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Zimbabwean Female Participation in Physics: Facets of Identity Formation Considered to Be of Significance by Female Students in Relation to Physics

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Abstract
The study explored facets of identity formation considered to be of significance by Zimbabwean female adolescent students in physics. Four high schools that were offering physics at A' level in the Midlands Province, in Zimbabwe were targeted. Nine female adolescents doing mathematics and physics and only mathematics were chosen. Data generation instruments were semi-structured interview and classroom observation guides. The results of this study indicate that facets of identity formation as confident, fearless, intelligent, and courageous, liking physics and being determined. These facets motivated female students studying physics to develop an identity in favour of physics, resulting in them opting to study physics as a subject of choice at A' Level. On the other hand, female students who had the potential to study physics but were studying only mathematics stated that fear of failing physics, not being courageous, lacking confidence and that physics was irrelevant to their career choice were significant in influencing their non-participation in physics. These facets may have enabled female students to form an identity that contributed towards their motivation for participation or lack of it in physics. The negative physics identity influences their perceptions of physics and their low participation in the subject.
Keywords: Identity formation, physics identity, facets, and participation

1. Introduction

Based on the principles of the Convention on the Rights of the Child, the expanded vision of basic education articulated in the World Declaration on Education for All (UNESCO, 2011) and the Dakar Education Framework (UNESCO, 2011), UNICEF (2000) commits itself to the vision that all children will be able to fulfil their rights to education, meet their basic learning needs, realise their full potential, and participate meaningfully in society. Despite this commitment, the problem of gender inequity in Zimbabwe is far from being resolved.

It is interesting to note that the 2013 Human Development Report[1] revealed that the Gender Inequality Index for Zimbabwe in 2012 was 0.583, ranking the country number 116 out of 148 countries surveyed (National Gender Policy, 2013). In view of the fact that women constitute about 52% of the total population in Zimbabwe, (National Gender Policy, 2013) under-representation of females, as indicated by the Gender Inequality Index, can have serious consequences to the economic development of the nation.

In 1999, the Nziramasanga Commission of Inquiry into Education and Training was set up by the Zimbabwean government with the task of evaluating the education system of the country. One of the terms of reference was for the team to interrogate the issue of gender equality in education. It is important to note that one of the key findings of the Commission was that gender disparities still persisted at all levels of education (Nziramasanga, 1999). The recurrence of gender concerns, despite decades of gender activism, illustrate that gender disparities are still embedded in the Zimbabwean education system.

As a follow up to the recommendations by the Nziramasanga Commission (1999), as well as in an effort to effectively transform the provisions of regional and international legal and human rights instruments to address the issue of gender discrimination, the Zimbabwean government launched the National Gender Policy (NGP) in 2004. One of the goals of the NGP was to:

"Eliminate all forms of discrimination against boys and girls in education and skills training which includes science and technology as well as to promote and encourage girls to take on science, mathematics and technology at all levels of education" (National Gender Policy, 2004, p. 10).

In 2004 the Zimbabwean government adopted the National Gender Policy, which sought to address several critical challenges related to empowering girls and women in education, in training, in politics, in the economy and in decision making. One of the goals of the National Gender Policy of 2004 is to promote and encourage girls to take on science, mathematics and technology at all levels of education. As a result, girls now enjoy equal access to primary and secondary education. However, (Mutekwe & Modiba, 2011b) show that despite these changes, educational institutions continue to reproduce disparities along gender lines. Unfortunately, the 2004 Education Act does not appear to be explicit enough on gender issues as it only mentions no discrimination at

[1] Produced by the United Nations Development Programme, 2012 cited by National Gender Policy, 2013

admission to any school. This Act takes no cognisance of the fact that by the time children go to school, they would have already been socialised into unequal positions. This is because gender differences are already socially inculcated into the lives of children from birth (Chirimuuta, 2006).

The NGP was revisited in 2013 with the vision of creating "a gender just society in which men and women enjoy equity, contribute and benefit as equal partners in the development of the country" (National Gender Policy, 2013, p. 11). Underpinning the NGP are the principles of equality, integration and inclusiveness which are meant to address gender disparities in Zimbabwean society.

Despite the adoption of the NGP, Mutekwe and Modiba (2011a) show that, educational institutions continue to reproduce disparities along gender lines. Many parents, educators and educational texts advance gender stereotypes that direct boys and girls to adopt highly polarised social roles in Zimbabwean society resulting in underrepresentation of females in science. The low participation of females in science is also illustrated in a study conducted by Gudyanga and Gudyanga (2012). The study was conducted in two co-educational schools, namely school A and school B. School A is located in the high density while school B is in the low density communities. See Figure 1.1 below.

The data as presented in Figure 1.1 below show that the participation of female students in science subjects over a three-year period is very low in both schools (A and B) in comparison to male students. It is interesting to note that, in school B no female students opted to do Physics at A-level in both 2009 and 2010.

