpretative Phenomenological Analysis (IPA) system. IPA recommends that data analysis and presentation on each case or participant be done independently so that comparisons are made at the end (Taylor, 2015). As such, data from each of the three schools were analysed and presented separately and comparisons were made among the schools at the end. Data analysis followed the themes that emerged from the data and these themes were closely related to the themes that addressed the research questions. Since the research questions were developed from the concepts in the theoretical framework, the themes were thus based on the theoretical framework.

For each school, data were presented following the order of data from document analysis, lesson observation, teacher interview, focus group discussion and School Head's interview. An interview was not carried out with Tatendashe Secondary School Head because he was not at the school when the researcher collected the data. The school did not give the researcher the School Head's cell phone number as it was their school policy that official business be conducted using the school's landline telephone number. The researcher failed to contact or visit the School Head later on as the schools were then closed indefinitely due to the COVID-19 pandemic. There was no focus group discussion at Tivongereiwo Secondary School because there was only one Combined Science teacher. Data was not collected from the fourth school, Nothando Secondary School, as schools were prematurely closed due to the corona virus pandemic and that coincided with the period when data was supposed to be collected from that school. It was also not possible to reschedule for data collection at Nothando Secondary school as the schools were closed indefinitely. Therefore, results were reported for three schools. Pseudonyms were used for all the schools, the sampled classes and all the participants so that their anomymity was maintained.

5.3.2 Document analysis of the Combined Science Syllabus Forms 1-4

The Combined Science Syllabus Forms 1-4 was analysed so that the official positions pertaining to the pedagogy and assessments of practical work were put into context. The syllabus was also reviewed so that the official position pertaining to state of science citizenship education was also put into context. The general information included in the Combined Science Syllabus Forms 1-4 emphasised that the learning area be taught using learner-centred pedagogies that stimulated critical-thinking and problem-solving skills. The syllabus also highlighted that practical work was an integral part of the pedagogies employed. The knowledge and skills were supposed to be acquired in a way that enhanced their application. The information was presented as:

- *"The syllabus provides an understanding in Combined Science and a suitable preparation for the study of science related fields*
- *A learner-centred practical approach to the subject is adopted to develop scientific thinking and application of acquired knowledge and skills*
- *It develops knowledge, understanding and practical application of basic scientific concepts and principles as well as the ability to handle information and critical-thinking*
- *Learners will gain practical experience and leadership skills through individual and group experimental work*
- *The syllabus covers science concepts such as observing, recording, measuring, presentation, interpretation of data and analysis*
- *It also imparts practical skills such as handling of apparatus, chemicals, plant and animal specimens safely and confidently"*
  (Combined Science Syllabus Forms 1-4, p. 1)

A wide range of pedagogies to be employed in the teaching and learning process were listed as:

"Emphasis should be placed on providing learners with practical experience so that they see science as an active and exciting study. Principles of individualisation, concreteness, totality and wholeness, self-activity and stimulation should underpin the implementation of teaching/learning methods in this learning area. The following methods are suggested:

- *Experiments*
- *Demonstrations*
- *Problem-solving*
- *Field trips*
- *Games*
- *Co-operative learning/Group work*
- *Simulations*
- *Case studies/Research*
- *Question and Answer*
- *Discussions*
- *Surveys, Interviews and Report writing*
- *Concept mapping*
- *Visual tactile*
- *Individualisation"*

(Combined Science Syllabus Forms 1-4, p. 2)

The syllabus recommended eight (8) periods of 35 minutes per week which was a time allocation of 4 hours 40 minutes. The emphasis of the syllabus was that the pedagogy was practical work oriented hence double periods were recommended. The syllabus recommended a class size of a maximum of 35 learners so as to accommodate adequate supervision of learners during practical work. Educational tours were recommended to link the science concepts and practical work to the field of work or the community. That is summarised by the statements that:

"For adequate coverage of the syllabus, a time allocation of 8 periods of 35 minutes per week is recommended

Double periods are recommended to accommodate practical work

The class size should not exceed 35 learners

At least 2 educational tours per year are recommended"

(Combined Science Syllabus Forms 1-4, p. 2)

The Combined Science learning area was supposed to develop skills that enhance the progression of a learner for further studies, a career or a science-enriched life. That was possible through the integration of cross cutting themes to the scientific concepts as indicated in the information:

"In order to foster competency development for further studies, life and work, the following cross-cutting priorities have to be taken into consideration in the teaching and learning of Combined Science:

- *Gender*
- *Children's rights and responsibilities*
- *Disaster risk management*
- *Financial literacy play store*
- *Health issues*
- *Heritage studies*
- *Collaboration*
- *Environmental issues*
- *Socio-cultural beliefs"*

(Combined Science Syllabus Forms 1-4, p. 1)

The aims of the syllabus were outlined as to enable learners to:

- *"provide an opportunity to develop desirable scientific literacy*

- *promote critical-thinking, creativity and problem solving skills that apply to real-life situations*
- *develop scientific practical skills, accuracy, objectivity, integrity, enquiry and team work*
- *develop attitudes relevant to science such as self-initiative, self-managing and enterprising*
- *relate scientific practices to sustainable use and extraction of value from our natural resources*
- *participate in the technological development of Zimbabwe and the global world"* (Combined Science Syllabus Forms 1-4, p. 1)

The objectives of the Combined Science learning area were that learners would be able to:

- *"apply scientific principles in solving problems and in understanding new situations*
- *describe observations, record results, interpret and draw conclusions from experiments*
- *demonstrate knowledge of scientific terms, laws, facts, concepts, theories and phenomena*
- *demonstrate knowledge and understanding in relation to scientific and technological applications with their social, economic and environmental implications*
- *demonstrate relevant attitudes to science such as accuracy and precision, objectivity, integrity, enquiry initiative, teamwork and inventiveness*
- *demonstrate knowledge and understanding of scientific instruments and apparatus including techniques of operations and aspects of safety*
- *use different forms of data presentation to give rational explanations of scientific phenomena*
- *plan, organize and carry out experimental investigations*
- *draw scientific diagrams in two dimensions*

- *apply scientific principles, formulae and methods to solve qualitative and quantitative problems*
- *apply scientific principles, methods and techniques in value addition and beneficiation of our natural resources*
- *use appropriate methods of recycling and/or disposing wastes*
- *communicate scientific information logically and concisely"*

(Combined Science Syllabus Forms 1-4, p. 1)

The assessment objectives listed in the syllabus formed the basis of the national summative assessments. The assessment objectives indicated that the development of critical-thinking skills, problem-solving, creativity, planning skills and practical skills were vital for learners as these were also part of the assessment objectives. Learners were required to be able to operate above the recall and comprehension levels. The assessment objectives stated that learners were assessed on their ability to demonstrate knowledge and understanding of:

- *"scientific instruments and apparatus, techniques and aspects of safety*
- *scientific units, terminology, symbols and conventions*
- *scientific quantities and how they are determined*
- *scientific phenomena, facts and laws, definitions, concepts, theories and models*
- *personal, social, economic and environmental implications of science applications*
- *extract information relevant to a particular context from data presented in diagrammatic, symbolic, graphical, numerical or verbal form*
- *use data to recognize patterns, formulate hypotheses and draw conclusions*
- *translate information from one form to another*
- *communicate logically and concisely*
- *explain facts, observations and phenomena in terms of scientific laws, theories and models*
- *explain technological applications of science and evaluate their associated personal, social, economic, and environmental implications*
- *make logical decisions based on the examination of evidence and arguments*

- *apply scientific principles, formulae and methods to solve qualitative and quantitative problems*
- *suggest explanations of unfamiliar facts, observations and phenomena*
- *follow instructions for practical work*
- *plan, organise and carry out experimental investigations*
- *select appropriate apparatus and materials for experimental work*
- *use apparatus and materials effectively and safely*
- *make accurate, systematic observations and measurements, recognising the variability of experimental measurements*
- *observe, measure and record results of experimental procedures*
- *identify possible sources of error in experimental procedures*
- *draw conclusions and make generalisations from experiments*
- *extract information from data presented in diagrammatic, graphical or numerical form"*

  (Combined Science Syllabus Forms 1-4, p. 88)

Table 5.25 shows the assessment objectives and the weighting they were assigned in the summative examinations. In Papers 1 and 2, knowledge and comprehension constituted 60% and handling information and problem-solving constituted 40% while Paper 3 was 100% experimental/practical skills (see Table 5.25).

Table 5.25

*Weighting of Combined Science assessment objectives (*source: Combined Science Syllabus Forms 1-4, p. 89*)*

	Assessment objectives	***Weighting***
Paper 1 and 2		
Knowledge and comprehension	***1.0***	***60%***
Handling information and problem-solving	***2.0***	***40%***
Paper 3		
Experimental skills	***3.0***	***100%***

5.3.3 Context of the first school: Takudzwa Secondary School

Takudzwa Secondary school was a government mixed sex boarding school. The school was in an urban setting and had some learners who were day scholars. The school was established before Zimbabwe attained independence in 1980. The general infrastructure of the school was good although some areas needed renovations, for example, the gas taps in the junior science laboratories were non-functional. A Form 3 Combined Science class was sampled. The class, Form 3 Dove, had forty-seven (47) learners and it was a mixed sex class. The class had six Combined Science lessons of thirty-five minutes each per week. The lessons were presented as double lessons on the school timetable. This was in line with the recommendation given in the Combined Science Syllabus Forms 1-4 which recommended double lessons to accommodate practical work. Form 3 Dove was taught Combined Science by Mrs. Rudo. Mrs. Rudo was a qualified science teacher who had teaching experience of thirty-two years. She held a Certificate in Education (Science) from a Zimbabwean Teacher's College and a Bachelor of Science Degree in Guidance and Counseling from a Zimbabwean University. Mrs. Rudo taught Combined Science and Biology. She had twenty-eight (28) lessons a week and was the Head of the Science Department at the school.

The school had seven science laboratories and one laboratory assistant. Three of the laboratories were reserved for Advanced level Chemistry, Biology and Physics teaching. The Forms One to Four science lessons were carried out using four laboratories. Mrs. Rudo carried all her lessons in one of the four laboratories designated for Forms One to Four. The laboratory was well ventilated and maintained a good level of cleanliness. However, the laboratory had some broken tables and all gas taps were non-functional.

5.3.3.1 An analysis of Mrs. Rudo's schemes of work

Document analysis was done for Mrs. Rudo's schemes of work for Term 1, a period from 14 January 2020 to 3 April 2020. The week when schools opened and the week when schools closed were not analysed since the teacher indicated that she carried out administrative roles like registration of learners and consultation with the parents of the learners. The analysis was focused on ten weeks. Since each week had three double lessons, the analysis focused on thirty double lessons. An analysis of the schemes of work was important as they had a crucial role of guiding the teaching and learning process through indicating the topics, content and objectives that were covered each week. The schemes of work also outlined the activities carried out and the pedagogies employed. They also indicated practical work carried out, the apparatus and chemicals used and the assessments given. Thus, the schemes of work were relevant to the current research which sought to understand the pedagogy of practical work and assessments in the teaching and learning of Combined Science in Zimbabwean schools. The justification sufficed for the schemes of work analysed. The analysis of the schemes of work was carried out under themes that answered the research sub-questions as indicated in the document analysis form (Appendix Q).

(a) The state of science practical work

The schemes of work indicated that learners carried out individual practical work as well as group practical work. Teacher demonstrations were also used to illustrate practical work during the teaching and learning process. A total of seven practical activities were indicated within thirty double lessons. That was an average of one practical work in four to five double lessons. Of the practical activities indicated, one was a teacher demonstration and six were carried out by learners. However, the schemes of work did not specify whether these practical activities were carried out by learners in groups or as individuals. Standard apparatus were mentioned, for example, the schemes of work alluded to the use of microscopes, vernier calipers and micrometer screw gauges.

(b) The state of science practical work assessment

No practical work assessments were indicated in the schemes of work. Only theory tests were indicated. While the current research was also focused on evaluating the assessments used for practical work, that was not applicable for Form 3 Dove since no practical tests or assignments were given to learners.

(c) The state of science citizenship education

It was also noted that the schemes did not relate the practical work or assessments to the concept of science citizenship education.

5.3.3.2 Form 3 Dove lesson observation

The lesson was observed in ta science laboratory on Tuesday 10 March 2020 from 10.30 am to 11.40 am. The topic covered was on acids, bases and salts. The objective covered was on identifying the regions of acidity, neutrality or alkalinity of a substance on the pH scale using universal indicator solution.

(a) Pedagogies employed

The teacher introduced the topic by linking it to the alimentary canal. The teacher asked probing and prompting questions and learners stated that the contents of the mouth were neutral and the contents of the stomach were acidic. The teacher then demonstrated the practical following the steps that she had written on the chalk board. The procedure showed sequential steps the learners were supposed to follow. The teacher demonstrated the experiment using one of the four solutions. Learners were then divided into groups of four or five and they carried out the practical work in their groups. They recorded their observations which they reported during a class discussion. The learners also cleaned the apparatus. The teacher used English and scientific language during the lesson and also used a vernacular language (Shona) to emphasise certain points. There were 47 learners and that made classroom control very difficult during practical work. The 47 Form 3 Dove learners in one class were above the 35 learners recommended in the Combined Science Syllabus Forms 1-4.

(b) An analysis of the teaching pedagogies used

The pedagogies employed were a teacher demonstration, learner group practical work and class discussions. As learners worked in their groups, there was learner collaboration. Learner-centred pedagogies were thus employed. There was active learner participation as learners carried out the practical work and also during class discussions. However, the step by step instructions written on the board and the teacher demonstration made the practical work an ineffective and undesirable "teacher-prescribed confirmatory" activity (Cowie, 2015, p. 69).

(c) Practical work done

The learners copied the procedure into their practical exercise books. One learner from each group was invited to collect the apparatus and the solutions needed to carry out the practical. Each group representative was given four test tubes, each containing one of the four solutions. The group representatives labeled the test tubes so that they would not confuse the solutions. The solutions were vinegar, water, a dish washing liquid that contained ammonia and a solution made from tooth paste. Each group representative was also given a small beaker with universal indicator solution and a dropper. The learners then carried out the experiment in groups. The learners made observations and recorded them on rough paper. One learner from each group was invited to report the group's observations during a class discussion. The learners then recorded observations that were endorsed by the teacher into their practical exercise books. The learners used textbooks which were used in the old curriculum by referring to the relevant topics. There was one copy of the relevant textbook and it was used by the teacher.

(d) Practical skills assessment(s) employed

No practical skills assessment was done during the experiment. The practical work carried out and class discussions did not make any reference to citizenship education.

5.3.3.3 Mrs. Rudo's interview

(a) Pedagogies used

When Mrs. Rudo responded to a question on the teaching methods she employed, she said

> *I usually do demonstrations, defining, describing, maybe at times carrying out experiments here and there and maybe going out for field studies.*

Mrs. Rudo thus stated that when she taught the Combined Science, she used demonstrations, class discussions and field tours especially when teaching about ecosystems. She also stated that she carried out some experiments with her classes.

Mrs. Rudo stated that her role during practical work was to explain the aim of the experiment so that the learners would be clear of what they were looking for as well as monitoring that the learners carried the procedure correctly. She said that during practical work, learners carried out the experiments in groups.

(b)The state of practical work

She stated that the general frequency of practical work was once per week depending on topics since some topics did not require experiments. According to Mrs. Rudo, the apparatus and chemicals were not very limiting at their school especially for the teachers to be able to carry out teacher demonstrations and learners' group practical work. She stated that

> *the resources here at Takudzwa Secondary School usually are not very limiting, we have most of the chemicals, we do have them though they are not in abundance, but at least we can use demonstrations.*

Mrs. Rudo pointed out that individual practical work was generally not carried out due to large classes and limited time. She highlighted that at Takudzwa Secondary School, teaching time in relation to the length of the syllabus was a challenge that led to limited practical work as illustrated in her statement that

> *we usually limit the number of experiments because of time. If we are going*

to be carrying out experiments always, then we won't go through our syllabus.

When responding to a question on any other challenges she faced in her teaching, she responded by saying that

> *challenges are there, especially the number of learners in our classes. They are too big which makes it difficult for us to carry out activities.*

Mrs. Rudo also lamented that some tables in the laboratory were broken and gas taps were not functional especially that there was no hope that they were going to be repaired as illustrated in her statements which referred to tables and gas taps respectively:

> *I have been reporting about the broken tables since last year.*

> *I have never seen them working, I came here in 2008, I found them broken.*

Mrs. Rudo also said that she had observed that learners were generally not forthcoming during practical work as they were afraid to handle the apparatus and the chemicals. The statement alluded to the fact that the majority of learners lacked exposure to practical work and as such were not confident and/or competent in handling the apparatus.

(c) Practical skills assessment

Mrs. Rudo mentioned that practical skills were assessed through the practical write-ups, for example, she assessed how a learner linked the aim of an experiment to the conclusion. She said on rare occasions, simple practical tests were given at the end of year at Form 3 and Lower 6 due to lack of resources, time and large classes. She added that preparations for practical tests were taxing on the part of the teacher. When asked how science practical skills assessments were linked to citizenship education, she said,

> *so far we can't say we have seen anything as yet. I am sure we are yet to see as we go along with the practicals.*

The comments painted a picture that practical skills assessments were not linked to citizenship education. Mrs. Rudo proposed that the assessment of practical skills could be linked to science citizenship through showcasing of artifacts produced by learners and rewards being offered to excelling learners even at school level.

(d) The state of citizenship education

On the concept of science citizenship education, Mrs. Rudo stated that it was demonstrated through science exhibitions. The exhibitions were platforms where learners showcased gadgets or artifacts that they would have produced using scientific concepts and principles. The science exhibitions allowed learners from different schools to compete on application of science concepts that were demonstrated through gadgets or simple machines that the learners produced. At Takudzwa Secondary School, the exhibitions were attended by learners who were members of the Science Club especially those who would have produced gadgets to showcase. Mrs. Rudo indicated that although preparations for science exhibitions were coordinated by the Science Club, any learner willing to participate in the exhibitions was always given support by the science teachers. She viewed the promotion of science citizenship education as a development that could lead to the production of many artifacts to improve the standard of lives of learners and citizens but was quick to point out that the learners would need to get a lot of financial support from the government. The science citizenship goal could be achieved if funding was availed and the number of exhibitions increased. She proposed that the number of exhibitions carried out could be increased per year so that more gadgets are produced.

According to Mrs. Rudo, science practical work was linked to citizenship education by mentioning the application of the practical work in the home situation. Responding to the question on how she linked practical work to citizenship education, she said that,

> *I usually link citizenship by maybe trying to mention the home situation.*

However, she pointed out that the majority of practical work done at school was not related to citizenship education.

Mrs. Rudo argued that citizenship education could be enhanced when learners practiced the practical skills learnt at school in their everyday lives at home, for example, learners could set their own biogas systems to use as a source of energy at home. Science citizenship education could be enhanced when learners practiced practical work at home as illustrated in her statement that *encourage the learners to open their eyes wider when they are at home to see how they can integrate the citizenship with what they have at home… they should try to open their eyes wider and see where the science they learn at school could be integrated in the home.*

However, Mrs. Rudo was quick to point out that learners would thus need to be exposed to more individual practical work for them to be able to confidently and correctly apply the concepts and skills learnt during practical lessons at home, a position which was yet to be fulfilled at their school.