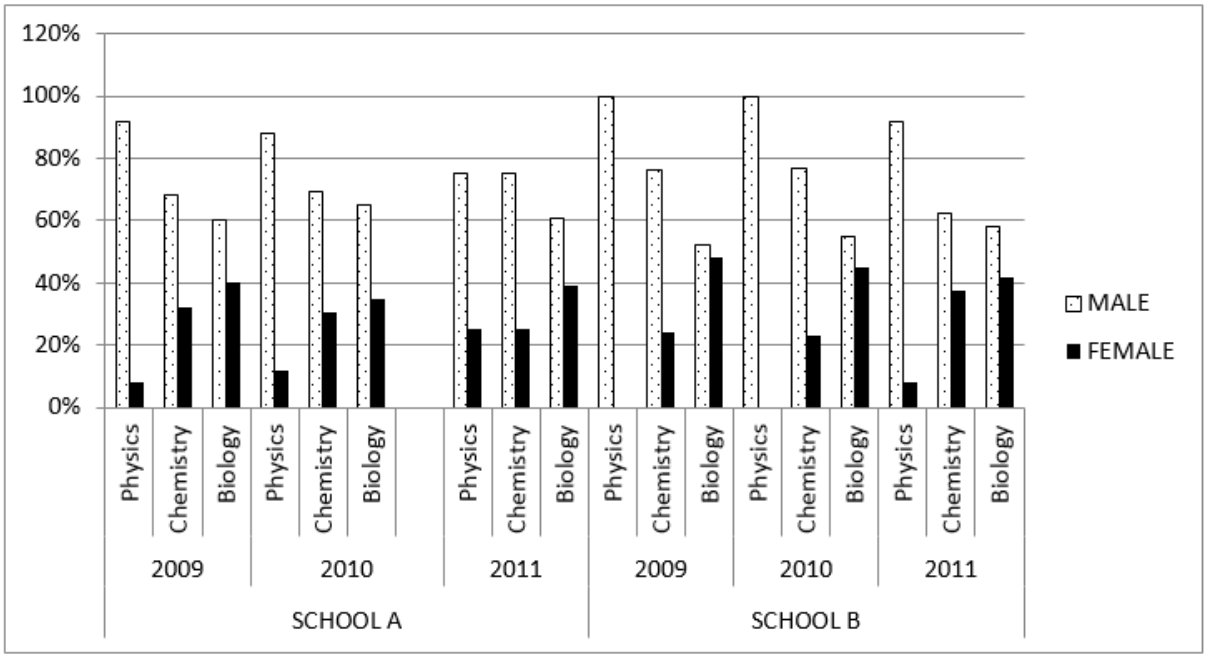

Figure 1.1: Enrolment of students in school A and School B in Physics by Gender. Source: (Gudyanga & Gudyanga, 2012).

Low enrolment of females in science in high schools leads to fewer females opting to choose science at tertiary levels. From the above, it seems that merely constituting relevant policy (for example NGP) is not enough to ensure participation of females in science. Female A- Level students are still underrepresented in science especially physics. There is therefore need to find facets of identity formation considered to be of significance by female students in relation to physics. This paper begins by exploring the rationale, the concept of identity and identity formation; it considers facets of identity formation, identity and learning and research question. Finally, it explores theoretical perspective, methodology and analysis and discussion of results.

2. Rationale and Research Question

The researcher was motivated to carry out this study by low enrolment of females in science in high schools which eventually leads to fewer females opting to choose science at tertiary levels. In considering the under-representation of females in Physics, this study focuses on identity formation as a possible driver for participation in Physics. In view of the fact that women constitute about 52% of the total population in Zimbabwe, (National Gender Policy, 2013). It is therefore important that their representation and participation in the development process should be commensurate with this numerical reality (National Gender Policy, 2013). The country as a developing nation cannot afford to waste human resources by ignoring the lack of participation of women [who make up half the population] in important scientific disciplines. In fact, there are no studies that focus on the relationship between female students' identity and their participation in physics, with special

emphasis on facets of identity formation considered to be of significance by female students in relation to physics, hence, this is the gap in the research that this study seeks to address.

This study is, therefore, timeous especially since Zimbabwe needs more scientists and technologists to meet its developmental agenda to be globally competitive as science and technology have long been recognised as the corner stone of development and prosperity in Africa (Asimeng-Boahene, 2006). Therefore, this means that economic prosperity is inter-linked with the utilisation and management of science and technology.

The under-representation of females in the sciences as described earlier is both a global and a Zimbabwean phenomenon. Despite both international and national recognition and concern for the lower numbers of women participating in physics, changes in policy seem to be making little if no difference on the ground. These observations point to the reflection that there is a disjuncture between policy formulation and implementation. A deeper understanding of the under-representation within the context of identity and identity formation could provide tangible clues as to what change parameters would influence a shift in perception amongst young women. Thus, the focus of the current study is encapsulated in the research question described below.

- Which facets of identity formation are considered to be of significance by female students in relation to physics?

Facets of identity formation are the self-descriptions of who the female students perceive themselves to be. According to Knight, Bernal, Garza, and Cota (1993), identities may be conceptualised as memory structures composed of schemas and that these schemas are self-theories that guide information processing by structuring experiences that control behaviour. A schema can also be defined as a collection of inter-associated mental representations that function together as a unit (Horowtz, 2010). It is, therefore, a mental concept that informs female students about what concept from a variety of experiences are then stored in memory (Leary & Tangney, 2003). Our brains create and use schemas as a short cut to make future encounters with similar situations easier to navigate. In relation to my study, schemas enable female students to form an identity or self-concept with respect to physics. The self-descriptions made by female students holistically contribute towards developing and eventually achieving a physics identity. These self-descriptions are the facets or units of thought expressed in words. In other words, the facets are symbolic expressions on one's self-concept in relation to physics and they contribute to the motivation towards physics.

3. Identity and Identity Formation

The term identity is derived from the Latin word *identitas*, which is derived from the word *idem,* meaning, the same, (Petersoo, 2007, p. 117). The term is defined differently by various theorists who attempt to explain it. For example, Castells (2004, p. 6) defines *identity* as, "people's source of meaning and experience," while Polman and Miller (2010, p. 884), consider it to be "the story that each one of us is creating for ourselves." Identity is personal and it is influenced and shaped by the context in which we live. Humans (for example, Zimabwean female A' Level students) have a natural tendency and desire to belong to a group or a community of practice (CoP) as "identity illustrates the desire and the need for human beings to interpret themselves as being part of something, or a certain entity" (Puusa & Tolvanen, 2006, p. 30).

Identity has always been explored at an individual level, and with the passage of time its investigation has been extended to include activities at a group level (Puusa & Tolvanen, 2006). This is mainly because identity cannot be viewed as separate from the social milieu in which it is located. Throughout the process of identity construction, individuals attempt to make meaning of who they are in relation to how others perceive them. The classifications and associations that take place do so through the interaction process within what Jenkins (2004, p. 17) terms, the "human world." Jenkins (2004, p. 17) identifies the following orders through which people can understand how the human world is constructed and experienced. In the first instance he identifies *the individual order* (first order) which relates to the interaction that happens in the mind of the individual. Secondly, there is *the interaction order* (second order) which involves the interaction that takes place in the form of relationships between or amongst individuals in their CoP. The impact of the first and second order interactions on identity is scrutinised in the context of personal and social identity.

3.1 Identity Formation

Generally, identity formation is "an ongoing process of negotiating and resolving conflicts between previously incorporated and new experiences," (Santora, 2003, p. 2). Jenkins (2004) and Moshman (2005) expound that individuals negotiate their identity within the interaction order. On the other hand, Castells (2004, p. 7) claims that "people use various construction apparatus from their past, such as their belief systems, their location in space and time, their genetic composition and their organisations to 'construct' their identity." Luhrmann and Eberl (2007, p. 117) contend that identity is "not something that can be found, but needs to be constructed." In addition, during the identity formation process, people act and interact. They "recognise themselves as social actors, as well as being recognised by others as a particular type of a person," (Munday, 2006, p. 91). Hence, one negotiates the meanings of one's experience as a member of a social community when constructing identity.

3.2 Identity and Learning

One's identity assists one to look for answers to frequently asked questions such as, "Who am I?" "Who do I want to be?" "Who could I be?" "What are my goals in life?" "How do I handle my relationship with other human beings?" and "What is my place with society as a human being?" (Puusa & Tolvanen, 2006, p. 29). Thus, identity can be understood as referring to the different meanings that individuals ascribe to themselves.

Typically, human beings characterise themselves based on structural features of membership to a group or with the help of characteristics that an individual associates himself/herself with. In other words, identity is formed by different characterisations of oneself. There is social interaction during identity formation as well as during learning. The individual's conception of who one is may be picked up from learning as individuals interact with others.

To learn is to take up a new practice or to change one's position in a community. Therefore, this implies that learning can change identity and the self. Wenger (1998, p. 151) defines identity as follows:

An identity then is a layering of events of participation and reification by which our experience and its social interpretation inform each other. As we encounter our effects on the world and develop our relations with others, these layers build upon each other to produce our identity as a very complex interweaving of participative experience and reificative projections. Bringing the two together through the negotiation of meaning, we construct who we are.

Lave and Wenger (1991) stress the social nature of learning and knowing, which can only develop through meaningful student engagement, experience, and practice within a social community. As students develop knowledge, competence, and meaning from these social interactions, they begin to construct their identities (who they wish they to be, in relation to these communities). Hence through learning and interacting within a learning community student identity and subsequent participation in physics is influenced.

4. Theoretical Perspective

Feminist Standpoint Theory (FST) and Wenger's Social Learning Theory (SLT) were considered appropriate for the purpose of this study. Gender and Identity Formation have been considered to be nested within a hybrid of these two theoretical frameworks.

Feminist standpoint theory has developed in response to feminist theorists' recognition that gender cannot be understood in isolation from other social categories. Feminist approaches in light of females' access to science are based on the central insight that:

- social reality is a gender construction and the normative aim of social science should be both to deconstruct this and to point to an alternative
- far from being objective, science in general is ideologically laden with male values (Delanty, 2005, p.123).

FST then, involves a commitment to the view that all attempts to know are socially situated. The social situation of an epistemic agent - her gender, class, race, ethnicity, sexuality and physical capacities - plays a role in forming what we know and limiting what we are able to know. They can affect what we are capable of knowing and what we are permitted to know (Roychoudhury, Tippins, & Nichols, 1995). In general, FST argues that there is a gender bias in problem definition, interpretation and normative critique (Smith, 2006). However, the premise of feminist standpoint theory is that the difference in the social experience of men and women give them different ways of looking at life and interpreting events, and hence different standpoints (Smith, 1987). This basic premise was applied by Harding (1998) to critique science. She argues that men and women have different standpoints in life, yet science is developed primarily from the perspective of one group, namely, male Eurocentric one. Women's experiences have been neglected as starting points of scientific research and as generators of evidence for or against knowledge claims. Could it be that women are greatly underrepresented in science and specifically in physics that science is developed from man's perspective? Feminist standpoint theorists (Harding, 2004; Smith, 2006), in general, argue that it is not surprising that many women are strangers to science because the logic of science dominated and developed by men can never be totally compatible with women's standpoints. Therefore, the low participation of Zimbabwean female students needs to be explored from this perspective. Women, as a result of their "different lived experiences, have a distinct standpoint" which can bring in different experiences and engender certain pattern of thought and understanding that is absent from science (Roychoudhury et al., 1995, p. 898)

There is a consensus among feminist standpoint theorists that a standpoint is not merely a perspective that is occupied simply by dint of being a woman. Whereas a perspective is occupied as a matter of the fact of one's socio-historical position and may well provide the starting point for the emergence of a standpoint. A "standpoint is earned through the experience of collective political struggle, a struggle that requires, as Hartsock puts it, both science and politics" (Harding 2004, p. 8). The formation of a standpoint requires shared experiences of oppression and of struggle against that oppression. A feminist standpoint may be taken (implicitly) as the position of all women, but what account is taken of class, race, sexuality, and other markers of difference, which structure the power relations that generate oppression, the shared experience of which forms the basis of the standpoint? By way of

emphasis of this point, Hartsock uses the label 'feminist standpoint' whereas Smith uses the label "women's standpoint", reflecting the way in which standpoint theory argues for "women's place" as a starting point for enquiry (Harding 2004, p. 21). The FST was used to select female students with different standpoints, i.e. female students doing physics and mathematics and female students doing only mathematics but having the potential to do physics as well. However, context is the central space in which identity is constructed during the gender-linked interactional patterns which occur in a specific culture.