(e) Challenges that militated against the implementation of science citizenship education

Mrs. Rudo reiterated that the implementation of science citizenship education was hindered by large classes, lack of adequate teaching time, a syllabus which was too long, lack of teacher motivation, lack of appropriate textbooks and heavy teacher workloads. She explained that even though the Combined Science Syllabus Forms 1-4 recommended eight (8) periods per week, the classes were allocated six (6) periods because the eight failed to fit on the school timetable due to a wide curriculum that was implemented at the school. Mrs. Rudo was seized with the completion of the syllabus which the current researcher interpreted as a requirement for the learners to be well prepared for the national summative examinations. She also stressed that teachers were de-motivated due to poor remuneration. Mrs. Rudo stated that the teacher remuneration was dwindling whilst the workload was increasing as illustrated by her statement that

workload is going up and remuneration is going down.

She also lamented the workload and the class sizes as illustrated by her statement that

you are supposed to have 30 lessons and above, not only 30 but 30 with 60 pupils in each class.

5.3.3.4 Takudzwa Secondary School's focus group discussion

The focus group discussion was carried out between 10.00 am and 11.00 am in the HOD's office. The researcher provided the participants with drinks and snacks and generally, the mood was very relaxed and friendly. Five teachers and one laboratory assistant attended. All the teachers were qualified science teachers who held Certificate in Education (Science), Diploma in Education

(Science), Bachelor of Science degree in Physics and Bachelor of Education (Chemistry). Their teaching experience ranged from twelve (12) years to thirty-two (32) years. The laboratory assistant had no professional training since she was just post Advanced level.

(a) Pedagogies employed during practical work

The Takudzwa Secondary School focus group pointed out that they taught Combined Science using a range of methods such as class discussions which were directed and focused by teacher questions, learner group assignments, teacher demonstrations and sometimes the lecture method. They stated that practical work was often carried out as teacher demonstrations and group practical work for learners. During practical work, the teacher wrote the aim, materials and instructions on the board for learners to copy and follow. The learners copied the instructions into their note exercise books. The teacher also availed the apparatus and chemicals required for the practical work in liaison with the laboratory assistant. Responding to the question regarding to the activities of a teacher during a practical, one of the participants said that the teacher's role was

> *to urge learners to interpret, to follow instructions and of course to avail to them the implements, the materials so that they can use. In most cases we don't make arrangements prior to the lesson but some arrangements still come to be done during the practical, in most cases that's when every teacher is most active just to make sure that the apparatus are there.*

During a teacher demonstration, the learners made observations and recorded them into the note exercise books and did not handle the apparatus. That was revealed by a participant who said

> *since most of their practicals are demonstrations, normally they observe, examine, if the practical involves colour changes.*

The teacher demonstrations and/or group practical work were generally carried out once a month or more than once depending on topics. That was stipulated in the responses of two of the participants. The first participant to the question on the frequency of the practical work said

> *handiti apa toda kutaura chokwadi chaicho? Tokwanisa kupedza aa kana once in a month inini hangu. (isn't it we are supposed to say the truth? We do ah once a month, in my case)*

Then the second participant said

demonstrations can be more than once a month.

The responses indicated that the teachers decided what to do with their classes with regard to practical work. Some teachers carried out more science practical activities as compared to others and no supervision was done. The focus group also said that some topics did not have practical work that could be carried out.

(b) Practical skills assessment

According to the focus group, there were two ways of assessing practical skills attained by learners. Practical skills were assessed through practical reports which the learners wrote. The teacher could tell from the report whether the learner carried out the procedure correctly or not, they said. Practical skills were also assessed as the teacher supervised how the learners handled the apparatus during a practical activity. The two positions were outlined by two participants whose responses were

> *yaa the results especially for example if it is titration if you want to know whether your learners have grasped what you taught them which means the titre values are supposed to be the same throughout the class*
>
> and
>
> *also as they carry out the practical you supervise how they are handling the apparatus.*

The focus group pointed out that the practical skills assessments they carried out at their school were not linked to science citizenship education hence the assessments did not promote citizenship education. The practical assessments were generally very limited during the teaching and learning process due to large classes of about sixty (60) learners per class, little time allocated to science, the need to cover the syllabus and limited apparatus and resources. The practical assessment was therefore very difficult to carry out at individual level, the focus group said. The focus group proposed that practical lessons and theory lessons could be done separately, for example, a block of four lessons could be time-tabled for science practical work per class per week.

(c) The state of science citizenship education

According to the focus group, issues of science citizenship education were addressed in the syllabus as visits to industries and projects were proposed. They stated that if learners could visit Sable Chemicals, (an industrial and agro-chemicals company in the Midlands province) for example, they could link science practical work to industrial production. They however pointed out that their school could not afford to send learners on such industrial tours. The focus group highlighted that soap production, which was part of the Combined Science Syllabus Forms 1-4, was a good topic that required the integration of science practical work to the concept of science citizenship education. The focus group pointed out that it would be beneficial if learners could carry out practical work within the school to produce soap which they could sell. The focus group also cited food preservation as a topic that could have practical work that was related to learner's lives. The learners could be given foodstuffs to preserve within the school. The learners would then be able to practice the skills at home. The focus group lamented that such topics were taught and learnt theoretically at their school because of lack of the resources required. They stated that they encouraged learners to apply science citizenship education for some topics that were based on discussions, for example, they encouraged learners who participated in sports to follow a diet recommended for sports and to avoid taking drugs. Thus, limited resources were limiting the implementation of science citizenship education. The focus group viewed the link between practical work and citizenship education as an important one arguing that learners would take science practical work seriously if it was linked to their way of life.

The focus group posited that the implementation of science citizenship education was possible only if fewer learners were assigned to science classes, resources were provided, teachers were motivated and science clubs were funded adequately to find solutions to community challenges. One of the participants said that

> *first and foremost is the teacher-pupil ratio, there should be less and less learners per one science teacher, and of course availability of resources.*

The focus group was optimistic that with adequate resources and time, science teachers and theirs learners could find solutions to most science-related challenges faced within the communities. For example, electricity was inadequate in Zimbabwe and science clubs could focus on finding alternatives if adequate resources were allocated to them. To expose more learners to the projects that were targeted at resolving community challenges, competitions could be held within a level, for example, Form One classes could compete on finding solutions to a particular problem faced in the community.

The focus group pointed out that science citizenship education was also hindered by policy issues, for example, taking learners out of the school premises was a taxing process which required clearance from the Ministry of Primary and Secondary Education (MoPSE). The focus group also suggested that parents needed to be involved in the concept of science citizenship education for them to embrace it and support the learners when they requested for materials to use at home to produce gadgets that would improve the families' way of life. Learners also needed to be encouraged to like science as they generally viewed science subjects as difficult subjects. The issue of large classes was highlighted many times and the focus group recommended that the teacher-learner ratio be reduced as was done in other practical subjects like Food and Nutrition where the ratio was comfortable and conducive for practical work. The focus group also suggested that more science teachers be recruited to deal with the large number of learners who studied Combined Science which was a compulsory learning area.

Benefits of an effective science education included the smooth running of marriages and families, they said. The example quoted was that spouses quarrelled over pots that were used to cook pork because one did not eat pork, failing to realise that once the pot is thoroughly cleaned, then the pork would no longer be within the pot. Another example cited was that families frequently had misunderstandings over a child suffering from dehydration, some members preferring to take the child to the hospital while other members would think that the child had been bewitched. The focus group argued that science citizenship education would give people scientific thinking, and as such, would resolve their challenges or problems scientifically. The focus group postulated that many gadgets and artifacts would also be produced since science citizenship education would promote inventiveness.

The focus group also felt that School Heads who had no science teaching background failed to appreciate why and how science departments at their schools were expensive compared to other departments within the school. As such, the School Heads failed to adequately support the science departments financially.

5.3.3.5 Takudzwa Secondary School Head's interview

(a) The state of science practical work pedagogy and assessment

Mr. Smart was the School Head and he pointed out that as a school, they had challenges in acquiring the apparatus and chemicals needed by the science department because these were very expensive and their school was struggling financially. He said that

> *teaching materials dzava kudhura especially masubstances for experiments dziri kudhura. (teaching materials are now expensive specially the substances that are used for experiments are expensive)*

He mentioned that they charged a science levy of ZW$100.00 (an equivalency of US$4 in March 2020). Very few learners paid their school fees and the science levy and the majority of the learners did not pay, as indicated by his statement that

> *vanwe vanozvinyararira zvavo, some pay just Form One wozovaona vava kucollector maresults. (some just keep quiet, some pay just Form One fees and then they will pay again when they come to collect their results)*

As a result of a tight budget and limited resources, there was minimal exposure of learners to practical work. Mr. Smart stated that,

> *experimental work is very minimum, I should confess, maybe the HOD can correct me there, but I believe it's very minimum.*

Mr. Smart pointed out that assessment of practical skills was mainly done theoretically, as practical work was not carried out frequently. He stated that *here and there tinoita hedu maexperiments but like I said it doesn't meet yatingati average standard so you find most of it is now theoretical. (here and there, we carry out experiments, but like I said, it doesn't meet what we can call average standard so you find most of it is now theoretical)*

Mr. Smart explained that as NASH (National Association of Secondary School Heads), they had requested the government to set up shops that would sell science equipment, apparatus and chemicals at reasonable prices. That was outlined in his statement that

takaita take a common position as NASH yokukumbira kuti matidini kutitsvagirawo, identify shops dzinotengesa science practical materials at maybe a reasonable price because vamwe varikutichaja mablack market rates.(we took a common position as NASH and requested that shops that sell science practical materials at maybe a reasonable price be identified because some are charging us using black market rates)

(b) The state of science citizenship education

On the issue of science citizenship education, Mr. Smart mentioned that the concept had not been fully embraced as the school was still in a transition state and was still operating with the mentality that science was done in a science laboratory. He said that

we are still in a transition period hatisati tanyatso absorber that thrust to its fullest…tichine that prejudice of yester year yokuti science inoitwa mulaboratory. (we are still operating in a transition period, we have not absorbed that thrust to its fullest…we still have that prejudice of yester year that science is done in a laboratory)

(c) Challenges that limited practical work and science citizenship education

Mr. Smart said that staff-development for School Heads and teachers was vital for them to be able to implement science citizenship education as summed up in his statement that

zvokuti totodawo some orientation and maybe staff-development yakatokura nokuti even our teachers you find most of us takatodzidza during those eras yokuti science yainzi inofanira kuitwa in the confines of the laboratory and this emphasis ye ZIMSEC or is it the Ministry yokuti kuti upiwe A level you should have put up a super structure ye laboratory *saka we still believe kuti ndimo munoitikira science since ichi emphasaiziwa saizvozvo. (we need some orientation and maybe serious staff-development because even our teachers, most of us were educated during the era that stipulated that science was done in a laboratory and also the ZIMSEC or is it Ministry position that for you to be cleared to have A level, you should have put up a super structure of a laboratory so we still believe that is where science takes place since it is emphasised as such)*

Mr. Smart felt that School Heads and science teachers needed staff-development on science citizenship since their background was deeply rooted in the belief that science was done in the laboratory and did not have the thrust to link it to the community.

5.3.4 Context of the second school: Tatendashe Secondary school

Tatendashe Secondary School was a government mixed sex day urban school. The school was situated within a high density residential area. The school had hot sitting, in other words, the learners were divided into two groups so that one group came to school at 8.00 am (the morning session) and the other group came to school at 11.00 am (the afternoon session). Hot sitting was adopted at the school because the infrastructure was not adequate for all classes to be held within one session. At Tatendashe Secondary School, the Form Two, Form Four, Lower Six and Upper Six classes were in the morning session while the Form One and Form Three classes were in the afternoon session. The school was established after Zimbabwe attained independence in 1980. The general infrastructure of the school was good although it was not adequate for the school's enrolment. Some of the rooms needed some renovations, for example, the gas and water taps in the science laboratories were non-functional. A Form 4 Combined Science class was sampled. The class, Form 4 Sheep, had fifty-two (52) learners and it was a mixed sex class. The class had six Combined Science lessons of thirty minutes each. The six lessons were allocated over a six day cycle. That meant that the lessons were less than six when we considered a five day week. The lessons were presented as double lessons on the school timetable. This was in line with the recommendation given in the Combined Science Syllabus Forms 1-4 which stated that "double periods are recommended to accommodate practical work" (p. 2). Form 4 Sheep was taught Combined Science by Mr. Rufaro. Mr. Rufaro was a qualified Mathematics teacher who had also been deployed to teach science. He taught Mathematics for twenty-four years and he was in his 15th year of science teaching. He held a Diploma in Education (Mathematics) from a Zimbabwean

Teacher's College. Mr. Rufaro taught Combined Science and Mathematics. He had thirty-six (36) lessons in the six day cycle that was implemented at the school.

The school had two science laboratories and did not have a laboratory assistant. All the classes shared the two laboratories which meant that some science lessons were carried out in classrooms. Teachers liaised so that the one conducting practical work was given priority to hold the lesson in the laboratory. The school had one textbook which was used by the teacher while learners used textbooks which were bought for the old curriculum. The laboratories were spacious, well ventilated and maintained a good level of cleanliness. However, all gas taps and water taps were non-functional.

5.3.4.1 An analysis of Mr. Rufaro's schemes of work

(a) The state of science practical work

The schemes of work indicated that the class went out for a field tour when they were studying the components of an ecosystem. The teacher also used teacher demonstrations during practical activities. Practical work was also carried out by learners. A total of eight practical activities were indicated in the schemes within twenty-five (25) double lessons. Of the eight practical activities indicated in the schemes of work, one was a field tour, three were teacher demonstrations and four were experiments carried out by learners in the laboratory. However, it was not clear whether the practical work carried out by the learners was done as group practical work or the learners did individual practical work.

(b) The state of science practical work assessment

No practical assessment was indicated in the twenty-five (25) double lessons that were analysed. Theory exercises and tests were indicated in the schemes of work.

(c) The state of science citizenship education

The schemes of work indicated a broad aim that focused on the concept of science citizenship education. It stated that Combined Science aimed to “promote critical-thinking, creativity and problem-solving skills that apply to real-life situations” (Mr. Rufaro’s schemes of work, p. 10). The schemes also indicated that the learners would be made conscious of environmental issues, life-skills and collaboration. However, it was not outlined how these citizenship issues were linked to each of the practical work stated.

5.3.4.2 Form 4 Sheep’s lesson observation

(a) Pedagogies employed

The lesson observation was carried out on Tuesday the 17th of March in a science laboratory from 7.20 am to 8.20 am. The topic covered by the lesson was food tests. The objective was to describe the test for fats. The pedagogies employed were a teacher demonstration, class discussions, group work, and learners’ individual practical work. The approach used was a learner-centred, inquiry-based pedagogy. The class had fifty-two (52) learners and was too large for effective teacher supervision and monitoring of learners. The teacher did not find time to interact with most of the learners at individual level.

(b) An analysis of the teaching pedagogies used

The ‘learner-inquiry’ was teacher directed and followed the cookbook style since the teacher laid out all the steps in the procedure so that learners would simply follow. The teacher also demonstrated the practical work first and learners observed his results. The individual practical work done by the learners was then a mere repetition of the teacher’s practical work and learners were confirming if their results were similar to those of the teacher instead of discovering them on their own.

(c) Practical work done

The learners copied the aim, a list of materials to be used and the procedure/method into their note exercise books. The learners carried out the practical work individually and recorded their observations and drew conclusions. The learners participated in a class discussion as they answered the teacher's oral questions pertaining to their observations and conclusions. The learners were divided into groups of six. One learner from each group collected the materials to be used by the group members. The learners in a group shared the cooking oil but each learner had a piece of the translucent paper. While the learners in a group were getting the cooking oil from the same container, they were carrying out the experiment individually as each one added a drop of the cooking oil to his/her own translucent paper. Each learner recorded his/her own observations. After the experiment, the learners put the translucent papers into a bin and handed over the test tubes with the remaining cooking oil to the teacher. The materials were cooking oil placed in test tubes, test tube racks, droppers and pieces of translucent paper.

(d) Assessment(s) employed

There was no practical assessment that was given to learners during the lesson that was observed.

(e) State of science citizenship education

The pedagogy was not integrated to the concept of citizenship education. No reference was made to the relevance that test for fats could have to the learners' everyday lives. There was no assessment activity given so the researcher could not evaluate the possible link between citizenship education and practical skills assessment.

5.3.4.3 Mr. Rufaro's interview

(a) Pedagogies used

Mr. Rufaro stated that he used a combo of methods when teaching Combined Science. He used demonstrations, directed discovery, research method and the Socratic methods. The teaching methods were based on inquiry and discussions which used the question and answer approach. He said

> *I mix, I use a combo… I use directed discovery, demonstrations, Socratic methods and also research method.*

He classified his combo of teaching methods as learner-centred. When asked to classify his combo he responded that

> *mine is learner-centred.*

Mr. Rufaro pointed out that he did not use the lecture method as he believed that learner participation was vital for effective learning to take place. He argued that

> *whatever the situation, we need a teaching method in which a learner participates, a learner learns well by participating.*

(b) State of practical work

Mr. Rufaro stated that the practical activities he carried out mostly were those that did not require chemicals, for example, observing ecosystems. Generally, he carried out practical work once in two weeks. He said that as he carried out one practical in two weeks, he combined many related concepts within the single experiment. That position was stated in his statement that

> *the practical that I will do will cover a number of aspects, for example, it's one practical but it will concentrate on, for example, testing on acidity or basicity of chemicals, at the same time I will be looking at neutralisation, so I make sure I merge my topics so that that one practical will cover six aspects.*

Mr. Rufaro pointed out that since his classes had learners of mixed ability, the majority of them missed the many concepts integrated in the single experiment but justified his approach as what was possible under the economic conditions. He said

> *some will grasp and most of them will not grasp but it's an economic situation, there is nothing I can do about it.*

During practical work, teacher demonstrations and group practical work were used and individual practical work for learners was rare due to limited resources. Mr. Rufaro revealed that position when he said that,

> *there will be demonstration and there will be group work, we don't have enough for individual work because we have so many learners…an average of sixty.*

Mr. Rufaro clarified that in most instances, the teacher demonstrated the practical work first so that learners were clear on how they were supposed to carry out the experiment. The learners then carried out the group experiments after the teacher demonstration. That was revealed in the statement that,

> *I demonstrate and I would like them to apply those skills immediately before they forget something.*

He pointed out that the learners recorded observations and drew conclusions from practical activities. The groups were generally composed of five or six learners. As the learners carried out the practical work, Mr. Rufaro said he monitored the learners, reinforced correct procedures and observations and corrected those who made mistakes.

However, Mr. Rufaro stated that the practical work carried out in the school was very limited compared to what it should be and blamed it on the economic situation. He argued that,

> *strictly speaking every lesson should be a practical lesson, you will agree with me, but because of the situation now practicals are going on but not as often as they should.*

(c) Practical skills assessment

He said that practical skills were assessed as learners carried out individual practical work. He said that he carried out practical skills assessments during school holidays when he had time to break his classes into small groups. The practical skills assessments were done for Forms Three and Four. He stated that he had observed that when learners were assessed for practical skills, they generally lacked confidence since they lacked adequate practice.