Wenger's (1998) social theory posits that individual learning is the development of modes of participating with others in society. Communities of practice are therefore a specific type of community that constitutes the most important arenas in which individuals learn. I used the ideas of communities of practice for data interpretation. For Wenger (1998), identity is, in the biggest sense, the 'who we are' that develops in our own minds and in the minds of others as we interact with them. In social learning, the learner acquires a new social "identity" as a result of a process of social recognition by the community, making this theory an important lens through which to analyse the behaviour of female students as they interact in the laboratories and physics classrooms.

SLT is premised on the fact that learning is a social commitment and that learning within a CoP "shapes not only what we do but also who we are and how we interpret what we do" (Wenger, 1998, p. 4). This implies that the development of one's identity is closely integrated with the learning that takes place as a result of one's participation in a community. Therefore, issues of identity are difficult to separate from those of learning. Wenger's SLT illustrates the ways and means by which members in a CoP engage with each other in creating new knowledge. SLT is built on four assumptions about what matters in learning and about the nature of knowledge and knowing, including:

- *Humans are social beings* (a central aspect of learning);
- *Knowledge* is a matter of competence with respect to valued enterprises;
- *Knowing* is a matter of active engagement in the world; and
- *Meaning* is our ability to experience the world and to engage with it in a meaningful way (Wenger, 1998, p. 4).

These four assumptions conceptualise learning as an inter-play of four components mediated by social participation, namely: meaning (learning as experience), practice (learning as doing), community (learning as belonging) and identity (learning as becoming) (Wenger, 1998, p. 5). These components are represented diagrammatically in Figure 2 below.

These four components which are deeply interconnected and mutually defining together provide a structured framework for SLT. As shown by figure 2, humans are considered to be social beings in each of the three theories. Learning in Wenger's social learning theory is viewed as social participation which is composed of four components: *Meaning* (learning as experience), *practice* (learning as doing), *community* (learning as belonging) and *identity* (learning as becoming). Socio-cultural and gender-related factors influence identity, and it becomes apparent that the shaping of identity largely occurs in learning communities. Therefore, Wenger's Social Learning Theory (SLT) is used as lens to interpret the behaviour of female students, learning and authoring their identities in a CoP.

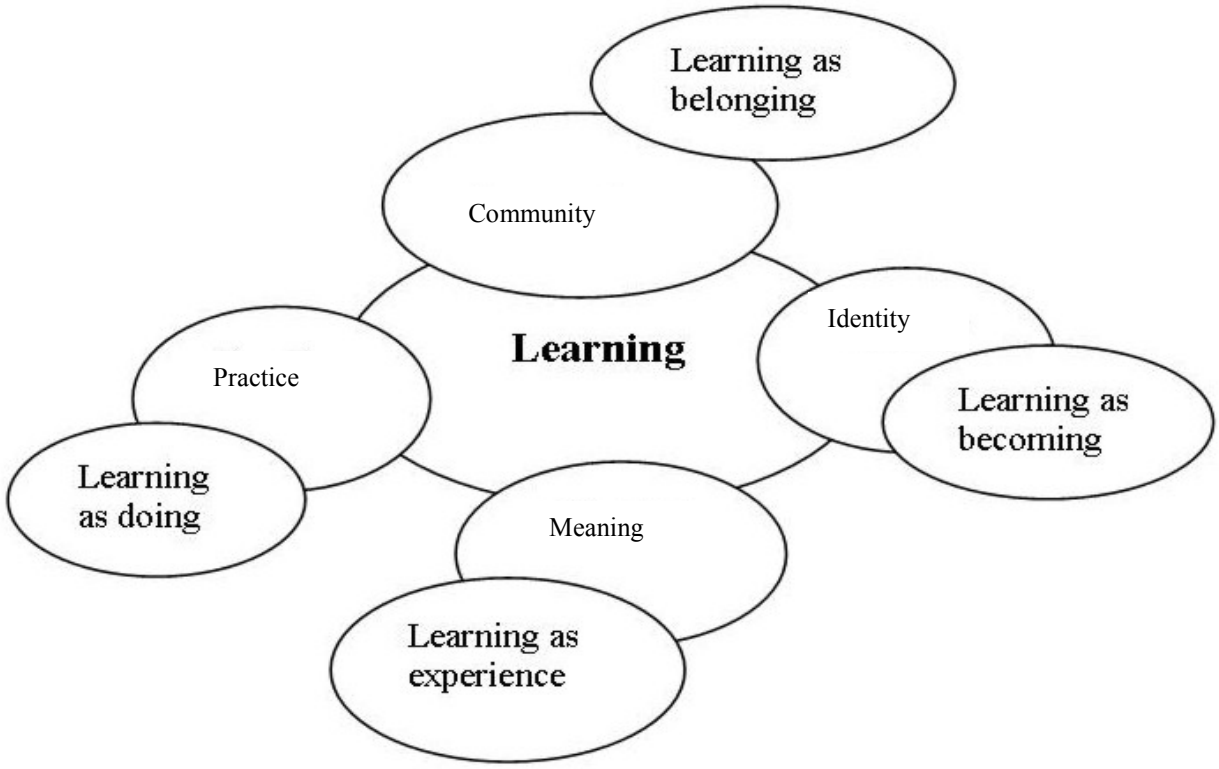

Figure: 2 Components of a Social Learning Theory (SLT) Source: (Wenger, 1998, p. 5)

A hybrid of two theoretical frameworks thus underpins this study. *Gender* and *Identity Formation* are nested within a Feminist Standpoint Epistemology as well as Wenger's (1998) social learning theory featuring CoP (See Figure 3 below).