Mr. Rufaro pointed out that the link between practical skills assessment and science citizenship education was yet to be developed and consolidated.

He also noted that educational assessment was critical to give importance to educational programmes so he proposed that the national examination board, ZIMSEC, also conduct science practical skills assessments that were linked to science citizenship education.

(d) State of citizenship education

Mr Rufaro viewed the concept of science citizenship education as not clear in the Combined Science Syllabus Forms 1-4 although some aspects were present. He said that even those aspects that were in the syllabus were implemented theoretically due to lack of resources, for example, the peanut butter-making process was taught theoretically even though the syllabus stipulated that it be taught practically. The practical teaching of the peanut butter-making process was hindered by lack of equipment, he said. He proposed that schools should fund science practical work through acquiring apparatus bit by bit. Mr. Rufaro said that if resources could be made available, it was possible for practical work to be linked to science citizenship education, for example, detergents could be made by learners in school during science practical work and could be used at home or even sold to make a living for the learners and their families. According to Mr. Rufaro, heavy teacher workloads and learner indiscipline were among the factors that limited science practical work in schools.

He was optimistic that science citizenship education could be effectively integrated to practical work pedagogy if industries were brought to schools. His explanation was that simple and affordable industrial equipment were supposed to be bought by the school so that their use could be integrated to science practical work. He gave the example of his personal peanut butter- making machine which he had brought to school and carried out practical work with his Form One class. He said the learners understood the process involved in peanut butter production better as they had experienced the process. He also mentioned that he had also brought a fresh chips making machine to school, asked some learners to help him as he prepared chips and four learners had interest to use the machine to make chips for sale. Mr. Rufaro argued that if the school could buy some simple industrial equipment, science classes could set aside time for production of items that could be sold by the school. That way, learners would master the skills which they needed to make a living. Thus, the link between school science practical work and citizenship education would create job opportunities for learners.

Science citizenship could be achieved by staff-developing the learners and parents so that their attitudes changed, he said. The MoPSE could provide the general policy guidelines on science citizenship education and schools could engage the learners and the parents during the implementation process.

(e) Challenges that militated against the implementation of citizenship education

Mr. Rufaro stated that citizenship education was hindered by human resource capacity as the school had few science teachers and had no laboratory assistant. The concept was also hindered by lack of resources. Large classes were also a challenge in the implementation of citizenship education.

(f) The Combined Science textbook situation at the school

Mr. Rufaro highlighted that the textbook situation at the school was critical. Combined Science textbooks were not available for learners as only teachers' copies were available. The learners used textbooks that were used in the old curriculum that had been phased out. Responding to a question on the school situation with regard to Combined Science textbooks, he said that,

> *we have a critical shortage of books, if I say shortage I think that is an understatement, we don't have, we only have teachers' textbooks.*

Mr. Rufaro explained that the lack of textbooks for learners forced him to write some notes on the board for learners to copy and sometimes two learners copied notes from his textbook and shared the notes with the rest of class, a situation that consumed valuable teaching and learning time.

5.3.4.4 Tatendashe Secondary School's focus group discussion

The focus group discussion was held on Wednesday the 18th of March in the HOD's office from 10.00 am to 11.00 am. The researcher provided the participants with drinks and snacks and generally, the mood was very relaxed and friendly. Six Combined Science teachers attended. Of the six, two were student teachers, the third teacher held a Diploma in Education (Science), the fourth had a qualification in Mathematics as he held a Diploma in Education (Mathematics) and two were university graduates whose degrees were not education specific. One had B Sc (Chemical

Engineering) and the other had B Sc (Biotechnology). The teachers had teaching experience which ranged from five months to twenty-seven (27) years.

(a) Pedagogies employed during practical work

The focus group mentioned that the pedagogies which they employed during the teaching and learning of Combined Science were question and answer, teacher demonstrations and partial research. Practical work was mainly delivered as improvised teacher demonstrations, learner demonstrations and/or group work. Partial research involved the teacher giving some information that assisted the learner to carry out an inquiry and resolve the problem. When the focus group was requested to classify the pedagogies they employed, one participant said

> *they are learner-centred.*

The other participants concurred. However, when the current researcher asked whether they also used the lecture method, they admitted that they also used it. They gave the reason for using the lecture method as lack of textbooks for learners, lack of apparatus and chemicals, large classes as well as lack of technologies that supported the teaching and learning process. They stated that they also used the lecture method to cover more content so that they were able to cover the syllabus. On lack of technologies to support the teaching and learning process, one participant said,

> *we do have a lot of resources that are trapped in our gadgets, we have notes, so many notes that we can give to learners but we don't have the interface, we don't have projectors, now those are issues that can save a lot of time like in a lesson dictating notes is time wasting.*

On why they used the lecture method, one member of the focus group put it across as,

> *no textbooks, no apparatus and also the classes are too big. Unenge wava kuto adhiresa rally.(no textbooks, no apparatus and also classes are too big. You act as if you are addressing a rally)*

Practical work was carried out using directed inquiry. Learners copied instructions and carried out practical work (in the event of group practical work) while the teacher monitored the learners as they took readings from instruments and read scales. The teacher also emphasised on safety.

When the current researcher asked the focus group to clarify on who carried out demonstrations, too participants responded. One participant said that one of the learners carried out the demonstration while the teacher guided the learner. The second participant said the teacher demonstrated first and one of the learners would re-demonstrate as illustrated by the statement

I demonstrate it and then ask one of the learners to re-demonstrate.

Asked whether the learners acquired adequate practical skills from the demonstrations, one participant replied

I doubt very much, most of them do not get those skills because they won't be conditioned enough by the time of the exam.

Thus, the focus group stated that the learners did not acquire adequate practical skills since they lacked practice. The focus group also pointed out that practical work was very limited and the teaching and learning process was mainly done theoretically due to lack of resources, large classes, lack of a laboratory assistant and inadequate teaching time especially because of the hot sitting that was practiced at the school. One participant said that

I have been dwelling on theory much because of those issues, numbers of learners, resources.

Another participant chipped in adding that time was not adequate because the teaching periods had been reduced from thirty-five (35) minutes to thirty (30) minutes. A third participant explained that the teachers also used some of the lesson time for practical work preparations since the school did not have a laboratory assistant.

Combined Science had six periods in a six day cycle and a lesson had thirty minutes. The time was relatively less, considering that the syllabus recommended eight lessons of thirty-five minutes each per five day learning week.

The group mentioned that they did not carry out control experiments even where they were required due to limited resources and limited time. They said that the control experiments were explained theoretically.

(b) Practical skills assessment

The focus group echoed the sentiments that effective practical skills assessments could only be done when learners were observed as they carried out practical work. They however indicated that they assessed for the practical skills through marking practical reports. They said that the science department had carried out real practical skills assessments in 2018. Teachers scored marks as learners carried out the experiments. One participant said that

> *last year but one, we were bold enough as a department to say this year we are going to assess the students practically by observing them as they do their practical.*

The focus group argued that the method was the best way of assessing learners for practical skills. One of the participants said that they had stopped that kind of practical skills assessment due to large classes and lack of human resources as some science teachers who transferred from the school were not replaced. The statement implied that the school was understaffed with regard to science teachers. The participant said

> *the classes keep ballooning and resources…human resources.*

Another participant highlighted that they abandoned that method of practical skills assessment because they were demoralised and de-motivated by the school administration that lacked an appreciation of the assessment method employed. The participant said

> *Ma'am zvenyu imwi kuurayiwa kwemunhu womukati, munhu womukati akatsondorwa unobva warega.(Ma'am the truth is that the inner person was killed, when the inner person is crushed, you just abandon it)*

The focus group proposed that School Heads should be invited when science teacher staff-development on practical work, its assessment and citizenship education was done so that they (the School Heads) appreciated the current pedagogies and assessments.

The focus group highlighted that the assessment of science practical skills in learners at their school was hindered by large classes, lack of support from the school administration, lack of adequate science teachers and laboratory assistants, limited time, and an examination-centred education system. Another challenge faced by teachers during practical work and its assessment was that of some learners who could not read or understand English which was used as the medium of instruction. The focus group also pointed out that learners lacked seriousness during practical work and proposed that schools could send some practical marks to ZIMSEC so that the marks were integrated to the learners' final grades.

(c) The state of science citizenship education

The focus group stated that the Combined Science Syllabus Forms 1-4 had some topics that emphasised on science citizenship education, for example, peanut butter production, soap production, waste disposal and recycling. The group pointed out that if practically taught, recycling of material could lead to the production of artifacts that could be even sold as highlighted in the statement that

> *learners may end up producing some artifacts that can be sold to the community… there are some who are making tiles out of plastics; sand and plastics, and those tiles are marketable.*

The focus group stated that learners could produce detergents which they could use within the laboratory, the school and even sell if school science practical work and citizenship education were integrated. The focus group pointed out that issues of citizenship education were discussed more on Biology topics like balanced diet, disease prevention and advantages of eating vegetables. The integration of science practical work had the potential to create science related careers as well as to improve the citizens' way of living, they said.

The focus group viewed the implementation of science citizenship education as also being hindered by policy, for example, it was difficult to take out learners for activities outside the school as that required clearance from MoPSE; lack of financial support to carry out science practical work that could enhance citizenship education; lack of teacher motivation and limited time.

The focus group was of the view that science citizenship education could be enhanced if learners were exposed to industrial work, parents were made conscious of citizenship education so that they supported it, resource support was offered by the school administration, facilitators or resource persons were invited to educate learners on community challenges for learners to be able to make an impact and more teachers and laboratory assistants were recruited. All stake holders needed to come together for the goal of science citizenship to be attained, that is, the learners, teachers, parents, schools and MoPSE should work together, they said.

5.3.5 Context of the third school: Tivongereiwo Secondary school

Tivongereiwo Secondary school was a government mixed sex satellite day school. The school was in a peri-urban setting. The school was established after Zimbabwe's land redistribution exercise introduced in 2000, which is also known as The Third Chimurenga. The general infrastructure of the school was poor. There were only six classrooms at the school. Of these six, two were still under construction. Although the two classrooms had been roofed, they still had no window panes and furniture. The school had no science laboratory and it had no laboratory assistant. The science equipment, apparatus and chemicals were kept in a storeroom and the teacher carried what she needed to a classroom whenever she had a practical lesson. A Form One Combined Science class was sampled. The class, Form 1 Camel, had sixty-seven (67) learners and it was a mixed sex class. The class had six Combined Science lessons of thirty-five minutes each per week. The lessons were presented as double lessons on the school timetable. This was in line with the recommendation given in the Combined Science Syllabus Forms 1-4 which stated that "double periods are recommended to accommodate practical work" (p. 2). Form 1 Camel was taught Combined Science by Mrs. Budiriro, a qualified science teacher who had teaching experience of four years. She held a Diploma in Education (Science) from a Zimbabwean Teacher's College and was studying towards a Bachelor of Education Degree (Chemistry) with a Zimbabwean University. Mrs. Budiriro taught Combined Science only. She had twenty-four (24) lessons per week.

Mrs. Budiriro held all her Combined Science lessons in classrooms. The classes at the school were very big, for example, Form 1 Camel had sixty-seven (67) learners. The learners were generally very crowded since a bench which was meant for two learners was shared by three learners. However, the Form 1 Camel classroom was well ventilated and clean.

The learners had relevant textbooks which were shared by those seated on the same bench. The textbooks, however, were kept at the school and the teacher brought them to the lesson and collected them at the end of the lesson.

5.3.5.1 An analysis for Mrs. Budiriro's schemes of work

(a) The state of science practical work

There was no practical work indicated in the schemes of work although topics that required practical work were included, for example, taking readings from laboratory apparatus, separation, factors that affect solubility, properties of the three states of matter and disposal of litter. No practical work was indicated within the twenty-four (24) lessons that were outlined.

(b) The state of science practical assessment

There were no practical assessments that were indicated in the schemes of work.

(c) The state of science citizenship education

Since no practical work was indicated for the class and no practical assessment had been indicated, it was not possible to evaluate if practical work was linked to citizenship education.

5.3.5.2 Form 1 Camel's lesson observation

(a) Pedagogies employed

The class observation was carried on Wednesday the 18th of March from 2.00 pm to 3.30 pm in the Form I Camel classroom. The topic taught was separation. The objective covered by the lesson was on stating the methods of separating mixtures. Mrs. Budiriro used a teacher demonstration as she carried out a revision exercise with the Form 1 Camel class. The teacher also used class discussions as she revised the questions. The learners had written an exercise on separation methods and the teacher was carrying out the revision after marking the exercise. Learners had generally scored very low marks. The learners were involved in the class discussions but did not participate in the practical work as the teacher was carrying out the demonstrations, stating the observations and writing the expected answers for the questions on the board. The learners who got certain answers correct were invited to read their answers to the class but these were very few. The learners copied the correct answers into their exercise books as corrections. The teacher used a vernacular language (Shona) as the medium of instruction arguing that most of the learners did not understand English.

(b) An analysis of the pedagogies used

The practical activities carried out were teacher demonstrations and learners were passive observers. The lesson was teacher-centred as the teacher performed the experiments alone and learners observed from their sitting positions. The teacher demonstrations were supposed to have been carried out during the teaching and learning process when the content on separation methods was covered, but the experiments were not carried out then. The topic had been taught theoretically.

(c) Practical work done

The apparatus and materials used were sulphur, iron fillings, magnet, filter paper, filter funnel, beaker, water and soil. Mixtures separated were iron fillings and sulphur, and soil and water.

(d) Practical skills assessment

The questions were on the use of a sieve, separation of oil from water, separation of chaff from grain, use of evaporation to separate a mixture of salt and water and labelling the components of the filtration process using a diagram. That was an alternative to practical assessment where the learners were deriving answers from recalling rather than observing. The assessment was supposed to be given as directing questions which would help the learners to get focused during a practical activity. The questions were supposed to be answered as the learners were observing what happened during the practical. The fact that questions based on practical work were given as theory questions made them abstract especially that the learners had not carried out the relevant practical work.

(e) The state of science citizenship education

The pedagogy employed did not integrate citizenship education to the practical work since instruments which were used for the separation process at home were not part of the apparatus used during the practical work. On the contrary, citizenship education was integrated in the assessment as there was reference to separation processes which were done at home. That brought the topic of separation to the context of the learners' lives.

5.3.5.3 Mrs. Budiriro's interview

(a) Pedagogies used

Mrs. Budiriro said that she mainly used learner-centred methods when teaching Combined Science as implicated in her statement

> *usually, we try the learner-centred, most of the time.*

However, she mentioned that she also used the lecture method as the school lacked technologies that supported the teaching and learning process. She stated that she also used the lecture method when she carried out revision exercises with her classes. Mrs. Budiriro argued that there were some topics which had to be taught using the lecture method citing stoichiometry as an example. She said

> *one topic I can pick up, a topic like stoichiometry, yaa that one we usually use the lecture method. We don't have other media within the school that we can use.*

(b) The state of practical work

Mrs. Budiriro said that learners carried out practical work mainly when they were in Form Four and had registered for the national end of course summative examinations with ZIMSEC. She said that some of the learners failed to raise examination fees for Combined Science and they dropped out of class. That reduced the number of learners in the Form Four class and she would then manage to supervise the fewer learners during practical work. She also said that some practical work was carried out using materials which the learners brought from home, for example, learners brought potatoes which the class used to carry practical work on osmosis.

Mrs. Budiriro stated that she rarely carried out practical work with the Form 1 Camel class**.** She said that generally, Form One practical work was carried out thrice a term. She said that if any class was to carry out practical work, she was responsible for the setting of equipment and the preparation of solutions. During the practical work, she wrote instructions on the board and monitored the learners as they carried out the practical work.

Practical work was limited due to lack of equipment and large classes, she said. She also felt that in her class, there were some learners who were supposed to be in a special class as they failed to comprehend even the instructions outlined for carrying out the practical work.

(c) Practical skills assessment

She pointed out that she assessed for practical skills as learners carried out the practical work as illustrated by her statement

> *usually through observations during experiments.*

She said that when she assessed for practical skills, she made arrangements with other teachers so that she had a block of four lessons since learners were too many and hence more time was needed to make the assessments. She pointed out that she did not link practical skills assessments to citizenship education.

When the current researcher asked her why she had not carried out practical work on separation methods with the Form 1 Camel class yet all the apparatus and materials needed were available at the school, she replied that the filter funnels were not enough and the school did not have water so she failed to get water she needed to make a mixture she would separate through filtration. The current researcher opined that the limited science practical work was not mainly due to lack of apparatus and chemicals as practical work had not been carried out even for experiments that were possible, that is, those that had apparatus and chemicals available.

(d) The state of citizenship education

Mrs. Budiriro said that the Combined Science Syllabus Forms 1-4 had some topics that enhanced science citizenship education. She cited peanut butter production and soap making as topics that were supposed to be used to integrate citizenship education to science practical work. She stated that the topic on separation of mixtures was also applicable at home and the related practical work could be linked to citizenship education. She said that the school did not have materials that were required for soap making and that limited the application of practical work to science citizenship education. She pointed out that when she was a learner, her school produced soap for sale. She stated that

> *We did soap at school, we sold our soap at school. If it's done that way, it would be great.*

(e) Challenges that militated against the implementation of science citizenship education

Mrs. Budiriro said that the implementation of the citizenship education was not clear in the syllabus but she linked assumed knowledge to what learners knew from home. She proposed that science citizenship education needed to have content and objectives that were clearly outlined in the syllabus. She also called on the government to fund practical work as well as offering financial support for projects that linked science practical work to the community. She highlighted that practical work required a class size that was manageable. Mrs. Budiriro also said that she needed staff-development on the assessment of practical work and the implementation of science citizenship education.

5.3.5.4 Tivongereiwo Secondary School Head's interview

(a) The state of science practical work and assessment

Mr. Bruce was the School Head. He said that the advantage of offering Combined Science to learners was that the learning area combined Biology, Chemistry and Physics, so learners had major concepts from all the three science disciplines. At Tivongereiwo Secondary School, practical work was carried out either in groups or individually, he said. He said the teacher used a mixture of interactive teaching methods.

On the frequency of practical work that was offered to the Form 1 Camel class, Mr. Bruce said that he was not sure about the current class but based his response on the previous year's Form One class which carried out one or two simple experiments per month. His response was

> *Ah, Form One class as of this year I cannot give a specific answer but from last year I think we will be talking of an experiment or two per month.*

Mr. Bruce welcomed improvisations in science and argued that even poor schools managed to offer practical work to their learners with minimal costs. He said that improvisations demystified the concept of practical work as more learners were now being exposed to it. He stated that

> *as a result zvakaita demystify nyaya yokuti science haigoneki muri mumamisha. (as a result it demystified the position that science practical was not possible in rural areas)*

Mr. Bruce said that practical work brought real value to science education. He lamented the alternative to practical assessment that was in the old curriculum and stressed that learners crammed experimental procedures and observations without having practical skills and that was undesirable for science education.

Mr. Bruce stated that learners were assessed for practical skills during practical work which they carried out in groups as pointed out in his statement that

> *I think they can be assessed especially when they are doing experiments…but because of shortages of maybe chemicals and other stuff, I have seen them doing group work, they are assessed in groups.*

(b) The state of science citizenship education

Mr. Bruce pointed out that continuous assessment was a good way to promote citizenship education. Referring to continuous assessment that was once introduced and suspended, he said

> *it is only that component of research or tasks which were removed, you remember that area, but actually since it started the learners had been involved in a lot of activities in each and every area and science in particular.*

Mr. Bruce noted that an effective science citizenship education had the potential of transforming communities to levels where members lived science-enriched lives. For example, knowledge on nutrition would enable a mother to feed her baby on a balanced diet to avoid kwashiorkor, he said.