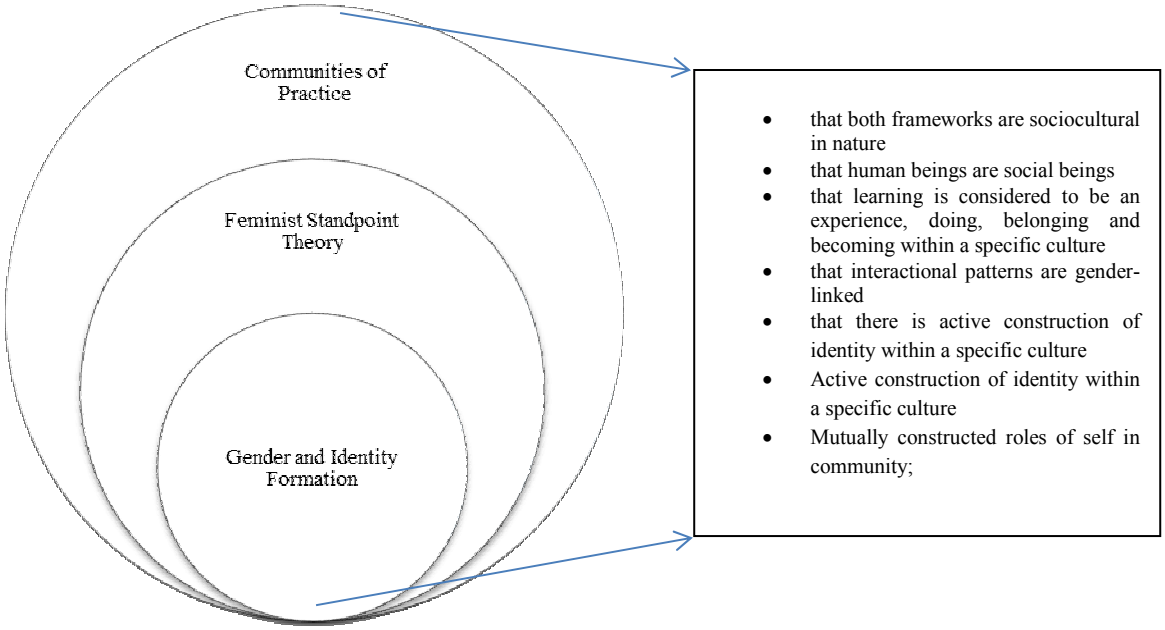

Figure 3: A hybrid of two theoretical frameworks

As shown by figure 1, humans are considered to be social beings in each of the two theories. This framework was used as an analytical toolkit in this study to elucidate the meanings within the stories of female students, with the aim of showing the Facets of identity formation considered to be of significance by Zimbabwean A-level female students in relation to physics.

5. Research Methodology

Qualitative research is descriptive in nature, since its purpose is to investigate, unearth and uncover more about

the specific phenomenon, and then provide detailed, comprehensive descriptions (Struwig & Stead, 2001; Wisker, 2001). It is primarily interpretive (Creswell, 2007, 2013). The assumption is that knowledge is obtained through people's descriptions of their "intentions, beliefs, values and reasons, meaning-making and self-understanding" (Henning, Van, & Smit, 2004, p. 20). It is a method of inquiry that is "systematic and interactive," and is employed to give an exposition of the life experiences of the participants and also to give meaning to them (Mouton, 2002, p.161) thereby gaining an in-depth understanding of the human perspectives at the individual level. Qualitative research takes place in the "participants' natural environment" (Creswell, 2013, p. 175). This affords the researcher an opportunity to enter the world of their participants and get the opportunity to obtain a "rich understanding of their world as they experience it" (Babbie, 2007, p. 312; Creswell & Plano, 2007, p. 30). The world of the participants is therefore seen as it "really is" (Anastas, 2004, p. 62). For the purpose of this study, interviews and lesson observations were conducted in the physics laboratory where the female students did their theory and physics practical lessons. This allowed me as the researcher, to observe the participants in their natural settings. The observations were carried out without trying to manipulate the natural context (Patton, 2002). As a qualitative researcher I therefore sought an in-depth understanding of phenomena as they occur naturally and no attempt was made to manipulate the situation. During these observations the researcher recorded the number of students in class, the gender ratio, where female students sit (in front, at the back or well spread out), whether they were comfortable in carrying out experiments or handling apparatus and their interaction patterns in class.

In this study, the data are reported verbatim through the words uttered by the participants to provide a true description of their reality (Creswell, 2007; Holloway & Wheeler, 2002). Creswell (2007, p. 169) explains that the responses from the participants are recorded by means of what he calls "thick, rich description." This thick description must be substantiated with abundant practical evidence and a theoretical foundation (Henning et al., 2004). The researcher reviewed the literature and used it to provide evidence for the purpose of the study and the research problem under investigation.

Interpretivists have different ontologies and the ontological stance embraces the idea of subjective and multiple realities. Such ideas have implications for the researcher's decisions on how to access the participants' different and subjective ways of looking at reality. Therefore, each and every participant in this study has her own reality. The participants' epistemology is centred on the construction of new knowledge during data generation from the participants' experiences. The epistemological assumption requires that the researcher gets as close as possible to the participants being studied. The closer I get to my participants, the more I can claim to know what I know (Creswell, 2013).

Axiology (role of values) relates to ethical considerations and our own viewpoints (Dillon & Wals, 2006). The axiological assumption of this study is that the under-representation of females in physics is an indicator of certain injustices in society caused by several sociocultural and economic factors and this resonates well with the Feminist Standpoint Theory (FST). The axiological assumption also requires that, as the researcher, I position myself in the study, by first admitting the value-laden nature of both the study and the information gathered in the field, and then secondly, by actively reporting my values and biases. A qualitative approach grounded in an interpretivist paradigm was used.