(c) Challenges that limited science practical work and citizenship education

Mr. Bruce pointed out that the classes were very large due to the limited number of classrooms. He said that the new block which had two classes was still under construction and window panes had not been fitted yet. He also pointed out that the teachers also preferred to teach one big class so that they reduced workloads rather than having a situation where a class was divided into two. Mr. Bruce pointed out that the teachers had initially argued for the classes to be split into two because they were too big and when that was done, the teachers changed their position and preferred to teach the learners in their big classes. Mr. Bruce thus said,

> *it came from the teachers themselves who were now saying especially during winter the rooms are not conducive. The advantage now which I saw to them is of reducing the workload.*

Mr. Bruce said that he had split the classes but the teachers continued to teach them as single classes since they were complaining of incapacitation due to poor remuneration since the previous year. Mr. Bruce alluded that teachers were de-motivated through his statement that,

> *we are coming from a situation where the teachers themselves are talking of aspects like incapacitation from last year that they would rather be comfortable teaching one class."*

He proposed staff-development for teachers on the concept of science citizenship education and on practical work pedagogy and assessment. His proposal was that,

> *in terms of assistance somehow from examination boards like ZIMSEC where we will be simply saying we will be having maybe workshops or seminars especially to these teachers so that they will actually accept some of the concepts and will be sharing ideas on how to do certain experiments.*

He suggested that government should equip schools with science apparatus and chemicals or alternatively the government could buy major/expensive equipment for a cluster of schools. That equipment could be borrowed by schools for the practical work and returned to the cluster centre. He also noted that science suppliers overcharged schools when the schools ordered science equipment.

Mr. Bruce pointed out that a science kit which was distributed to schools by the MoPSE which comprised of the basic science equipment and chemicals ended up with some chemicals and metals being kept in the storeroom until they expired. The statement alluded to the possibility of limited science practical work even when the chemicals or materials were available.

5.3.6 Synthesis of the qualitative results

A synthesis of the results that emanated from the three schools that were sampled was presented in Tables 5.26 (a) to 5.26 (e). The synthesis of results was presented in line with the research sub-questions as well as other results that did not directly address any of the four research sub-questions.

Table 5.26 (a)

A synthesis of the qualitative results: Research sub-question 1

Research sub-question	Theme	School	Results
To what extent is citizenship education integrated in the pedagogy of science practical work in Combined Science in Zimbabwe?	State of science practical work	Takudzwa Secondary	Limited practical work was done by the learners. Science practical work was delivered through teacher demonstrations and/or learner group work. These were not frequently done as a range of 3-7 practical activities were carried out per term (in 30 double lessons). Individual practical work was rarely carried out. The science equipment used was standard. Practical work was not linked to citizenship education. No science practical work was carried out to resolve community challenges. Any reference to issues of citizenship was done theoretically with no practical work.
		Tatendashe Secondary	Limited practical work was carried out. Teacher or learner demonstrations as well as group work were used. These were not frequently done as a range of 3-8 practical activities were carried out per term (in 25 double lessons). Individual practical work was rarely carried out. Standard apparatus were complemented with improvised apparatus. Practical work was not linked to the community and issues of citizenship education were referred to theoretically.

	Tivongereiwo Secondary	Science practical work was very limited. Teacher demonstrations and learner group work were employed during practical work and individual learner practical work was rare. A range of 0-6 practical activities were carried out per term (in 30 double lessons). The apparatus used at the school were a mixture of the standard and the improvised. Science practical work was not linked to citizenship education. Practical work was carried out within the confinements of the school and no community challenges were resolved through school science practical work.

Table 5.26 (b)

A synthesis of the qualitative results: Research sub-question 2

Research sub-question	Theme	School	Results
To what extent is citizenship education integrated in the assessment of science practical work in Combined Science in Zimbabwe?	State of science practical skills assessment	Takudzwa Secondary, Tatendashe Secondary and Tivongereiwo Secondary	Science practical skills assessments were not carried out during the normal class lessons. They were carried out during major school assessments like the Midyear examinations and were mainly offered to Form Fours. Otherwise, learners were assessed for practical skills theoretically. There was no link between the practical skills assessments carried out within schools and science citizenship education. The results were the same in all the three sampled schools.

Table 5.26 (c)

A synthesis of the qualitative results: Research sub-question 3

Research sub-question	Theme	School	Results
How could citizenship education be integrated in the pedagogy of science practical work?	State of science citizenship education	Takudzwa Secondary	Proposed adequate motivation for teachers in terms of remuneration. Proposed allocation of adequate teaching time for Combined Science. Proposed staff-development for School Heads and science teachers on pedagogies that enhance citizenship education. Conscientizing the learners and parents on issues of science citizenship education. Proposed aligning policy issues to the concept of citizenship education.
		Tatendashe Secondary	Proposed staff-development for School Heads and science teachers on pedagogies that enhance practical work and citizenship education. Proposed that issues of science citizenship be made clear in the syllabus. Proposed setting up of simple industrial equipment within schools for the production of simple items by learners during science practical work.

		Conscientizing the learners and parents on issues of science citizenship education. Proposed aligning policy issues to the concept of science citizenship education.
	Tivongereiwo Secondary	Proposed staff-development for science teachers on pedagogies that enhance practical work and citizenship education. Proposed the inclusion of content, objectives and pedagogies that address the issue of science citizenship education in the syllabus.

Table 5.26 (d)

A synthesis of the qualitative results: Research sub-question 4

Research sub-question	Theme	School	Results
How could citizenship education be integrated in the assessment of science practical work?	State of science citizenship education	Takudzwa Secondary	Proposed staff-development for School Heads science teachers on practical skills assessments that enhance science citizenship education.
		Tatendashe Secondary	Proposed staff-development for School Heads and science teachers on practical skills assessments that enhance science citizenship education. Aligning national summative assessments to science citizenship education.
		Tivongereiwo Secondary	Proposed staff-development for science teachers on practical skills assessments that enhance citizenship education.

Table 5.26 (e)

A synthesis of the qualitative results: Other results

Research sub-question	Theme	School	Results
Other results	challenges that militated against practical work, practical skills assessment and citizenship education	Takudzwa Secondary	Inadequate equipment, apparatus and chemicals Large science classes (a high teacher-learner ratio) A heavy teacher workload Inadequate teaching time Lack of learners' textbooks Poor teacher remuneration leading to lack of motivation Lack of staff-development on the concept of citizenship education Policy issues
		Tatendashe Secondary	Inadequate equipment, apparatus and chemicals Inadequate science teachers Lack of laboratory assistants A heavy teacher workload Lack of technologies that support the teaching and learning process

		Large science classes (a high teacher-learner ratio) Inadequate teaching time Lack of learners' textbooks Lack of staff-development on the concept of citizenship education De-motivation from the school administration Learner indiscipline Policy issues
	Tivongereiwo Secondary	Inadequate equipment, apparatus and chemicals Lack of water within the school Lack of technologies that support the teaching and learning process A heavy teacher workload Large science classes (a high teacher-learner ratio) Lack of staff-development on the concept of practical work, practical skills assessments and citizenship education

5.4 Limitations and delimitations of the current research

The current researcher is a qualified former high school science teacher who taught at four schools in Zimbabwe and two schools in Botswana. She taught science from January 1993 to November 2013 (21 years) before joining the Zimbabwe School Examinations Council (ZIMSEC) as the

Integrated Science Subject Manager. When the school curriculum was reviewed in 2015, Integrated Science was replaced with Combined Science, so the current researcher became the Combined Science Subject Manager. ZIMSEC is the national examination board in Zimbabwe and is responsible for the development and administration of the national summative examinations. As the Combined Science Subject Manager, the current researcher supervised the Combined Science examiners who were invited by ZIMSEC as contract workers. This posed possible power dynamics with respondents of the questionnaire in the cross-sectional survey research design. The current researcher explained her role during the data capturing process and assured the respondents that their data would remain anonymous.

The current researcher constantly reflected on her role during data capturing, interpretation and discussion to minimise subjectivity due to her background as a science teacher. The current researcher strove to remain objective so that she would not influence the data collection procedures, recordings, interpretations and findings. The current researcher aimed to be objective throughout the research and maintained personal integrity.

5.5 Conclusion

The current chapter analysed and presented data collected from both the cross-sectional survey and the multiple-case study. The data was presented based on the main concepts presented in the theoretical framework employed in the current research. The main concepts in the theoretical framework were the focus of the research sub-questions hence by addressing the research sub-questions, the data were also addressing the concepts in the theoretical framework. The next chapter discusses the results that were presented in this chapter with a view to address the research questions.

CHAPTER 6: DISCUSSION OF THE FINDINGS: A REFLECTION ON LITERATURE

6.1 Introduction

The current chapter discusses the results that were presented in Chapter 5. As stated in Chapter 4, the current research was carried out using a mixed methods research approach which employed a cross-sectional survey and a multiple-case study. Quantitative and qualitative data were thus gathered, and the results were presented in Chapter 5, as an attempt to respond to the research question presented in Chapter 1. The results obtained from the cross-sectional survey and the results obtained from the multiple-case study are discussed in the current chapter. The discussion of the results is based on the literature review (presented in Chapters 2 and 3), as well as the theoretical framework. The discussion leads to the development of a framework for integrating citizenship education in the pedagogy and assessment of science practical work. The developed framework for integrating citizenship education to the pedagogy and assessment of science practical work is presented under section 6.4.2 of the current chapter.

Four sub-questions were raised in the current research, so the discussion was anchored on the four sub-questions. The main research question, as presented in Chapter 1, was:

> *How could a framework for integrating citizenship education in the pedagogy and assessment of science practical work be developed, using Combined Science in Zimbabwe as a case study?*

The research question was answered through the use of four research sub-questions, which were:

1. To what extent is citizenship education integrated in the pedagogy of science practical work in Combined Science in Zimbabwe?
2. To what extent is citizenship education integrated in the assessment of science practical work in Combined Science in Zimbabwe?
3. How could citizenship education be integrated in the pedagogy of science practical work?
4. How could citizenship education be integrated in the assessment of science practical work?

The literature review focused on the effective pedagogies for science practical work, effective practical work assessments and citizenship education. These were the main concepts outlined by the theoretical framework. In responding to the above questions, the findings in the current research were presented in relation to existing knowledge. These findings were also discussed in relation to each of the four research sub-questions.

6.2 Findings that corroborate existing literature

6.2.1 Pedagogy of practical work

The first research sub-question was addressed first. The sub-question examined the extent to which citizenship education was integrated in the pedagogy of Combined Science practical work in Zimbabwe. The sub-question was thus discussed in relation to the related literature review, the theoretical framework, results on the pedagogy of practical work as well as how citizenship education was integrated in the pedagogy of science practical work.

In Zimbabwe, the Report of the Presidential Commission of Inquiry into Education and Training (1999) lamented that the curriculum was too theoretical and academic at the expense of practical exposure of learners to real-life challenges. The teaching and learning processes were detached from the community. This in turn led to the development of learners, and ultimately citizens, who had knowledge which they could not apply to solve real-life challenges. More recently, Hoeg and Bencze (2017) note that pedagogies that enhance science citizenship education were not practiced in schools as educational policies did not specify that schools identify any community challenges to resolve with their science classes. In line with Hoeg and Bencze (2017) the current research has found that in Combined Science, citizenship education was left to individual teachers to teach in ways that were not supervised. The current research shows that science departments were not mandated to resolve science related challenges within their communities. This finding suggests that the concept of science citizenship education remains rhetoric in Zimbabwe.

Given that there was no clear citizenship education mandate, the extent to which teachers could integrate it in their teaching was explored, particularly in relation to availability of resources. From the cross-sectional survey results, the majority of the respondents indicated that the state of science equipment in their schools was average or better. In the multiple-case study, lesson observations and teacher interviews also indicated that the schools had the basic standard apparatus in terms of teaching resources. However, it emerged during the lesson observations and interviews that the standard science apparatus and equipment which schools had were failing to sustain the large classes and some improvisations were then necessary. Otherwise, the basic standard apparatus were available in the schools. The current researcher noted that lack of science equipment, apparatus and chemicals was possibly not the main reason for the limited science practical work in schools. There was a wide range of reasons that contributed to the general limited Combined Science practical work in schools which included teacher attitudes, teachers' PCK, large classes, heavy teacher workloads, limited lesson time, poor teacher motivation and lack of laboratory technicians/assistants. These challenges were noted in literature as general challenges that hindered science practical work. These findings further suggest that the integration of citizenship education in the Zimbabwean Combined Science education may be limited.

Literature revealed that practical work ought to be an integral part of any effective science education programme (Abrahams, Reiss & Sharpe, 2013; Barak, 2017; Collins, 2011; Cowie, 2015). The respondents in the cross-sectional survey and the multiple-case study concurred that science practical work was essential to aid learners to construct authentic scientific knowledge. The general results indicated that Combined Science learners carried out some practical work as advocated for in literature. However, the practical work carried out was limited with regard to the pedagogy employed, the assessments carried out, its relevancy to learners' lives and its frequency. In turn, this may have a negative impact on the extent to which citizenship education could be realised.

An analysis of the Combined Science Syllabus Forms 1-4 indicated that the learning area was supposed to have frequent practical work but the current research results indicated that practical work was very limited. More than half of the respondents in the cross-sectional survey indicated that they carried out practical work once in a period of two weeks or more. In the multiple-case study, an analysis of the Combined Science schemes of work, teacher interviews, School Heads interviews and focus group discussions concurred that practical work was carried out on an average of once in two weeks or more. The results from both the cross-sectional survey and the multiple-case study indicated that practical work was very limited for the Combined Science classes. The scientific concepts were mainly taught theoretically and that made them abstract to learners. The abstract teaching and learning of science concepts which side-lined science practical work has been identified in literature as one of the reasons why science education failed to produce knowledge that learners could apply in real-life situations (Bennett, 2015; Chowdhury, 2016; Dewey, 1995; Dillon, 2012; Healy, 2013). As such, the current researcher concludes that the limited extent to which practical work was integrated in science lessons, may limit the actualization of citizenship education.

6.2.2 Assessment of practical work

The second research sub-question addressed the extent to which citizenship education was integrated into the assessment of Combined Science practical work in Zimbabwe. Literature indicates that teachers generally lacked skills with regard to assessment of practical skills and also reveals that assessments were generally not aligned to pedagogies (Fadzil & Saat, 2019; Hussain et al., 2018; Millar, 2013; World Bank, 2008). The multiple-case study found that formative assessment of practical skills was not done by all the three sampled schools. The assessment of practical skills using practical work was also not done during the teaching and learning process. In the cross-sectional survey, the majority of the respondents indicated that the assessment of practical skills in learners should be done using practical tests and examinations, a situation which was not practiced by the sampled schools. Given these results, it is evident that citizenship-related skills, which would generally be integrated in the assessment of practical work, may not be assessed or developed in the Zimbabwean context. This may have negative ramifications for citizenship education as a whole.

The findings in the multiple-case study result was different from the cross-sectional survey result in that the practical skills were not assessed using practical tests during the teaching and learning process. The current researcher found that this difference could mean that the practical tests referred to in the cross-sectional survey were those administered during the mock examinations. Such practical skills assessments, however, would not benefit the learners as they were not administered during the longer period of the teaching and learning process. As such, learners would generally be incompetent in practical activities due to lack of practice. In the cross-sectional survey, about one fifth of the respondents stated that they used the alternative to practical (theory) tests and examinations. The result could mean that while the competence-based curriculum in Zimbabwe had scraped off the alternative to practical (theory) way of assessing for science practical skills, some teachers were still practicing it even though this practice was not aligned to the demands of the competence-based curriculum. The participants in the multiple-case study stated that it was ideal to assess learners for practical skills as learners carried out practical work or tests but said they were not doing that. They still assessed for practical skills using theory tests for a variety of reasons which included inadequate apparatus and chemicals, limited time, lack of laboratory assistants, lack of teacher motivation, large classes and heavy teacher workloads. Practical assessments were not done in all the three schools that participated in the multiple-case study. This position is in line with literature since formative assessments of practical skills were generally reported to lack alignment to the teaching and learning process. The current researcher views this position as a serious setback for any meaningful scientific literacy in Zimbabwe as the majority of learners would most likely graduate from secondary schools with minimum practical skills while they greatly need them for their daily lives. Lack of science practical skills among learners in this regard suggests that learners' ability to solve societal problems using scientific knowledge and skills may be compromised. In turn, this further suggests that citizenship education may not be realised adequately.

6.2.3 Recommended strategies for integrating citizenship education into the pedagogy of science practical work

The third research sub-question interrogated how citizenship education could be integrated in the pedagogy of science practical work.

The respondents in the cross-sectional survey and the participants in the multiple-case study gave the same recommendations on what is required for citizenship education to be integrated in the pedagogy of science practical work. The key recommendations in this regard were as follows:

- Government and industry funding of science practical work so that uniform resources would be available in all schools for the teaching and learning process to have significant science practical work
- staff-development for School Heads and science teachers on practical work pedagogies that enhanced science citizenship education
- an integration of citizenship education to the science content and objectives in the syllabus
- frequent practical work since it motivates learners
- allocation of adequate teaching and learning time for Combined Science
- application of practical work to solve science related community challenges
- adequate motivation for teachers in terms of remuneration and working conditions
- having project-based learning which benefits the community

The participants in the multiple-case study also highlighted that it was important to conscientize the learners and parents on issues of science citizenship education. They also recommended setting up of simple industrial equipment within schools for the production of simple items by learners during science practical lessons, for example, production of detergents. The participants also recommended that government could buy major and/or expensive equipment for a cluster of schools so that the schools could share it during the teaching and learning process. The participants also recommended that the government could set up shops that sell science equipment, apparatus and chemicals at subsidized prices and schools could buy from the government shops at affordable prices. The recommendations put the responsibility of having clear policies, teacher staff-development, science practical work resource allocation, and effective implementation of science citizenship education on the shoulders of the Zimbabwean government. These positions were stated in literature as requirements to achieve a national citizenship education agenda which was generally found to be lacking in many countries across the world (Adeyemi, 2018; Fensham, 2012; Mukundu, Chineka & Madzudzo; 2017; Witschge & van de Werfhorst, 2016).

6.2.4 Recommended strategies for integrating citizenship education into the assessment of science practical work

The fourth research sub-question interrogated how citizenship education could be integrated in the assessment of science practical work. The respondents in the cross-sectional survey and the participants in the multiple-case study recommended that:

- staff-development for School Heads and science teachers on practical work assessments that enhanced science citizenship education be carried out
- assessments that addressed issues of science citizenship education be included in the syllabus and in educational assessment policies
- national summative science practical skills assessments be aligned to formative practical skills assessments that promote science citizenship education
- practical skills should be assessed through practical tests
- there should be project-based learner assessments which link science practical work to community needs and challenges

The recommendations were also given in literature as essential strategies for promoting citizenship education (Decristan et al., 2015; Hart, 2012; Hussain et al., 2018; Schulz et al., 2017; Sigauke, 2013).