5.1 Sample and Context

This study took place in an educational context in Zimbabwe where, for decades, far fewer females have been enrolling for physics and mathematics compared to that of males. Three of the four schools purposively selected for the study were co-education government schools categorised as rural, low and high density schools based on the social and economic standards of the communities in which the schools are situated. The fourth school was an all-girls non-government school categorised as a low density school. Low density schools are generally well resourced with adequate laboratory facilities (usually 3 laboratories for senior and 2 for junior students) and well-qualified science teachers. The all-girls school has six laboratories, three for junior and three for senior students. Generally, high density schools are not well resourced, having only two laboratories, one for the senior and one for the junior students. The three categories of schools selected for the study can be considered as representative of the types of schools in the broader Zimbabwean context. Therefore, it was important to determine if the interaction patterns which shape the identity formation of females would vary as the school setting changes.

Sampling refers to the process used to select a portion of the population for the study (Nieuwenhuis, 2007, p. 79). Since Gweru district has sixteen high schools, I purposively selected four schools which I assumed had the appropriate data I wanted (Creswell, 2013). Of the four schools one was from a rural impoverished region, with a population of two female students who were studying mathematics, one was from the high density urban schools (low income) which comprised my sample with a population of three students studying physics twenty- five mathematics and the other one was from low density urban schools (middle income). Ten female students were studying physics and fifty mathematics. All three of these schools are coeducational. The fourth school was a low

density boarding school for girls only and a total of fifty female students were studying physics and one hundred and seven mathematics. The participants were drawn from a population of A-level female science students at these selected schools.

Female adolescents aged 18years and above doing Advanced Level (A-level) in lower 6 (form 5) or in upper 6 (form 6) were chosen as the participants of this study. Purposive sampling was used to select prospective participants from a population of female science students from the four different schools. A sampling questionnaire was designed and self-administered to all female students doing A-level sciences. This served to purposively identify participants who met the inclusion criterion of age limit of eighteen years and above. The inclusion criteria also considered participants whose subjects were either mathematics with physics or mathematics without physics.

Purposive sampling entails that the inquirer selects individuals and sites for a study because they can suitably inform an understanding of the research problem and the central phenomenon being studied (Creswell 2007, p. 125; 2013, p. 124). I focused on two groups of female students (with different stand points). Those who were studying physics and mathematics as a combination and those doing only mathematics to enable me to find the facets of identity formation considered to be of significance by female students in relation to physics and how these would influence Zimbabwean A-level female students' perceptions of and participation in physics. Students studying mathematics only, are potential students to study physics but they had not opted to study the subject. It is significant that their perceptions and the way they perceive themselves would shed more light to low female participation in physics.

Based on the criteria employed in the purposive sampling, I chose nine students to participate in the study. From the low density school, two female students were selected, one doing mathematics and physics, and the second one doing mathematics without physics. Three female students were chosen from the high density urban school, one doing mathematics and physics, one doing mathematics without physics and the third student doing physics without mathematics. Traditionally, students at A-level enrol for both physics and mathematics as a combination of subjects to pursue a career in physics or in engineering. Her inclusion therefore would enrich the generated data. Two students were selected from the low density all-girls school, one doing mathematics and physics and the second student doing mathematics without physics. All rural schools did not offer physics because they did not have laboratory facilities, materials and equipment and therefore offered only mathematics. The rural school that was chosen had only two female A-level students doing mathematics hence both students became part of the sample.

5.2 Research Instruments

This study is of such a nature that one cannot conduct experiments, especially when one needs to find meaning in the lived experiences of the female participants and relationships (rapport between the teacher and the female participants and among male and female students) as they participated in physics lessons. To get an in-depth understanding of the relationships and experiences of these students, I needed to adopt a qualitative approach to research, which assisted me not only to report on the findings, but to constantly engage with the study throughout by means of argument and reasoning.

Observation is a systematic process of recording the behaviour and patterns of participation without necessarily questioning or communicating with the participants (Nieuwenhuis, 2007). As a qualitative data generating technique, observation was used to enable the researcher to gain a deeper understanding of the phenomenon being observed (ibid.). Only the students who were doing physics were observed as they learnt physics. The risk is that observation by its very nature is highly selective and subjective since researchers focus on specific events or objects within the whole thereby cutting them off from the whole (Creswell, 2007; Nieuwenhuis, 2007). The risk of observation was minimised by formulating an observational schedule which was then used during the data generation process. Female students were observed doing their theory and practical lessons in physics. These lessons were video-taped to enable me to extract the facets of identity formation considered to be of significance by female students in relation to physics. It is a naturalistic technique in the interpretive paradigm (ibid.) where female students were observed in their natural environment as previously stated. Observation provided me with an insider perspective of the group dynamics and behaviours in different settings. Observation allowed me to hear, see, to begin to experience (observation) and reflect on (which is part of the interim data analysis) how setting is socially constructed in terms of "power, communication lines, discourse and language" (Nieuwenhuis, 2007, p. 84). To minimise the Hawthorne effect, I observed three lessons without collecting any data to enable the students to get used to my presence. This enabled me as a researcher to build a relationship with the participants in their setting. The observation data was used to inform interviews with the students.

The nine participants were interviewed individually and the interview sessions which were audio-taped were thirty minutes to an hour each. The purpose of the individual interviews was to allow the students to unfold their narratives about their experiences with science in general and physics in particular. The setting allowed the students to articulate themselves without interruptions. As a researcher, I had room to explore participant responses by asking for clarification or additional information. I also had the freedom to be more friendly and sociable. As

Huysamen (2001, p. 8) argues, semi-structured interviews allow the interviewer to use probes with a view to cleaning up vague responses or to ask for incomplete answers to be elaborated on. I used such probes which varied from 'why?' to 'could you tell me more about this' or 'could you elaborate on this.'

The orally generated stories were transcribed and transformed into written texts for analysis i.e. all the narrative data that had been recorded in audio and video form was transcribed verbatim in English, the language in which the data generation procedure had been conducted. The transcripts were compared with the recorded data to ensure that every word had been captured in the transcripts. During the transcription, all the names of the participants were replaced with pseudonyms or labels such as S1, S2 etc.

Creswell (2013, p. 179) claims that the process of data analysis involves "coding and organising themes, representing the data and forming an interpretation of them." The steps are interconnected and form a spiral of activities, all related to the analysis and representation of data. Data analysis is making sense of data in terms of the participants' definitions of the situation, noting patterns, themes, categories and regularities (Creswell, 2007; Nieuwenhuis, 2007). It rests heavily on interpretation and one has to note that there are frequently multiple interpretations to be made of qualitative data. Qualitative data analysis, therefore, tends to be an ongoing and iterative process, implying that "data generation, processing, analysis and reporting are intertwined" and not merely a number of successive steps (Nieuwenhuis, 2007, p. 100). The goal in analysing qualitative data was to summarise what I had seen and heard in terms of common words, phrases, themes or patterns that aided my understanding of that which was emerging (Creswell, 2007; Nieuwenhuis, 2007). The data was then coded to obtain categories and themes that best described the influence of identity formation on female students' perception and participation in Physics. A summary of the analysis of thematic process is given (Table 1).

Table 1 The process of the thematic analysis (Braun & Clarke, 2006, p. 87; Holmegaard, Madsen, & Ulriksen, 2014, p. 195).

Phase	Description of process
1. Getting familiar with the data	In this phase, I first transcribed the data and then reading and re-reading the interviews while noting down initial ideas bearing the research questions in mind.
2. Generating themes	Constructed several themes i.e. coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code. Systematising of the data across the entire data set, and relevant quotes from each interview were gathered under each theme.
3. Searching the data	In this phase, I understood the patterns within the themes in a more comprehensive context of meaning according to my theoretical framework. This part of the process is about recontextualising the meaning within the students' narratives by using Sfard and Prusak (2005) and Wengers' CoP as the lenses.
4. Understanding the themes with the theoretical framework	Reviewing the themes by re-reading the transcripts to check if themes and theoretical interpretations work in relation to the entire data set
5. Reviewing themes	Defining the analysis heading towards a thick description of the data, moving across the data set but also looking deeper into some specific interviews or narratives. Picking out quotes illustrating points and patterns in the themes. In short, it is selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.
6. Producing the text	

It is my contention that the stories told by the participants during the data-generation process represent what Clandinin and Huber (2002, p. 163) refer to in the three-dimensional narrative inquiry metaphorical space as the "wholeness" of their lives. Clandinin and Huber (2002, p. 163) assert that the "wholeness of life" is constituted by personal and social aspects and a continuity that is embedded in the notion of past, present and future, and in the notion of situatedness.

6. Analysis of Results and Discussion

Identity formation, which is part of the natural process of adolescence, is seen as the development of their self-concept. Identity is the major component of one's self-concept and the self has been used as an organising construct for understanding the identity (Leary & Tangney, 2003). The values transmitted to female students through the socialisation process become internalised and represent an important aspect of the self-concept (Knight et al., 1993). Subsequently, these internalised values become guides for behaviour. Thus, female students' self-concept mediates the relation between socialisation experiences and their behaviour (ibid.). Self-concept refers to a set of abilities, opinions and thoughts by which we define and categorise ourselves (Gouws, Kruger, & Burger, 2008). Self-concept is, therefore, composed of multiple identities, hence it is multidimensional in nature (Knight et al., 1993). The self-concept is dynamic in the sense that it may change from time to time and from situation to situation. With respect to this study, the physics self-concept implies how students perceive themselves in relation to physics now and in the future (Horowitz, 2012).

Table 2 below summarises female participants' facets of identity formation that they consider to be of significance with respect to physics. As shown in Table 1, all nine female participants doing physics and/or mathematics described themselves as being *intelligent* and *hard working.* These facets support the development of an identity that would enable the female students to compete well in physics or mathematics that are culturally stereotyped as being masculine and perceived as difficult subjects. In Zimbabwe, female students are perceived by the community as being less intelligent than male students and are, therefore, expected to study biology and not physics. This implies that they needed to be hard workers if they were to register a pass in the subject.

An examination of the list of facets of identity described in Table 2 and interview data indicate three categories of students. The first category are those who were doing physics (S1, S2, S8 and S3), displaying a measure of confidence in the subject. The second category are those who were doing only mathematics (S4 and S5) despite having the potential to do physics but lacking in courage. The last category are those who were doing mathematics only (S6, S7 and S9) but did not do physics because of a lack of laboratory resources at school or due to a career interest not related to physics. The self-descriptions common to the first category of participants doing physics (see Table 2) are listed as:

Confident, determined, courageous, fearless, like challenges, likes physics, not intimidated by boys, and determined to prove that girls can study physics.

These facets that the participants perceived themselves to possess, spurred them into defying the cultural expectations when they opted to study physics. These facets enabled the female students to go against the prevailing cultural norms in the sense that they seemed to contribute towards developing a physics identity. For example, the fact that females stated that they *like physics* might imply that they were displaying positive attitudes towards the subject. It might also imply that they were creating a positive identity that motivated them to keep on studying the subject since they *liked challenges* as well. The participants' desire to prove that they were just as able to study and pass physics as male students could result in the achievement of a science identity in general and a physics identity in particular. The category of students who chose to do physics was not intimidated by male students. S2 explained that she was excited being in a male domain and, hence, she was not afraid to be amongst the male students.