6.2.5 Challenges that hindered the integration of citizenship education to science practical work

The results obtained from both the cross-sectional survey and the multiple-case study concurred on challenges that militated against the effective integration of citizenship education to the pedagogy and assessment of science practical work. The challenges, outlined from both the cross-sectional survey and the multiple-case study, were:

- lack of teacher staff-development on the concept of science citizenship education
- lack of a clear policy and policy direction on issues of science citizenship education

- lack of adequate Combined Science teaching and learning time for the integration of citizenship education
- large Combined Science classes (a high teacher-learner ratio)
- lack of adequate science equipment, apparatus and chemicals
- lack of or inadequate laboratory technicians/assistants
- heavy teacher workloads
- lack of suitable Combined Science textbooks for learners
- inadequate trained science teachers in some schools
- an education system that is examinations-driven
- poor teacher remuneration leading to poor teacher motivation

Additional challenges that were mentioned in the multiple-case study were that some learners who were supposed to be in special classes (for example, non-readers) attended mainstream classes, policy issues (for example, clearance was needed for learners to go out of the school premises), lack of technologies that support the teaching and learning process as well as teacher de-motivation from School Heads, and lack of financial support to buy science apparatus and chemicals from School Heads. The participants also lamented none or late payment of school fees and levies by most of the learners in government schools which handicapped the smooth running of the school. These challenges hindered the deployment of suitable practical work pedagogies and assessments as well as the implementation of science citizenship education. These challenges were noted in literature as some of the challenges that limited scientific literacy (Barak, 2014; Crawford, 2012; European Commission, 2015; Sickel et al., 2015; Towndrow et al., 2010; World Bank, 2008).

6.2.6 Possible benefits of integrating citizenship education to science practical work

The respondents in the cross-sectional survey and the participants in the multiple-case study concurred on the possible benefits of effective science citizenship education when they stated that it could produce science learners and eventually citizens who could be able to solve socio-scientific problems, could be sensitive to issues of environmental sustainability and could live science-enriched lives. Participants in the multiple-case study also argued that the integration of citizenship education into the pedagogy and assessment of science practical work had the potential of producing learners and citizens who could generate science related careers and could also produce gadgets and artifacts that could be sold to earn a living since science citizenship education would promote inventiveness. The finding is supported by literature as scholars view science citizenship education as having the potential to enrich citizens' lives (Ahmad, 2017; Hoeg & Bencze, 2017; Schulz et al., 2017).

6.3 Findings that contradict existing literature

(a) Science practical work pedagogy contradiction

Literature justified practical work in science as essential to reduce the abstract nature of science (Barak, 2017; Chowdhury, 2016; Cowie, 2015; Dewey, 1995). Practical work was also argued to be critical for learners to acquire scientific skills that could be applied in science and in everyday lives of the learners. Scholars and science educators posited that science lessons were basically supposed to be practical lessons (Babaci-Wilhite, 2017; Fadzil & Saat, 2019; Skelton et al., 2018; Williams, 2011; Millar, 2010; Abrahams, Michael & Sharpe, 2014; Stone, 2014; Cobern et al., 2014; Silm et al., 2017; Dagys, 2017). However, the current research found that in the Zimbabwean context, science practical work was generally limited during the teaching and learning of Combined Science. The frequency of the practical work thus fell short of what is advocated for in literature.

Science practical work pedagogy should be learner-centred and inquiry-based to promote learners' critical-thinking skills, problem-solving skills and application of scientific knowledge (Chowdhury, 2016; Dewey, 1995; Oxfam, 2015). Inquiry-based social constructivist pedagogies should result in learners constructing their own knowledge. During the teaching and learning process, the learners go through processes of experiential-cognitive conflict, reflection, adjustment, accommodation, rejection and/or reframing, hence the end result is meaningful learning. This is possible when the pedagogy employed is learner-centred and truly learner inquiry-based. The learners should interrogate the learning materials, content, objectives, procedures and gather data during the practical work. The learners should report their findings in a way that makes sense to them and draw conclusions based on scientific principles. Learner collaboration is vital during knowledge construction as peers help to clarify each other's misconceptions. Learners should not be passive receptors during the practical work. The teacher should act as a facilitator and not as a source of knowledge (Agarkar, 2019; Barak, 2017; Bell, Maeng & Binns, 2013; Healy, 2013; Pagliaro, 2013; Toraman & Demir, 2016). Literature thus reveals that practical work is best learnt when learner-centred, inquiry-based teaching methods are employed. Teacher demonstrations, when they are used, should be applied in a manner that arouses learner interest and curiosity to explore further on the concept or the practical work. Subsequently, learners are driven by intrinsic motivation and the knowledge constructed is applied in real-life situations. The current researcher however, laments that the pedagogies employed during practical work, which were generally teacher-centred confirmatory experiments, as observed in the current research, contradicted literature as they were not ideal for learners to acquire problem-solving skills, critical-thinking skills and creativity. The pedagogies were also not aligned to the promotion of the concept of science citizenship education as there was likely to be limited practical skills acquisition and application by the learners. The fact that the pedagogies employed were not promoting citizenship education could mean that the science practical work could be failing to impart skills that were necessary in the learners' real lives.

In the current research, the majority of respondents in the cross-sectional survey stated that they used inquiry-based methods. That was also the position revealed by the participants in the multiple-case study as well. However, the teacher interviews, lesson observations and focus group discussions revealed that the inquiry-based teaching methods the participants were referring to were the cookbook kind of confirmatory teaching. The results also indicated that the practical work was generally teacher-centred. During a practical activity, the teacher stated the aim, outlined the procedure on the board, brought the apparatus and materials required and carried out a teacher demonstration, with very little or no contribution from the learners. The teacher carried out the experiment first through a teacher demonstration and emphasised on the observations the learners were supposed to record. The learners were then supposed to repeat the experiment in groups or individually. The practical work done by the learners had no academic value as the learners did not contribute to the procedure, the materials and apparatus required for the practical work, the safety measures and the observations. The teacher told the learners everything and the practical work was thus not a scientific inquiry that led to the learners constructing knowledge. The learners were most likely not going to apply the concepts and skills that they were supposed to acquire from science to live science-enriched lives. Such an approach has been blamed for producing learners that were highly academic but lacked practical skills (Report of the Presidential Commission of Inquiry into Education and Training, 1999). Integrated Science Forms 3-4 which was offered to Zimbabwean learners until 2016 was blamed for producing learners who failed to wire a 3-pin plug due to its lack of a science practical examination and subsequently limited science practical work during the teaching and learning process.

The current researcher interpreted the inquiry-based pedagogies practiced by the teachers observed in the current research as different from those which are based on social constructivism because the teachers were not acting as facilitators but as the sources of knowledge. The teachers were outlining the learning objectives, the experimental procedures, the materials and apparatus needed for the experiments and were carrying out teacher demonstrations with no or very limited learner participation. Such 'inquiry-based' pedagogies used by teachers would most likely produce learners who lacked critical-thinking and problem-solving skills as these were not fostered during the practical work. Such pedagogies contradicted the inquiry-based, learner-centred, peer collaboration and active learner involvement advocated for by social constructivism and the theoretical framework employed in the current research. The inquiry-based pedagogies employed contradicted the position stipulated in literature (Blumenfeld, 2006; Cowie, 2015; Millar, 2009; Millar, 2013). The current researcher posits that the teachers demonstrated a pedagogical misunderstanding of the inquiry-based pedagogies that lead to learners constructing knowledge and instead, used inquiry-based methods which were just confirmatory in nature. Teacher staff-development on the inquiry-based pedagogies based on social constructivism would help to align the pedagogies to the curriculum goals. The staff-development could enable the teachers to teach practical work in a way that could result in learners constructing knowledge which they could apply in their lives.

Science education could enhance science citizenship if the pedagogies employed during the teaching and learning process included active engagement on science related community challenges to offer solutions (Albe, 2015; Chowdhury, 2016; Eurydice, 2005; Hoeg & Bencze, 2017; Rudolph & Horibe, 2016; Matthews, 2014). In the cross-sectional survey, there was no clear position on the integration of citizenship education to science practical work during the teaching and learning process. This position could mean that the concept of citizenship education was left to individual teachers for the implementation. In the multiple-case study, all the three science departments had no policy on the integration of citizenship education into the pedagogy and assessment of science practical work and as such, some teachers did not put emphasis on citizenship education. The teachers, however, generally reported that they verbally encouraged the learners to apply the concepts learnt at school in their real lives. There were no teacher supervised activities that integrated the science practical work to community challenges or learners' daily lives. The results show that the concept of science citizenship education in Zimbabwean schools lacked clarity, and therefore, there was no effective integration of citizenship education to the pedagogy and assessment of practical work. The lack of integration of citizenship issues into science practical work contradicts literature which advocates for active engagements of learners in science-related community challenges.

(b) Science practical work assessment contradiction

Formative assessment is described as an integral part of the teaching and learning process as it is used to give a better understanding of the aims and objectives of the curriculum, evaluate the educational pedagogies and assessments used during the teaching and learning process and use the data collected to improve instruction (Abrahams, Reiss & Sharpe, 2013; Corrigan et al., 2013; Yore, 2012). The teacher bases his/her decisions on the data obtained from formative assessments to evaluate the learner's academic progress or lack of it as well as the effectiveness of the teaching methods employed. The teacher thus could modify the pedagogies employed if the learners demonstrated that they did not master the concepts or could move on the next topic if data showed that the learners had acquired the intended concepts and skills. On the contrary, the results of the current research showed that the teacher side-lined the formative assessment of practical skills using practical tests although they pointed out that it was the most effective way to get feedback on the teaching and learning process. The teaching and learning process thus lacked evaluation on the effectiveness of pedagogies used to teach practical skills. The lack of meaningful practical skills assessments during the teaching and learning process had the potential of completely missing the intended goals of the curriculum.

Millar (2013) argues that curriculum, pedagogy and assessment should be aligned for an effective implementation of any educational programme. In the summative examinations which were administered by the national examination board, ZIMSEC, practical skills were assessed using a practical examination. The assessment of practical skills during the teaching and learning process was thus not aligned to the summative assessment. The lack of alignment between formative and summative assessments could result in poor practical skills and lack of confidence for learners with regard to science practical work. The lack of formative practical skills assessments during the teaching and learning of science practical work contradicted literature which generally presents pedagogy and assessment as inseparable. Many scholars argue for educational assessment which they view as essential to check on learning progress as well as evaluating the effectiveness of the pedagogies employed (Black, 2013; Corrigan et al., 2013; Long et al., 2011; Millar, 2013). The current researcher views teaching and learning of science practical skills without formative assessments as 'blind instruction' which has the potential of missing the curriculum goals as well as the conceptual challenges which the learners might have.

(c) Combined Science Syllabus Forms 1-4 contraction

The document analysis of the Combined Science Syllabus Forms 1-4 indicated that the classes were supposed to have a maximum of thirty-five (35) learners, yet the results collected revealed that classes were generally very large, with an average of sixty learners per class. This position contradicted literature which argued that effective science practical skills learning needed a low teacher-learner ratio.

The Combined Science Syllabus Forms 1-4 included the concept of citizenship education although the term was not referred to as such. The syllabus stipulated that science education was supposed to enhance competencies that enhanced scientific literacy and could be applied to real-life situations. The pedagogies employed were also supposed to develop enterprising skills and self-initiatives in the learners. Such skills were attributes of good citizenship education which could be achieved through employing learner-centred pedagogies as indicated in literature (Agarkar, 2019; Healy, 2013; Pagliaro, 2013; Toraman & Demir, 2016). On the contrary, the teaching and learning process generally employed teacher-centred pedagogies, a position that contradicted literature.

The syllabus analysis critically revealed that learners were supposed to "plan, organize and carry out experimental investigations" and that process entailed the selection of appropriate apparatus and materials for experimental work by learners (Combined Science Syllabus Forms 1-4, p. 1). The summative assessment of learners' practical skills required that the learners be able to determine the quantities to be used in experiments, justifying how the proposed quantities were determined. The practical skills were supposed to be acquired when the learners were in charge of the science practical work from the planning stages to the carrying out of the practical work and the reporting of the results. However, the results of the current research revealed teacher dominance in almost all the aspects of the science practical work. That position of imposing knowledge to learners contradicts both the literature and the theoretical framework employed in the current research which advocate for learner-centred pedagogies which are based on social constructivism principles. The syllabus, which is a policy document, intended to guide teachers on the content, objectives, teaching methods and assessments was thus not adhered to with regard to the implementation of the pedagogies suggested for practical work.

6.4 Findings which have not been reported before

6.4.1 Deviation from policy

One of critical findings in the current study was that teachers and schools deviated from the policy on practical work. This deviation could jeopardize the extent to which citizenship education is integrated through practical work. For example, the Combined Science syllabus recommended that the learning area be allocated four double lessons per class per five days teaching week. A double lesson was supposed to be one hour ten minutes (two lessons of thirty five minutes each). The general results showed that Combined Science was allocated double lessons on the school timetables and that generally each lesson was thirty five minutes long although the results also indicated that some classes are allocated periods of thirty (30) minutes. Four (4) double lessons per five days week, which were recommended in the Combined Science Syllabus, were rarely assigned to Combined Science classes as the majority of classes were allocated three (3) double lessons per five days teaching week. Some schools used timetables that ran on a six day cycle and had three double lessons in six days. In such a scenario, the teaching and learning time was even limited further. The limited time was stated as a challenge that militated against practical work. The current researcher sees the Combined Science learning area as having been allocated enough time in the syllabus, that is, four double lessons of thirty-five (35) minutes in a five day teaching and learning week (Monday to Friday). It is also important to note that the implementation of the Combined Science in the competence-based curriculum failed to move away from the position of the old curriculum where Integrated Science was offered three double lessons per week. The Combined Science teaching and learning time was limited at school level as schools adopted a wide curriculum and offered many subjects which then competed stiffly for time. A common deviation by schools from a clearly outlined policy without consequences has not been seen in literature. The current researcher posits that the limited teaching and learning time assigned to Combined Science classes may point to lack of supervision from the MoPSE. Alternatively, the curriculum may be too wide for it to be effectively implemented. All things considered, the current researcher argues that the limited teaching and learning time and the deviation from policy may impact negatively on learner exposure to science practical work. This in turn could affect learners' exposure to citizenship education as they may not adequately develop science process skills.

The current research also found that practical work assessments during the teaching and learning process lacked uniformity and supervision. The results showed that the integration of citizenship education to science practical work assessments may also have lacked uniformity as individual teachers were focusing on it in different ways. The lack of integration of citizenship education to practical work assessment stood out vividly in the multiple-case study results which showed that practical skills assessments were not carried out during the teaching and learning process. There was no link between the practical skills assessments carried out within schools and science citizenship education. The results were the same in all the three schools. The integration of citizenship education to the pedagogy and assessment of science practical work has not been defined in literature. This gap, further justified the need for a framework for integrating citizenship education in science practical work, so that schools, teachers and learners could be guided in a manner that would make science education beneficial to citizens and their communities.

6.4.2 The framework for integrating citizenship education into science practical work

At the core of the current research was the need for the development of a framework for integrating citizenship education in science practical work. This is stated in the aim and main research question of the current research. The lack of consistent integration of citizenship education in Combined Science practical work in Zimbabwe, which was observed in the current research, further justified the need for this framework. Therefore, synthesizing from the data, in response to the last two sub-questions (i.e., how could citizenship education be integrated in the pedagogy of science practical work, and, how could citizenship education be integrated in the assessment of science practical work?), the current research has identified eight pillars which form the framework for integrating citizenship education in science practical work (Figure 6.1).

The framework for integrating citizenship education to the pedagogy and assessment of science practical work developed in the current research has not been reported in literature before as it emerged from the findings of the current research. The framework developed in the current research was based on the results obtained in the current research. Based on the results, an effective citizenship education programme that is integrated to the pedagogy and assessment of science practical work has to be anchored by eight pillars of support. The pillars support the programme of science citizenship education and are also interconnected among themselves (Figure 6.1).

Figure 6.1. *The framework for the integration of citizenship education to science practical work*

As shown in Figure 6.1, the eight pillars of support, as identified from the research results, are:

- educational policies
- staff-development
- community challenges and needs
- science content and objectives
- constructivist pedagogies
- constructivist assessments
- programme monitoring and evaluation
- programme resource allocation

To bring clarity to the framework (Figure 6.1), it is imperative that the eight pillars of support be well articulated. For example, the question on what encompasses constructivist pedagogies should be clarified. Each pillar of support which is part of the framework is thus described.

a) Educational policies

The Ministry of Primary and Secondary Education (MoPSE), which is the custodian of educational policies and programmes, should have clear policies on citizenship education. The policies should specify the contribution each learning area has to make to the lives of the learners. Science citizenship education should be clearly mandated to deal with community challenges that are science related, for example, carrying out sustainable projects and awareness campaigns that address issues of nutrition, health, energy, water quality and pollution.

The schools should be guided on the community related activities and projects that they should carry out with their science classes. For example, the policy could stipulate that learners spend two hours every week on projects and activities that were community related and reports are generated on the progress made. The policy should be clear on the time that should be allocated for the implementation of citizenship education. While the citizenship education should be flexible to address the challenges peculiar to a particular community, the science classes should be guided with a policy that gives broad aims that should be addressed.

The policy should address the issue of the teacher-learner ratio. A ratio of one teacher to a maximum of thirty-five learners which is recommended in the Combined Science Syllabus Forms 1-4 should be enforced as a policy undertaking so that classes are manageable.

Policy should also address the issue of teacher workload. Many participants and respondents in the current research indicated that a heavy workload was hindering both science practical work and citizenship education. A heavy teacher workload was qualified as thirty lessons or more per week. The teacher should be allowed space to carry out research work, plan lessons and mark learners' written tests and exercises. The maximum number of lessons per week, which should be below thirty periods, should be stated in the implemented policy after further consultations with teachers' unions.

The MoPSE should have a policy on the recruitment of laboratory technicians/assistants as the goal of exposing learners to effective science practical work could not be attained if teachers were not supported in the preparation of practical work. MoPSE should employ laboratory technicians/assistants on the basis of the number of learners studying science at a particular school.

b) Staff-development

School Heads and teachers should be staff-developed on citizenship education so that they appreciate it, they know what they aim to achieve, the relevant pedagogies and assessments that should be employed and most importantly, that they willingly and enthusiastically embrace it. The school administrators and teachers also need to be motivated in terms of good remuneration so that they work hard to impart the science practical skills, carry out suitable assessments and integrate citizenship education to the teaching and learning process.