Table 2: The facets of identity formation considered to be of significance by female students in relation to physics

Phase	Description of process
1. Getting familiar with the data	In this phase, I first transcribed the data and then reading and re-reading the interviews while noting down initial ideas bearing the research questions in mind.
2. Generating themes	Constructed several themes i.e. coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code. Systematising of the data across the entire data set, and relevant quotes from each interview were gathered under each theme.
3. Searching the data	In this phase, I understood the patterns within the themes in a more comprehensive context of meaning according to my theoretical framework. This part of the process is about recontextualising the meaning within the students' narratives by using Sfard and Prusak (2005) and Wengers' CoP as the lenses.
4. Understanding the themes with the theoretical framework	Reviewing the themes by re-reading the transcripts to check if themes and theoretical interpretations work in relation to the entire data set
5. Reviewing themes	Defining the analysis heading towards a thick description of the data, moving across the data set but also looking deeper into some specific interviews or narratives. Picking out quotes illustrating points and patterns in the themes. In short, it is selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.
6. Producing the text	

All the female students doing physics were in families where they grew up with male siblings, for example, S1 had four brothers and four male cousins, S2 had three brothers and S8 had two brothers and hence they may have been very comfortable in a male-dominated classroom environment. The female students considered themselves capable of studying physics and, hence, they participated fully in the subject. Classroom observation data confirmed what the female students narrated during interviews. They displayed confidence when carrying out the experiments as well class presentations. They handled apparatus well, participated actively and asked questions in their communities of practice. For example, S8 highlighted that she was an inquisitive student who asked a lot of questions, especially during lessons, demonstrating her passion in participating in this CoP. All the facets that the female students outlined were also noted during the classroom observations, implying that the students were creating a physics identity for themselves. How students engage in school science is influenced by how students view themselves and whether they see themselves as the kind of people who could engage in science, specifically in physics (Brickhouse, Lowery, & Schultz, 2000). It is therefore crucial to understand students' identities and how their identities interact with school science identities which impact on their participation in physics.

As opposed to the first category of students studying physics, the second category of students, S4 and S5, enrolled for mathematics despite the fact that the schools they attended offered physics at A-level. In spite of the fact that they said they were intelligent and hardworking, they also expressed facets which did not seem to motivate them to study physics. These were:

Fear of failure in physics, not courageous, lacked confidence, do not like physics and that physics was irrelevant to their career aspirations.

These facets did not seem to create a self-concept that would allow the female participants to cross the cultural boundaries expected of them. For example, fear of failure in physics and not being courageous enough to take on the challenge indicate that the identity that these female students may have created might not have allowed

them to aspire to study physics. S4 and S5 appeared to have succumbed to cultural pressure. In this context culture, which is "the collective programming of the mind that distinguishes the members of one group or category of people from others" (Hofstede, 2011, p.3) was at work in these female students. Although these students described themselves as being intelligent, cultural socialisation from a young age prevented them from studying physics, indicating the strangle hold of cultural views on an individual. Bala, Chalil, and Gupta (2012) argued that people's lives are strongly influenced and shaped by prevailing cultural norms that, as they are passed down from generation to generation through learning, give identity to a group of people.

The third category of female students studying mathematics (S6, S7 and S9) is considered next. S6 and S7 were studying at an under-resourced rural school with no laboratory facilities while S9 was at a well-resourced all-girls school. These three participants described themselves as:

Courageous, determined, confident, fearless if given the opportunity/fearless, likes physics

By stating that they liked the physics, the female participants were displaying positive attitudes for the subject as previously alluded to. This indicates that the participants may have developed a self-concept that may have influenced the creation of a positive physics identity. These self-descriptions were also a clear indication that S6 and S7 specifically, had the ability to study physics. For example, they stated that they were fearless if given the opportunity, indicating that they might have developed positive self-concepts that encouraged them to be courageous and determined to prove that girls can study physics in an environment with deep rooted cultural practices. S9 on the other hand, had the opportunity to study physics, but because she was aspiring to be an economist, believed that physics was irrelevant. She had a family role model i.e. her elder sister who had done physics at A-level and was studying pharmacy at a university, as she explains:

S9: *Basically no one discouraged me from doing physics because my big sister did physics, chemistry and maths and is now doing pharmacy.*

Despite having a role model and her parents encouraging her to study physics, S9 did not opt to study physics. This indicates that career prospects can influence the subjects one may opt to do.

To sum up, it was evident that the female students doing physics were stronger personalities who could steer away from peer pressure and sociocultural expectations. They were more assertive about what they wanted to do in life. I may, therefore, describe these female participants as having formed a positive physics identity which might have encouraged them to engage or participate fully in this CoP. In a sense then, our identities are the vehicles from which we participate with others in community i.e. "vehicles that provide both potentials for and limitations to our participation, and that are modified as we learn and grow through mutual participation in joint enterprises with others" (Van Zoest & Bohl, 2008, p. 320). As highlighted above, the facets of identity formation considered to influence female students' participation in physics include confidence, being courageous, determined, fearless, and intelligent, being a hard worker and liking challenging situations. On the other hand, female students who had the potential to study physics but were studying only mathematics stated that fear of failing physics, not being courageous, lacking confidence and that physics was irrelevant to their career choice were significant in influencing their non-participation in physics. These facets or self-descriptions of how the female students perceive themselves may influence their self-concepts that may have enabled female students to form an identity that contributed towards their motivation for participation or lack of it in physics.

7. Conclusion

The facets of identity formation considered to influence female students' participation in physics included confidence, being courageous, determined, fearless and intelligent and being a hard worker who likes challenging situations. The participants needed courage, determination, belief in one's capability, agency etc. to go against cultural gender stereotyping and gender role expectations that seem to discourage them from participating in physics and mathematics at A-level. These facets or self-descriptions of how the female students perceived themselves, positively influenced their self-concepts and enabled them to form an identity that contributed to their motivation towards participation in physics. On the other hand, female students who had the potential to study physics but were studying only mathematics stated that the fear of failing physics, not being courageous, lacking confidence and that physics was boring and irrelevant to their career choice significantly influenced their non-participation in physics. I therefore recommend the need to introduce gender sensitivity (ability to perceive existing inequalities) and gender awareness programmes to pre- and post-training teacher courses. In other words, gender sensitive education needs to be introduced and enhanced so that teachers will not perpetuate male dominance and female subordination in their lessons. Staff development is also needed to help teachers develop strategies to increase the participation of female students in physics.

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