The current research identified that teachers were generally employing teacher-controlled and dominated confirmatory practical work which they classified as inquiry-based pedagogies. The inquiry-based pedagogies that were employed limited the learners' development of critical-thinking skills and problem-solving skills. Staff-development on learner-centred, inquiry-based pedagogies that were constructivist in nature would be needed to support the concept of effective science citizenship education.

c) Community challenges and needs

The MoPSE should put in place programmes to educate parents and teachers on the concept of citizenship education, otherwise it could be rejected at the implementation stage if stakeholders failed to understand its aims. The science classes should involve the communities in the process of identifying the challenges that they would resolve. The schools should involve the communities in identifying knowledge gaps and hence the needs of the communities, for example, the use of technologies to resolve community challenges and science practical solutions to mitigate the impact of climate change. Communities may use alternative sources of fuel such as solar energy to reduce the use of fossil fuels and may have plants and vegetation around their homes. The schools would need the help of the community leaders to mobilise their people so that the activities and projects could be successful.

d) Science content and objectives

The aims, content and objectives that address citizenship education should be clearly outlined in the Combined Science Syllabus. The science practical work carried out within the school should be related to the community, industry or learner's life and hence its relevance to citizens. For example production of sanitisers that help to fight the COVID-19 pandemic could be included in the Combined Science Syllabus and should be practically-based so that the learners produce them to serve their families and communities. The syllabus should specify science practical work that should be done on a large scale to benefit learners and their communities. For example, detergent production could be done on a large scale that benefits the school, learners and the community and that could be clearly outlined in the syllabus.

e) Constructivist pedagogies

The syllabus should clearly outline constructivist pedagogies that could be used to link science practical work to citizenship education. The constructivist pedagogies, as outlined in Chapter 2, should be inquiry-based pedagogies which include practical work, project-based learning (PBL), argumentation, discussion and collaborative learning. The pedagogies should also be supported by relevant technologies.

f) Constructivist assessments

The syllabus should clearly outline the constructivist assessments that link science practical work to citizenship education. The assessment of learners' practical skills should be done as learners carry out the practical work. The teacher should assess as the learner is in the process of doing the actual practical work. For example, if the teacher is assessing the learner's ability to use a measuring cylinder, then the teacher should score marks for placing the measuring cylinder on a flat surface, reading from the meniscus and taking the reading at eye-level as well as correct reading of the scale on the measuring cylinder. These skills cannot be effectively assessed theoretically.

Aligning summative national assessments to practical work assessments that are linked to citizenship education is vital to keep the programme focused. Schools, learners and teachers are seized with attaining good grades in the national summative examinations that are offered by ZIMSEC. The national examinations are high stakes since they are used for grading and certification. The learning area content, practical skills and assessment methods that are emphasised by ZIMSEC are the ones that are also emphasised during the teaching and learning process. The concept of science citizenship education should also be part of the national assessments if it is to be taken seriously by the parents, schools, teachers and learners.

g) Programme monitoring and evaluation

Attainable targets should be set, then monitored and supervised during the implementation stage to enhance successful implementation. The programme should be evaluated so that improvements could be effected. Monitoring and evaluation would help schools to understand the processes required of them and also help to keep a uniform standard of attainment across schools. Monitoring also gives feedback on the challenges that may be experienced during the implementation stage but were impossible to identify at the planning stage. The challenges would then be addressed in real-time so that they would not derail the programme. The monitoring programme should be the responsibility of the MoPSE.

h) Programme resource allocation

The Ministry of Primary and Secondary Education should fund practical work in schools and community projects that learners would be involved in. MoPSE could seek assistance from the Industry and Commerce sector, international organisations such as the United Nations Children's Fund (UNICEF) as well as Non-Governmental Organisations (NGOs). Schools could also generate funds from science practical work related projects such as the production and sale of soap and detergents, which could be a viable project throughout the country. Funding is critical for the realisation of the science citizenship education agenda, otherwise the idea would never bear fruit.

6.5 Potential impact of the framework for the integration of citizenship education into science practical work

The main research question, as presented in Chapter 1, was:

How could a framework for integrating citizenship education in the pedagogy and assessment of science practical work be developed, using Combined Science in Zimbabwe as a case study?

Four sub-questions were raised in the current research, so the potential impact of the framework for integrating citizenship education will be discussed in response to the four sub-questions.

The first research sub-question was concerned with the extent to which citizenship education was integrated in the pedagogy of science practical work in Combined Science in Zimbabwe. The finding was that there was no uniform integration of science citizenship education in the pedagogy of practical work during the teaching and learning of Combined Science practical work in Zimbabwe. Linking of citizenship education to the pedagogy of science practical work was left to the discretion of teachers in an unsupervised way. The developed framework has the potential of clarifying the pedagogies that teachers could employ during science practical work so that learners would be involved in knowledge construction. The pedagogies could also enhance citizenship education as the framework highlights the connection between science practical work and community challenges and needs. That connection could imply that science concepts and skills acquired by learners could benefit the learners and their communities.

The second research sub-question examined the extent to which citizenship education was integrated in the assessment of science practical work in Combined Science in Zimbabwe. The finding was that the concept of citizenship education was not integrated to the assessment of science practical work. The teachers had no framework that guided them to link practical work assessment to citizenship education. The developed framework, therefore, has the potential to clarify the link. The framework brings into context the vital connection between constructivist assessments and community challenges and needs. The framework also aligns educational policies, staff-development and programme resource allocation to constructivist assessments that enhance citizenship. The current research found that alignment to be lacking and hence a major setback to the implementation of science citizenship education by the Combined Science teachers in Zimbabwe.

The third research sub-question interrogated how citizenship education could be integrated into the pedagogy of science practical work. The developed framework, which is based on the current research findings, highlighted the crucial connections among the eight pillars of support which are required to enhance the integration of citizenship education into the pedagogy of science practical work. Adequate resources, staff-development, supportive educational policies, suitable science content and objectives as well as programme monitoring and evaluation are required to implement constructivist pedagogies that address community challenges and needs and thus enhance science citizenship education. These connections are outlined by the framework developed in the current research, and as such, the framework has the potential to promote effective science citizenship education through addressing community challenges and needs through the pedagogy of science practical work.

The fourth research sub-question interrogated how citizenship education could be integrated into the assessment of science practical work. Closely related to the argument on the third research sub-question, adequate resources, staff-development, supportive educational policies, suitable science content and objectives as well as programme monitoring and evaluation are required to implement constructivist assessments that address community challenges and needs to enhance science citizenship education. The framework thus has the potential to integrate citizenship education to science practical work assessment.

The framework for the integration of citizenship education into science practical work has the potential to inform both educational policy makers and educators on policies, pedagogies and assessments that promote science citizenship education. The framework is also relevant to inform the MoPSE on programmes that they need to the put in place for the effective implementation of science citizenship education in Zimbabwe.

6.6 Conclusion

The current research gathered information that indicated that science citizenship education, practical work, practical work pedagogies and practical skills assessments needed to be given more attention by stakeholders such as MoPSE, ZIMSEC, schools, teachers and learners. The research also collected data on how practical work pedagogies and assessments could be aligned to citizenship education so that they enhanced it. Data were also collected on challenges that militated against science citizenship education. The current research findings led to the development of a framework that could be used to integrate citizenship education to the pedagogy and assessment of Combined Science practical work in Zimbabwe. The framework was developed from the results of the current research. The framework is based on eight principles which are referred to as the eight pillars of support in the current research. The eight pillars of support identified as critical for sustaining citizenship education are educational policies, staff-development, community challenges and needs, science content and objectives, constructivist pedagogies, constructivist assessments, programme monitoring and evaluation and programme resource allocation. Although the framework was developed from a research based on Combined Science in Zimbabwe, it can still be applied to other science subjects like Biology, Chemistry and Physics globally. The framework on the integration of citizenship education into the pedagogy and assessment of practical work would assist curriculum designers, policy makers and educators to plan, develop and implement effective science citizenship education nationally as well as globally.

6.7 Recommendations for future research

The concept of science citizenship education still requires research as there is very limited literature on researches that have been carried out to address it especially in African countries. Future research may focus on the following points:

- the relationship that exists between the exposure of learners to practical work and practical skills assessments during the teaching and learning process and the summative practical examination grades

Such a research has the potential to clarify the impact of the formative science practical work assessments to the summative practical examinations. A positive correlation between formative assessment and summative assessment has the potential to persuade teachers to expose learners to more formative practical work assessments as they value the grades and certification that is associated with summative examinations.

- the ideal conditions that are required for effective science citizenship education implementation by schools

The research has the potential of examining the actual conditions that are required by schools to effectively implement the programmes that promote science citizenship education. The research would put theory into actual practice and hence recommend the best conditions based on examining a programme on science citizenship.

- how the national summative assessments could be aligned to formative schools' assessments so that science citizenship education could be enhanced

The research could examine many possible ways of linking formative and summative science practical work assessments to communities' challenges and needs and recommend the best methods that enhance effective science citizenship education based on the findings of the research. Such a research has the potential to blur the division that exists between formative and summative assessments as well as informing best assessment practices that enhance science citizenship education. For example, students may apply the concepts and the practical skills that they learn under titration stoichiometry, quantitative and qualitative analysis to analyse the quality of water that is used to different purposes by the communities. Both the national and formative assessments would thus enhance citizenship education as they would be linked to the resources used by the communities.

- how effective the framework developed in the current research is when used in the implementation of science citizenship education

The framework developed in the current research has not been tested and as such, the proposals are theoretical. A research that implements the framework could be beneficial as the framework could be evaluated. That would allow for any necessary modifications to the proposed framework to be made.

6.8 Lessons for developing researchers

Carrying out a research is like a journey which requires proper planning and resources. The current researcher used a mixed methods research approach and employed a cross-sectional survey as well as a multiple-case study. The mixed methods research approach employed approximated carrying out two researches in terms of the time needed for data collection and analysis, researcher expertise and financial resources required. However, the data collected, using the mixed methods research, are so rich that the research approach becomes a worthwhile endeavour. The current researcher thus views the mixed methods research approach employed in the current research as very effective in terms of data collection.

In the cross-sectional survey employed, Combined Science teachers who were examiners with ZIMSEC in 2019 were sampled as respondents. The challenge faced with the sampling was that the examiners were not quite representative with regard to qualifications, teaching experience and the province they were coming from. Some provinces had more numbers than others, for example, the examiners from Bulawayo were fewer than the number that the current researcher had intended to sample. The lesson learnt here was that the research process could require the researcher to modify the procedure initially planned. The modifications should however be carried out to miminise the effect that they may have to the data collection process and should also be reported for the research to be credible.

In the multiple-case study, the current researcher used Combined Science interviews, focus group discussions with Combined Science teachers, School Heads interviews, lesson observations and document analysis of the Combined Science Schemes of work to collect data. The current researcher realised that the data source triangulation was effective in providing rich data. However, the researcher spent only a week at each of the sampled schools. All the data collecting procedures were only carried out in a single event at each of the sampled schools. The data collection process could have been affected by the Hawthorne effect which could be minimised by an extended stay at each school by the current researcher, time and resources permitting.

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Summary of appendices

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Appendix A: MoPSE permission request letter

The Permanent Secretary
Ministry of Primary and Secondary Education
Ambassador House
P.O Box CY 121
Harare

Date

Dear Madam

RE: Request for permission to:

1. administer a questionnaire to Combined Science teachers who are examiners with the Zimbabwe School Examinations Council (ZIMSEC)

2. conduct research at four secondary schools in the Midlands Province namely

Takudzwa Secondary School (Kwekwe district), Nothando Secondary School (Shurugwi district), Tivongereiwo Secondary School (Gweru district) and Tatendashe Secondary School (Chirumhanzu district).

Title: Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe

I, Elenia Javangwe, am doing research under the supervision of Prof L.E Mnguni, a professor in the Department of Science and Technology Education towards a Doctor of Philosophy in Education/PhD at the University of South Africa. I am employed by the Zimbabwe School Examinations Council (ZIMSEC) as the Combined Science Subject Manager. My address is ZIMSEC Head Office, Upper East Road, Mount Pleasant. My cell number is 0772397189 and my e-mail is ejavangwe@zimsec.co.zw.

The aim of the study is to develop a framework for integrating citizenship education in the pedagogy and assessment of science practical work. The framework would then inform educators, curriculum developers and policy makers about the pedagogy and assessment models that enhance citizenry and useful science education.

The research employs a mixed-methods research approach that combines a multiple-case study research and a cross-sectional survey.

The study entails the use of a semi-structured questionnaire in the cross-sectional survey and semi-structured interviews with Combined Science teachers and the School Heads, non- participant lesson observations, focus group discussions with science teachers, document analysis of Combined Science schemes of work, audio recording, photographs and video recording to collect data, in the multiple-case study research. Photographs taken and video recordings will focus on the equipment used in the teaching and learning of practical skills and not on participants in order to protect their identities and hence maintain the cases anonymous. Document analysis will focus on the Combined Science timetables, schemes of work, practical worksheets and formative tests. Audio tapes will be used for recording the interviews, focus group discussions as well as the discussions during the teaching and learning process. Focus group discussions will also be recorded as minutes and a diary will be used to record data during lesson observations.

The Ministry of Primary and Secondary Education is the responsible authority for the schools (sites of data collection) and the Combined Science teachers, who are the sources of data collected in the research. It is therefore important that permission to carry out the research be granted by the Ministry of Primary and Secondary Education.

The benefits of this research are its potential contribution to science education in Zimbabwe and globally as it will propose a framework for the pedagogy and assessment of practical work which enhance effective citizenship education. The framework for science citizenship education would assist in focusing science educators to employ pedagogies and assessments which improve the acquisition of science practical skills in learners. The learners would thus be empowered to apply science concepts to solve real-life socio-scientific challenges.

There are no potential risks to participants that are foreseen. The researcher will not breach the official secrecy act. The participating schools and participants/respondents will remain anonymous as pseudonyms will be used. Research data will be used only for thesis and educational publications. Feedback procedure will entail distributing a summary of the research findings and recommendations to the Ministry of Primary and Secondary Education's Head Office and to participating schools. The final report will be submitted in October 2020.

I kindly request for permission to carry out a cross-sectional survey and a multiple-case study research as stipulated above.

Yours Sincerely

Elenia Javangwe

UNISA Student (Student number 63506610)

Appendix B: School permission request letter

Request for permission to conduct research at a Secondary/High School

The Head
Address of school

Date

Dear Sir/Madam

RE: Request for permission to conduct research at ……………………………………. School

I, Elenia Javangwe, am doing research under the supervision of Prof L.E Mnguni, a professor in the Department of Science and Technology Education towards a Doctor of Philosophy in Education/ PhD at the University of South Africa. The study is not funded. We are inviting your school to participate in a study entitled "Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe."

The aim of the study is to develop a framework for integrating citizenship education in the pedagogy and assessment of science practical work. The framework would then inform educators, curriculum developers and policy makers about the pedagogy and assessment models that enhance citizenry and authentic science education.

Your school has been selected because it represents many secondary schools in terms of its context and its purpose.

The study entails the use of a semi-structured interview with a Combined Science teacher and the School Head, a class observation, a focus group discussion with Combined Science teachers, document analysis, audio recording, photographs and videos to collect data. Photographs taken and video recordings will focus on equipment used in the teaching and learning of science practical skills and not on participants in order to protect their identities and hence maintain the cases anonymous. Document analysis will focus on the Combined Science timetables, schemes of work, practical worksheets and tests. Audio tapes will be used for recording the interviews, focus group discussions as well as the discussions during the teaching and learning process. Focus group discussions will also be recorded as minutes and a diary will be used to record data during lesson observations.

The benefits of this research include the proposal of a framework for the pedagogy and assessment of science practical work in such a way that it promotes citizen education and hence lead to authentic science education.

There are no potential risks to participants that are foreseen.

There will be no reimbursement or any incentives for participation in the research.

Feedback procedure will entail distributing a summary of the research findings and recommendations to your school and the participants.

Permission for the research has been granted by the Ministry of Primary and Secondary Education in Zimbabwe and the Ethics Committee of the College of Education, UNISA.

Yours sincerely

Elenia Javangwe

UNISA Student (Student number 63506610)

Appendix C: ZIMSEC permission request letter

Request for permission to conduct research at a Zimbabwe School Examinations Council (ZIMSEC) Marking Centre

The Director
Zimbabwe School Examinations Council
P.O Box CY 1464
Causeway
Harare

25 November 2019

Dear Sir

RE: Request for permission to conduct research at a ZIMSEC Marking Centre

I, Elenia Javangwe, am doing research under the supervision of Prof L.E Mnguni, a professor in the Department of Science and Technology Education towards a Doctor of Philosophy in Education/PhD at the University of South Africa. The study is not funded. We are inviting the Combined Science examiners at your marking centre to participate in a study entitled "Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe".

The aim of the study is to develop a framework for integrating citizenship education in the pedagogy and assessment of science practical work. The framework would then inform educators, curriculum developers and policy makers about the pedagogy and assessment models that enhance citizenry and authentic science education.

Your marking centre has been selected because it hosts the Combined Science teachers in their capacity as Combined Science examiners. The questionnaire seeks to collect data relating to the pedagogy and assessment of Combined Science in Zimbabwean schools. The questionnaire does **not** focus on ZIMSEC business.

The research entails the use of a structured questionnaire which the Combined Science teachers/examiners will respond to in two hours. The respondents' identities are not sort so that they remain anonymous.

The benefits of this research include the proposal of a framework for the pedagogy and assessment of science practical work in such a way that it promotes citizen education and hence lead to authentic science education.

There are no potential risks to participants that are foreseen.

There will be no reimbursement or any incentives for participation in the research.
Feedback procedure will entail distributing a summary of the research findings and recommendations to the Ministry of Primary and Secondary Education, ZIMSEC and the participants.

Permission for the study has been granted by the Ministry of Primary and Secondary Education in Zimbabwe and the Ethics Committee of the College of Education, UNISA.

The questionnaire to be administered to the Combined Science examiners, the research abstract, UNISA ethics approval certificate and the Ministry of Primary and Secondary Education permission granting letter are attached.

Yours sincerely

Elenia Javangwe

UNISA Student (Student number 63506610)

Appendix D: Participant information sheet

PARTICIPANT INFORMATION SHEET

Title: **"Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe"**

DEAR PROSPECTIVE PARTICIPANT

My name is Elenia Javangwe and I am doing research under the supervision of Prof L.E Mnguni, a professor in the Department of Science and Technology Education towards a Doctor of Philosophy in Education/ at the PhD at theUniversity of South Africa. The research has no funding. We are inviting you to participate in a study entitled "Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe."

WHAT IS THE PURPOSE OF THE STUDY?

This study is expected to collect important information that could lead to the proposal of a framework for the pedagogy and assessment of science practical work in such a way that it promotes citizenship education and hence lead to authentic science education.

WHY AM I BEING INVITED TO PARTICIPATE?

You are invited because being a Combined Science teacher, your expertise and experience in the teaching and learning process informs the research on the state of science practical work and citizenship education.

All the Combined Science teachers in the four participating schools are invited to participate in the research as well as approximately 700 Combined Science teachers who are examiners with ZIMSEC who will participate in a cross-sectional survey.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS RESEARCH?

For the cross-sectional survey participants, the research entails approximately two hours of answering semi-structured questions in the questionnaire. For the sampled schools, the research involves semi-structured interviews, focus group discussions and lesson observations for the Combined Science teachers at the four cases. School Heads at the sampled schools will also be interviewed. Document analysis will focus on the Combined Science timetables, schemes of work, practical worksheets and tests. Audio tapes will be used for recording the interviews, focus group discussions as well as the discussions during the teaching and learning process. Photographs taken and video recordings will focus on equipment used in the teaching and learning of practical skills and not on participants in order to protect their identities and hence maintain the cases anonymous. Questions asked focus on the pedagogy and assessment of science practical work in relation to citizenship education. Lesson observation will be carried out with sampled Combined Science classes at the four schools. Interviews and focus group discussions will take a maximum of one and half hours each and carried out once per each case. The questionnaire will be 2 hours long and completed in a single day since it will be a cross-sectional survey.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

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 form. You are free to withdraw at any time and without giving a reason. However, if you are participating in the cross-sectional survey, the questionnaires are anonymous so it will not be possible to withdraw once you have handed it in.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

This study is expected to collect important information that could lead to the proposal of a framework for the pedagogy and assessment of science practical work in such a way that it promotes citizenship education and hence lead to authentic science learning. This development will be good for science educators as they will produce learners who will contribute meaningfully to socio-scientific issues within their communities.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

This research has no unforeseen potential risks but participants may suffer the inconvenience of working while being observed by a stranger (the researcher). They may also be inconvenienced in terms of the extra time they may require to do the interviews and focus group discussions.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

You have the right to insist that your name will not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research. 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. A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report.

A focus group discussion is a qualitative data gathering method that brings members with similar experiences together to discuss about a topic under research. 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, the researcher cannot guarantee that other participants in the focus group will treat information confidentially. The researcher shall, however, encourage all participants to do so. For this reason, the researcher advises you not to disclose personally sensitive information during the focus group discussions.

HOW WILL THE RESEARCHER PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cabinet at ZIMSEC Head Office, which is the researcher's place of work, 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.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

The research is not funded and there are no rewards or payment, financial or otherwise, that will be made to the participants. There are no costs that are incurred by participants as the researcher will be visiting them.

HAS THE RESEARCH RECEIVED ETHICS APPROVAL

This study has received written approval from the Research Ethics Review Committee of the College of Education, UNISA. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Elenia Javangwe on +263772397189 or email ejavangwe@zimsec.co.zw or eleniaj@yahoo.com. The findings will be accessible for five years.

Should you require any further information or want to contact the researcher about any aspect of this study, please contact Elenia Javangwe on +263772397189 or email ejavangwe@zimsec.co.zw or eleniaj@yahoo.com. If you have questions about this study, please ask the researcher or her research supervisor, Prof L.E Mnguni, Department of Science and Technology, College of Education, University of South Africa. The e-mail of the research supervisor is mngunile@unisa.ac.za.

Should you have concerns about the way in which the research has been conducted, you may contact Prof L.E Mnguni on +27 (0) 12 429 4614 or e-mail him at mngunle@unisa.ac.za.

Thank you for taking time to read this information sheet and for participating in this study.

Elenia Javangwe

UNISA Student (Student number 63506610)

Appendix E: General research consent

CONSENT TO PARTICIPATE IN THIS STUDY (Return slip)

I, ………………………………………………………………………………(participant name) confirm that Elenia Javangwe, asking my consent to take part in this research, has told me about the nature, procedure, potential benefits and anticipated inconveniences of participation.

I have read 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.

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 interviews/class observations/focus group discussions. (Delete the inapplicable)

I have received a signed copy of the informed consent agreement.

Participant's Signature ……………………………………. Date ………………………

Researcher's Name & Surname (please print) Elenia Javangwe

Researcher's signature ………………………………….. Date …………………………..

Appendix F: Request for interview letter

LETTER REQUESTING AN ADULT TO PARTICIPATE IN AN INTERVIEW

Dear ……

I, Elenia Javangwe, am conducting a research as a doctoral student entitled "Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe" at the University of South Africa. Permission for the study has been granted by the Ministry of Primary and Secondary Education in Zimbabwe and the Ethics Committee of the College of Education, UNISA. I have purposively identified you as a possible participant because of your valuable experience and expertise related to my research topic.

I would like to provide you with more information about this research and what your involvement would entail if you should agree to take part. The aim of the research is to develop a framework for integrating citizenship education in the pedagogy and assessment of science practical work. The framework would then inform science educators, curriculum developers and policy makers about the pedagogy and assessment models that enhance citizenry and authentic science education.

In this interview, I would like to have your views and opinions on this topic. This information can be used to improve the pedagogy and assessment of science so that it promotes citizenship education.

Your participation in this study is voluntary. It will involve an interview of approximately one and half hours in length to take place in a mutually agreed upon location at a time convenient to you. You may decline to answer any of the interview questions if you so wish. Furthermore, you may decide to withdraw from this study at any time without any negative consequences.

With your kind permission, the interview will be audio-recorded to facilitate collection of accurate information and later transcribed for analysis. Shortly after the transcription has been completed, I will send you a copy of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or to clarify any points. All information you provide is considered completely confidential. Your name will not appear in any publication resulting from this study and any identifying information will be omitted from the report. However, with your permission, anonymous quotations may be used. Data collected during this study will be retained on a password protected computer for 5 years in my locked office.

The benefits of this research are its potential contribution to science education in Zimbabwe and globally as it will propose a framework for the pedagogy and assessment of practical work that enhance effective citizenship education. There are no known or anticipated risks to you as a participant in this study. The research is not funded. You will not be reimbursed or receive any incentives for your participation in the research.

If you would like to be informed of the final research findings, please contact Elenia Javangwe on +263772397189 or email ejavangwe@zimsec.co.zw or eleniaj@yahoo.com. The findings will be accessible for five years.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact me at +263772397189 or by e-mail at ejavangwe@zimsec.co.zw.

I look forward to speaking to you and thank you in advance for your assistance in this research. If you accept my invitation to participate, I will request you to sign the consent form.

Yours sincerely

Elenia Javangwe	....	....
Researcher's name	Researcher's signature	Date

Appendix G: Consent for interview participation

CONSENT FORM FOR AN INTERVIEW (Return slip)

I have read the information presented in the information letter about the study in science education. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and add any additional details I wanted. I am aware that I have the option of allowing my interview to be audio recorded to ensure an accurate recording of my responses. I am also aware that excerpts from the interview may be included in publications to come from this research, with the understanding that the quotations will be anonymous. I was informed that I may withdraw my consent at any time without penalty by advising the researcher. With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

Participant's Name (Please print): ……………………………………………………………

Participant's Signature: …………………………………………………………

Researcher's Name: (Please print) Elenia Javangwe

Researcher's Signature: .... Date: ....

Appendix H: Request for survey letter

COVER LETTER FOR A QUESTIONNAIRE

Combined Science Teachers Survey Questionnaire

Title: Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe

Dear respondent

I, Elenia Javangwe, am doing research under the supervision of Prof L.E Mnguni, a professor in the Department of Science and Technology Education towards a Doctor of Philosophy in Education/ PhD at the University of South Africa. We are inviting you to participate in a survey by completing a questionnaire. You have been selected by a purposive sampling strategy from the population of 1000. Hence, I invite you to take part in this survey.

The aim of this study is to investigate the state of the pedagogy and assessment of practical work in the Combined Science learning area in Zimbabwe and how it fosters citizenship education. The findings of the study may benefit science education since its focus is on proposing a framework science citizenship education.

You are kindly requested to complete a questionnaire, comprising six sections as honestly and frankly as possible and according to your personal views and experience. No foreseeable risks are associated with the completion of the questionnaire which is for research purposes only. The questionnaire will take approximately two hours to complete.

You are not required to indicate your name or school name and your anonymity will be ensured. However, indication of your age, gender, occupation position, province etcetera will contribute to a more comprehensive analysis. All information obtained from this questionnaire will be used for research purposes only and will remain confidential. Your participation in this survey is voluntary and you have the right to omit any question if you so desire, or to withdraw from answering this survey without penalty at any stage. However, the questionnaires are anonymous so it will not be possible to withdraw once you have handed it in.

After the completion of the study, an electronic summary of the findings of the research will be made available to you on request.

Permission to undertake this cross-sectional survey has been granted by the Ministry of Primary and Secondary Education in Zimbabwe, the ZIMSEC Director and the Ethics Committee of the College of Education, UNISA. If you have any research-related enquiries, they can be addressed directly to me or my supervisor. My contact details are: +263772397189 e-mail: ejavangwe@zimsec.co.zw or eleniaj@yahoo.com and my supervisor can be reached at +27 (0) 12 429 4614, Department of Science and Technology Education, College of Education, UNISA, e-mail: mngunle@unisa.ac.za.

By completing the questionnaire, you imply that you have agreed to participate in this research. There are no known or anticipated risks to you as a respondent in this research. The research is not funded. You will not be reimbursed or receive any incentives for your participation in the research. Please return the completed questionnaire to ZIMSEC office at the marking centre before 23 December 2019.

Appendix I: Consent for survey participation

CONSENT FORM FOR PARTICIPATING IN A SURVEY (Return slip)

I have read the information presented in the information letter about the study in science education. I have had the opportunity to ask any questions related to this study and to receive satisfactory answers to my questions. I am aware that responses to the questionnaire may be included in publications to come from this research, with the understanding that the responses will be anonymous. I was informed that I may withdraw my consent at any time, before the submission of the questionnaire, without penalty by advising the researcher. However, I also understand that the questionnaires are anonymous so it will not be possible to withdraw once I have handed it in. With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

Participant's Name (Please print): ……………………………………………………………

Participant's Signature: …………………………………………………………

Researcher's Name: (Please print) Elenia Javangwe

Researcher's Signature: .... Date: ....

Appendix J: Request for focus group participation letter

REQUESTING AN ADULT TO PARTICIPATE IN A FOCUS GROUP DISCUSSION

Dear …………………………………………………………………………………………...

I, Elenia Javangwe, am conducting a research as a doctoral student entitled "Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe" at the University of South Africa. Permission for the study has been granted by the Ministry of Primary and Secondary Education in Zimbabwe and the Ethics Committee of the College of Education, UNISA. I have purposively identified you as a possible participant in the focus group discussion because of your valuable experience and expertise related to my research topic.

I would like to provide you with more information about this project and what your involvement would entail if you should agree to take part. The aim of the research is to develop a framework for integrating citizenship education in the pedagogy and assessment of science practical work. The framework would then inform science educators, curriculum developers and policy makers about the pedagogy and assessment models that enhance citizenry and authentic science education.

In the focus group discussion, I would like to have your views and opinions on this topic. This information can be used to improve the pedagogy and assessment of science so that it promotes citizenship education.

Your participation in this study is voluntary. It will involve a focus group discussion of approximately one and half hours in length to take place in a mutually agreed upon location at a time convenient to the group. You may decline to answer any of the questions if you so wish. Furthermore, you may decide to withdraw from this study at any time without any negative consequences.

The discussion will be audio-recorded to facilitate collection of accurate information and later transcribed for analysis. Shortly after the transcription has been completed, I will send you a copy of the transcript to give you an opportunity to confirm the accuracy of the discussion and to add or to clarify any points. All information you provide is considered completely confidential. Your name will not appear in any publication resulting from this study and any identifying information will be omitted from the report. 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 during the focus group discussions.

Anonymous quotations may be used. Data collected during this study will be retained on a password protected computer for 5 years in my lockable office.

The benefits of this study are its potential contribution to science education in Zimbabwe and globally as it will propose a framework for the pedagogy and assessment of practical work that enhances effective citizenship education. There are no known or anticipated risks to you as a participant in this study. The research is not funded. You will not be reimbursed or receive any incentives for your participation in the research.

If you would like to be informed of the final research findings, please contact Elenia Javangwe on +263772397189 or email ejavangwe@zimsec.co.zw or eleniaj@yahoo.com. The findings will be accessible for five years.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact me at +263772397189 or by e-mail at ejavangwe@zimsec.co.zw.

I look forward to speaking to you and thank you in advance for your assistance in this research. If you accept my invitation to participate, I will request you to sign the consent form.

Yours sincerely

Elenia Javangwe	....	....
Researcher's name	Researcher's signature	Date

Appendix K: Consent for focus group participation

FOCUS GROUP CONSENT AND CONFIDENTIALITY AGREEMENT (Return slip)

I.. grant consent that the information I share during the focus group may be used by Elenia Javangwe 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’s Signature: ....

Researcher’s Name: (Please print): Elenia Javangwe

Researcher’s Signature: .... Date: ....

Appendix L: Request for lesson observations letter

LETTER REQUESTING A TEACHER FOR LESSON OBSERVATIONS

Dear ……………………………………………………………………………………………

I, Elenia Javangwe, am conducting a research as a doctoral student entitled "Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe" at the University of South Africa. Permission for the study has been granted by the Ministry of Primary and Secondary Education in Zimbabwe and the Ethics Committee of the College of Education, UNISA. I have purposively identified you as a possible Combined Science teacher whom I may observe during the teaching and learning process because of your valuable experience and expertise related to my research topic.

I would like to provide you with more information about this project and what your involvement would entail if you should agree to take part. The aim of the research is to develop a framework for integrating citizenship education in the pedagogy and assessment of science practical work. The framework would then inform science educators, curriculum developers and policy makers about the pedagogy and assessment models that enhance citizenry and authentic science education.

During the lesson observations, I would use a checklist to gather information on practical work, its pedagogy and assessment, as well as how it fosters citizenship education. This information can be used to improve the pedagogy and assessment of science so that it promotes citizenship education.

Your participation in this research is voluntary. It will involve an observation of a Combined Science lesson. The researcher will be a non-participating observer. You may decide to withdraw from this study at any time without any negative consequences.

The lesson will also be audio-recorded to facilitate collection of accurate information and later transcribed for analysis. All information gathered is considered confidential. Your name will not appear in any publication resulting from this study and any identifying information will be omitted from the report. Data collected during this study will be retained on a password protected computer for 5 years in my locked office.

The benefits of this research are its potential contribution to science education in Zimbabwe and globally as it will propose a framework for the pedagogy and assessment of practical work that enhance effective citizenship education. There are no known or anticipated risks to you as a participant in this research. The research is not funded. You will not be reimbursed or receive any incentives for your participation in the research.

If you would like to be informed of the final research findings, please contact Elenia Javangwe on +263772397189 or email ejavangwe@zimsec.co.zw or eleniaj@yahoo.com. The findings will be accessible for five years.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact me at +263772397189 or by e-mail at ejavangwe@zimsec.co.zw.

I look forward to speaking to you and thank you in advance for your assistance in this research. If you accept my invitation to participate, I will request you to sign the consent form.

Yours sincerely

Elenia Javangwe	....	....
Researcher's name	Researcher's signature	Date

Appendix M: Consent for lesson observations

CONSENT FORM FOR LESSON OBSERVATIONS (Return slip)

I have read the information presented in the information letter about the study in science education. I have had the opportunity to ask any questions related to this study and to receive satisfactory answers to my questions. I am aware that information gathered during the class observations may be included in publications to come from this research, with the understanding that the information will be anonymous. I was informed that I may withdraw my consent at any time, without penalty by advising the researcher. With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

Participant's Name (Please print): ……………………………………………………………

Participant's Signature: ……………………………………………………………

Researcher's Name: (Please print) Elenia Javangwe

Researcher's Signature: .... Date: ....

Appendix N: Interview schedule

INTERVIEW SCHEDULE

Thank you for your willingness to answer the questions in this interview guide. The purpose of this interview is to determine what your views are on the pedagogy and assessment of practical work in Combined Science. The research focuses on how practical work in science can contribute to citizenship education. There are no right or wrong answers. Your real name will not be revealed when we report on the findings.

Key terms defined

Citizenship Education: Eurydice (2005, p. 10) defines citizenship education as "school education for young people, which seeks to ensure that they become active and responsible citizens capable of contributing to the development and well-being of the society in which they live." In this research, science citizenship education is viewed as teaching, learning and assessment methods that promote active interaction of learners and their societies on issues that are related to science.

Pedagogy: Alexander (2008, p. 47) cited in Black (2014, p. 487-488) defines pedagogy as "the act of teaching together with its attendant discourse of educational theories, evidence and justifications," and defines the core activities of teaching as tasks, activities, interactions and assessment. This research however defines pedagogy as the theory and practices that are involved during the teaching and learning process but without incorporating assessment.

Assessment: Educational assessment can be viewed as the process of appraising knowledge, skills and competencies of learners.

Science Practical work: Toplis (2012, p. 531) defines practical work as "hands-on student activity" while Millar (2010, p. 109) defines it as "any school teaching and learning in which the students, working individually or in small groups, observe and/or manipulate the objects or materials they are studying. In this research, practical work refers to any procedure that is carried out by learners which enables them to construct knowledge including laboratory experiments, field tours and observations and learner demonstrations.

SECTIONS FOR THE COMBINED SCIENCE TEACHER

Section A

1. What is your teaching experience?

2. What are your professional qualifications?

Section B

3. Which methods do you generally use when teaching Combined Science?

4. How often do you carry out practical work with the Combined Science classes?

5. What are the major activities which you, as the teacher, generally carry out during practical lessons?

6. What are the general roles of learners during practical lessons?

7. How are issues of science citizenship education addressed in the competence-based curriculum?

8. How do you link science practical work to citizenship education?

9. What are the challenges which militate against effective science pedagogy?

Section C

10. How do you assess learners for practicals skills?

11. How are the practical assessments promoting citizenship education?

12. What are the challenges faced when learners are assessed for practical skills?

Section D

13. What can be done to integrate citizenship education to science pedagogy?

14. How can effective citizenship education be promoted in the teaching and learning of science practical work?

Section E

15. What can be done to integrate citizenship education to science practical assessments?

16. How can citizenship education be promoted in the assessment of science practical work?

Section F: General Questions

17. What are the possible benefits of science citizenship education?

18. What are the challenges which militate against promoting science citizenship education?

19. How can the goal of promoting science citizenship education be achieved?

20. Do you have anything concerning science practical work teaching/assessment/ citizenship education that you wish to discuss with the researcher?

Thank you for making time to discuss the issues raised in the interview with me. I greatly appreciate your contribution.

SECTION FOR THE SCHOOL HEAD

21. What are the advantages of offering Combined Science to the learners?

22. Which teaching methods are used by the teachers to teach Combined Science?

23. Are Combined Science learners exposed to science practical work? And if so, how often?

24. Do the teaching methods employed by the teachers promote citizenship education?

25. How are the learner’s science practical skills assessed at your school?

26. What is the state of science citizenship education at your school?

27. Which are the best methods of teaching practical work which may enhance citizenship education?

28. Which are the best methods of assessing practical work which may enhance citizenship education?

29. Do you have anything concerning science practical work teaching/assessment/ citizenship education that you wish to discuss with the researcher?

Thank you for making time to discuss the issues raised in the interview with me. I greatly appreciate your contribution.

Appendix O: Lesson observation checklist

Lesson Observation Checklist

Pseudonym of teacher ……………………………………………………………………………

Location of class (laboratory/room) ……………………………………………………………………

Teaching experience ……………………………………………………………………………

Qualifications ……………………………………………………………………………

Form/class taught ……………………………………………………………………………

Observer ……………………………………………………………………………

Date of observation ……………………………………………………………………………

Start time ……………………………………………………………………………

End time ……………………………………………………………………………

The researcher records the observations made under the headings in the table.

Activity	**Comments**
Topic(s) taught	
Objective(s) covered	

Teaching method(s) employed	
Comments on the teaching method(s) used	
Learner participation	
Practical work	

Apparatus and chemicals	
Assessment(s) employed	
Comments on assessment(s) used	
Integration of citizenship education to pedagogy	

Integration of citizenship education to assessment	
Any other observation(s)	

Appendix P: Focus group moderation schedule

FOCUS GROUP MODERATION SCHEDULE

Thank you for your willingness to be involved in a discussion on the research topic entitled "Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe" The purpose of the focus group discussion is to determine what your views are on the pedagogy and assessment of practical work in Combined Science. The research focuses on how practical work in science can contribute to citizenship education. There are no right or wrong answers. Your real name will not be revealed when we report on the findings.

Key terms defined

Citizenship Education: Eurydice (2005, p. 10) defines citizenship education as "school education for young people, which seeks to ensure that they become active and responsible citizens capable of contributing to the development and well-being of the society in which they live." In this research, science citizenship education is viewed as teaching, learning and assessment methods that promote active interaction of learners and their societies on issues that are related to science.

Pedagogy: Alexander (2008, p. 47) cited in Black (2014, p. 487-488) defines pedagogy as "the act of teaching together with its attendant discourse of educational theories, evidence and justifications," and defines the core activities of teaching as tasks, activities, interactions and assessment. This research however defines pedagogy as the theory and practices that are involved during the teaching and learning process but without incorporating assessment.

Assessment: Educational assessment can be viewed as the process of appraising knowledge, skills and competencies of learners.

Science Practical work: Toplis (2012, p. 531) defines practical work as "hands-on student activity" while Millar (2010, p. 109) defines it as "any school teaching and learning in which the students, working individually or in small groups, observe and/or manipulate the objects or materials they are studying. In this research, practical work refers to any procedure that is carried out by learners which enables them to construct knowledge including laboratory experiments, field tours and observations and learner demonstrations.

Section A

1. What is your teaching experience?

2. What are your professional qualifications?

Section B

3. Which methods do you generally use when teaching Combined Science?

4. How often do you carry out practical work with the Combined Science classes?

5. What are the major activities which you, as the teacher, generally carry out during practical lessons?

6. What are the general roles of learners during practical lessons?

7. How are issues of science citizenship education addressed in the competence-based curriculum?

8. How do you link science practical work to citizenship education?

9. What are the challenges which militate against effective science pedagogy?

Section C

10. How do you assess learners for practicals skills?

11. How are the practical assessments promoting citizenship education?

12. What are the challenges faced when learners are assessed for practical skills?

Section D

13. What can be done to integrate citizenship education to science pedagogy?

14. How can effective citizenship education be promoted in the teaching and learning of practical work?

Section E

15. What can be done to integrate citizenship education to science practical assessments?

16. How can citizenship education be promoted in the assessment of science practical work?

Section F: General Questions

17. What are the possible benefits of science citizenship education?

18. What are the challenges which militate against promoting science citizenship education?

19. How can the goal of promoting science citizenship education be achieved?

20. Do you have anything concerning science practical work teaching/assessment/ citizenship education that you wish to discuss with the researcher?

Thank you for making time to discuss the issues raised in the focus group discussion. I greatly appreciate your contribution.

Appendix Q: Document analysis form

Document Analysis form

Document ……………………………………………………………………………………………

Focus area	**Notes**
Source of document	
Purpose of document	
Relevance of document to present research • Pedagogy of science practical work • Frequency of science practical work • Type of science practical work • Frequency of science practical assessments • Type of science practical assessments • Apparatus and chemicals used during science practical work	
Link between science practical work and science citizenship education	

Appendix R: Survey questionnaire

Combined Science Teachers' Survey Questionnaire

Thank you for your willingness to answer questions in the questionnaire for a survey on the research topic entitled "Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe". The purpose of the questionnaire is to determine what your views are on the pedagogy and assessment of practical work in Combined Science. The research focuses on how practical work in science can contribute to citizenship education. There are no right or wrong answers. Your real name will not be revealed when we report on the findings.

Key terms defined

Citizenship Education: Eurydice (2005, p. 10) defines citizenship education as "school education for young people, which seeks to ensure that they become active and responsible citizens capable of contributing to the development and well-being of the society in which they live." In this research, science citizenship education is viewed as teaching, learning and assessment methods that promote active interaction of learners and their societies on issues that are related to science.

Pedagogy: Alexander (2008, p. 47) cited in Black (2014, p. 487-488) defines pedagogy as "the act of teaching together with its attendant discourse of educational theories, evidence and justifications," and defines the core activities of teaching as tasks, activities, interactions and assessment. This research however defines pedagogy as the theory and practices that are involved during the teaching and learning process but without incorporating assessment.

Assessment: Educational assessment can be viewed as the process of appraising knowledge, skills and competencies of learners.

Science Practical work: Toplis (2012, p. 531) defines practical work as "hands-on student activity" while Millar (2010, p. 109) defines it as "any school teaching and learning in which the students, working individually or in small groups, observe and/or manipulate the objects or materials they are studying. In this research, practical work refers to any procedure that is carried out by learners which enables them to construct knowledge. Practical work includes laboratory experiments, field tours and observations and learner demonstrations.

Please tick the appropriate box(es) for questions 1 to 26 and give a description for question 27.

Section A

1. Sex

M	F	other

2. Your School's Province

Byo	Har	Mat-S	Mat-N	Midl	Masv	Mash-C	Mash-W	Mash-E	Mani

3. Teaching experience

1-5 years	6-10 years	11-15 years	16-20 years	21-25 years	26-30 years	31-35 years	36+ years

4. Qualification(s)

CE/Dip Ed	B Ed	M Ed	PhD	B Sc	other (specify)

5. Type of school

mixed sex rural day	Mixed sex urban day	Mixed sex boarding	Mixed sex farm/satellite day	single sex urban day	other (specify)

6. Science subject(s) taught

Combined Science	Biology	Chemistry	Physics	other (specify)

7. Rate science equipment at your school

very good	good	average	poor	very poor

Section B

8. Which teaching methods do you mostly use when teaching Combined Science?

teacher-centred /lecture method	learner-centred /inquiry-based	both lecture method /inquiry-based	project-based	other (specify

9. How many 35 minutes Combined Science lessons are on the school timetable per class per week?

5 lessons	6 lessons	7 lessons	8 lessons	other (specify)

10. How often do you carry out practical work with a Combined Science class?

every lesson	twice a week	once a week	once in two weeks	once a month	once a term	other(specify)

11. What are the major activities which you, as the teacher, generally carry out during practical lessons?

give written instructions and guide learners as they carry out the practical work	give oral instructions and guide learners as they carry out the practical work	carry out teacher demonstrations	Other (specify)

12. What are the general roles of the learners during practical lessons?

writing notes and making observations from teacher demonstrations	individual practical work	group practical work	organising and cleaning apparatus	other (specify)

13. How are issues of science citizenship education addressed in the competence-based curriculum?

not addressed	integrated in Combined Science	integrated in other learning areas	I don't know	other (specify)

14. How do you link science practical work to citizenship education during your teaching?

linking practical work to a learner's everyday life	using practical work to solve science related community problems	linking practical work to school projects	not emphasising on citizenship education	other (specify)

15. What are the challenges which militate against effective science practical work?

large classes	lack of apparatus	lack of chemicals	a heavy teacher workload	inadequate teaching time	poor teaching methods	inadequate trained science teachers	other (specify)

Section C

16. How do you assess learners for science practical skills?

use alternative to practical tests and examinations	use practical tests and examinations	use science projects	other (specify)

17. How are the science practical assessments promoting citizenship education?

linking practical work to everyday life	using practical knowledge to solve science problems	using practical tasks to arouse interest in science	other (specify)

18. What are the challenges faced when learners are assessed for science practical skills?

large classes	lack of apparatus	lack of chemicals	a heavy work load	inadequate time	poor question setting	inadequate trained science teachers	other (specify)

Section D

19. Have you received staff-development on the implementation of science citizenship education?

Yes	no	not sure

20. What can be done to promote the integration of citizenship education to science pedagogy?

highlight science citizenship education in educational policy	link pedagogies to citizenship promotion	integrate citizenship to science content and objectives	other (specify)

21. How can citizenship education be promoted in the pedagogy of science practical work?

include science citizenship education philosophy in the science syllabus	staff-develop teachers on pedagogies that promote science citizenship education	use science practical work to solve science related community challenges	other (specify)

Section E

22. How can science practical skills in learners/candidates be effectively assessed?

using a practical test	using a theory test	using a project	other (specify)

23. How can citizenship education be enhanced in the assessment of science practical work?

highlight citizenship in educational assessment policy	link assessments to science citizenship education	staff-develop teachers on assessments that promote citizenship education	other (specify)

Section F: General Questions

24. What is/are the possible benefit(s) of science citizenship education?

producing learners who could solve socio-scientific problems	producing learners who would live science enriched lives	producing learners who could be sensitive to environmental sustainability issues	other (specify)

25. What is/are the challenge(s) which militate(s) against promoting citizenship education?

lack of clear policy	lack of teacher staff-development on citizenship education	lack of objectives on citizenship education in the syllabus	lack of adequate time for integrating citizenship education	other (specify)

26. How can the goal of promoting science citizenship education be achieved?

having clear policy direction	staff-developing teachers on citizenship education	having content and objectives on citizenship education in the syllabus	solving socio-scientific problems in the community	having project-based learning	other (specify)

27. Comment on anything concerning science practical work teaching/assessment/ citizenship education that you wish to bring to the attention of the researcher.

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Thank you for making time to answer questions raised in the questionnaire. I greatly appreciate your contribution.

Appendix S: Provincial Education Director permission request letter

The Provincial Education Director (PED)

Ministry of Primary and Secondary Education

Midlands Province

New Government Complex

Gweru

Date

Dear Sir/Madam

RE: Request for permission to conduct research at four secondary schools in the Midlands province namely: Takudzwa Secondary School (Kwekwe district), Nothando Secondary School (Shurugwi district), Tivongereiwo Secondary School (Gweru district) and Tatendashe Secondary School (Chirumhanzu district).

Title: Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe

I, Elenia Javangwe, am doing research under the supervision of Prof L.E Mnguni, a professor in the Department of Science and Technology Education towards a Doctor of Philosophy in Education/PhD at the University of South Africa. I am employed by the Zimbabwe School Examinations Council (ZIMSEC) as the Combined Science Subject Manager. My address is ZIMSEC Head Office, Upper East Road, Mount Pleasant. My cell number is 0772397189 and my e-mail is ejavangwe@zimsec.co.zw.

The aim of the research is to develop a framework for integrating citizenship education in the pedagogy and assessment of science practical work. The framework would then inform educators, curriculum developers and policy makers about the pedagogy and assessment models that enhance citizenry and useful science education.

The research entails the use semi-structured interviews with science teachers and the School Heads, non-participant lesson observations, focus group discussions with Combined Science teachers, document analysis, audio recording, photographs and video recordings to collect data.

Photographs taken and video recordings will focus on equipment used in the teaching and learning of practical skills and not on participants in order to protect their identities and hence maintain the cases anonymous. Document analysis will focus on the Combined Science timetables, schemes of work, practical worksheets and tests. Audio tapes will be used for recording the interviews, focus group discussions as well as the discussions during the teaching and learning process. Focus group discussions will also be recorded as minutes and a diary will be used to record data during lesson observations.

The benefits of this study are its potential contribution to science education in Zimbabwe and globally as it will propose a framework for the pedagogy and assessment of practical work which enhance effective citizenship education. The framework for science citizenship education would assist in focusing science educators to employ pedagogies and assessments which improve the acquisition of science practical skills in learners. The learners would thus be empowered to apply science concepts to solve real-life socio-scientific challenges.

There are no potential risks to participants that are foreseen. The researcher will not breach the official secrecy act. The participating schools and participants/respondents will remain anonymous as pseudonyms will be used. Research data will be used only for thesis and educational publications. Feedback procedure will entail distributing a summary of the research findings and recommendations to the Ministry of Primary and Secondary Education's Head Office, the Midlands Province and participating schools. The final report will be submitted in October 2020.
An application has also been made to the MoPSE Permanent Secretary and permission has been granted (see attachment).
I kindly request for permission to carry out the multiple-case study research in the Midlands province at the above mentioned schools.

Yours Sincerely

Elenia Javangwe

UNISA Student (Student number 63506610)

Appendix T: UNISA ethics approval certificate

UNISA university of south africa

UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE

Date: 2019/06/12

Ref: **2019/06/12/63506610/38/MC**
Name: Mrs E Javangwe
Student: 63506610

Dear Mrs Javangwe

Decision: Ethics Approval from 2019/06/12 to 2024/06/12

Researcher(s): Name: Mrs E Javangwe
E-mail address: 63506610@mylife.unisa.ac.za
Telephone: +263 77 239 7189

Supervisor(s): Name: Prof LE Mnguni
E-mail address: mngunle@unisa.ac.za
Telephone: +27 12 429 4614

Title of research:

Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe.

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 2019/06/12 to 2024/06/12.

*The **low risk** application was reviewed by the Ethics Review Committee on 2019/06/12 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.
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.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

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 **2024/06/12.** Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number **2019/06/12/63506610/38/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

Approved - decision template – updated 16 Feb 2017

University of South Africa
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Appendix U: MoPSE Permanent Secretary permission granting letter

Affidavit: Appendix U has a typographic error where Javangwe has been miss pelt as Javagwe.

All communications should be addressed to
"The Secretary for Primary & Secondary Education
Telephone: 0242794895/0242796211
Telegraphic address: "EDUCATION"
Fax: 794505

ZIMBABWE

Reference: C/426/3/Midlands
Ministry of Primary and
Secondary Education
P.O Box CY 121
Causeway
HARARE
27 August 2019

Elenia Javagwe
ZIMSEC Head Office
Upper East Road
Mount Pleasant

Re: **PERMISSION TO VISIT FOUR SECONDARY SCHOOLS IN MIDLANDS PROVINCE FOR RESEARCH PURPOSES:**

Reference is made to your application to carry out a research at the above mentioned schools in Midlands Province on the research title:

"DEVELOPING A FRAMEWORK FOR INTEGRATING CITIZENSHIP EDUCATION IN THE PEDAGOGY AND ASSESSMENT OF SCIENCE PRACTICAL WORK: THE CASE OF COMBINED SCIENCE IN ZIMBABWE. "

Permission is hereby granted. However, you are required to liaise with the Provincial Education Director Midlands Province who is responsible for the schools which you want to involve in your research. You should ensure that your research work does not disrupt the normal operations of the school. Where students are involved, parental consent is required.

You are also required to provide a copy of your final report to the Secretary for Primary and Secondary Education.

MIN. OF PRY. & SEC. EDUCATION
POLICY PLANNING RESEARCH
AND DEVELOPMENT
25 SEP 2019
P.O. BOX CY 121, CAUSEWAY

T. Thabela (Mrs)
SECRETARY FOR PRIMARY AND SECONDARY EDUCATION
Cc: P.E.D –Midlands Province

Appendix V: PED (Midlands) permission granting letter

All communications should be addressed to"The Provincial Education Director"
Telephone:054- 222460

Fax: 054- 226482

Ministry of Primary and Secondary Education
P.O Box 737
GWERU

02 March 2020

Elenia Javangwe
ZIMSEC Head Office
Upper East Road
Mount Pleasant

Dear Sir/Madam

APPLICATION FOR PERMISSION TO CARRY OUT AN EDUCATIONAL RESEARCH IN MIDLANDS PROVINCE:

" DEVELOPING A FRAMEWORK FOR THE INTEGRATING CITIZENSHIP EDUCATION IN THE PEDAGOGY AND ASSESSMENT OF SCIENCE PRACTICALS WORK: THE CASE OF COMBINED SCIENCE IN THE ZIMBABWE ."

In the Midlands Province has been granted on the conditions that:

1. in carrying out this you do not disturb the learning and teaching programmes in schools.
2. you avail the Ministry of Primary and Secondary Education with a copy of your research findings.
3. this permission can be withdrawn at anytime by the Provincial Education Director or by any higher officer.

The Provincial Education Director wishes you success in your research work and in your studies.

MIN. OF PRY. & SEC. EDUCATION
DEPUTY P.E.D. (JUNIOR EDUCATION)
02 MAR 2020
P.O. BOX 737, GWERU
ZIMBABWE

MATUTU L.
ACTING PROVINCIAL EDUCATION DIRECTOR: MIDLANDS

Appendix W: ZIMSEC Director permission granting document

Request for permission to conduct research at a Zimbabwe School Examinations Council (ZIMSEC) Marking Centre

The Director
Zimbabwe School Examinations Council
P.O Box CY 1464
Causeway
Harare

25 November 2019

Dear Sir

RE: Request for permission to conduct research at a ZIMSEC Marking Centre

I, Elenia Javangwe, am doing research under the supervision of Prof L.E Mnguni, a professor in the Department of Science and Technology Education towards a Doctor of Philosophy in Education/D Ed at the University of South Africa. The study is not funded. We are inviting the Combined Science examiners at your marking centre to participate in a study entitled "Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe".

The aim of the study is to develop a framework for integrating citizenship education in the pedagogy and assessment of science practical work. The framework would then inform educators, curriculum developers and policy makers about the pedagogy and assessment models that enhances citizenry and authentic science education.

Your marking centre has been selected because it hosts the Combined Science teachers in their capacity as Combined Science examiners. The questionnaire seeks to collect data relating to the pedagogy and assessment of Combined Science in Zimbabwean schools. The questionnaire does **not** focus on ZIMSEC business.

The study entails the use of a structured questionnaire which the Combined Science teachers/examiners will respond to in two hours. The respondents' identities are not sort so that they remain anonymous.

The benefits of this study include the proposal of a framework for the pedagogy and assessment of science practical work in such a way that it promotes citizen education and hence lead to authentic science education.

There are no potential risks to participants that are foreseen.

There will be no reimbursement or any incentives for participation in the research.

Feedback procedure will entail distributing a summary of the research findings and recommendations to the Ministry of Primary and Secondary Education, ZIMSEC and the participants.

Permission for the study has been given by the Ministry of Primary and Secondary Education in Zimbabwe and the Ethics Committee of the College of Education, UNISA.

The questionnaire to be administered to the Combined Science examiners, the research abstract, UNISA ethical clearance and the Ministry of Primary and Secondary education permission letter are attached.

Yours sincerely

Elenia Javangwe

UNISA Student (Student number 63506610)

Permission is granted

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL
DIRECTOR
2019 -11- 25
Tel: 304552/3 / 304905
P.O BOX CY 1464, CAUSEWAY HARARE

Appendix X: Thesis editing certificate

Tel: 260464/260490/260525 MIDLANDS STATE UNIVERSITY P. BAG 9055
260541/260566/260568 Gweru
260554/ Ext 211 Zimbabwe
Fax: 260233/260311 DEPARTMENT OF ENGLISH AND COMMUNICATION

THESIS EDITING CERTIFICATE

DATE 15 JULY 2020

TO WHOM IT MAY CONCERN

Please be advised that I, Hugh Mangeya, completed professional academic editing on the following thesis, submitted in accordance with the requirements of Doctor of Philosophy in Education, for ELENIA JAVANGWE:

Developing a framework for integrating citizenship education in the pedagogy and assessment of science practical work: The case of Combined Science in Zimbabwe

This included editing of spelling, grammar, register and other language-related items as well as assistance with referencing and layout

Disclaimer

Please note that all changes were tracked and either accepted or rejected at the client's discretion. I thus take no responsibility for the final document as it may differ from what I supplied to the client.

Yours faithfully

Mangeya H (PhD)

BA Hons (Dual-Linguistics and Shona) UZ, MA (Applied English Linguistics) MSU, PhD (Unisa)
Cell phone: +263774435259 e-mail: mangeyau@staff.msu.ac.zw