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The Effect of Multimedia Cases on Science Teaching Self-Efficacy Beliefs of Prospective Teachers in Kenya

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Abstract

This study examined the effects of multimedia cases on science teaching self-efficacy beliefs of prospective teachers in Kenya using mixed methods in data collection and analysis. Collaborating with two teacher educators at Central University, I designed and implemented two multimedia case-based intervention lessons, one with prospective chemistry teachers and the other with prospective physics teachers. I determined the changes in self-efficacy beliefs using a pretest and posttest with the Science Teaching Efficacy Beliefs Instrument (STEBI) for N=41 participants. I also collected data using a worksheet during the intervention lesson. When the prospective teachers went for their field practice, I sampled eight of them for in depth interviews to determine what they drew on from the intervention lesson during their classroom teaching.

I used Roth McDuffie's et al. (2014) framing to categorize the comments that the prospective teachers made on the worksheet into the four lenses of teacher, students, task or power and participation. I used paired sample t-test to determine the changes in self-efficacy beliefs and then developed profiles of the prospective teachers from the in depth interviews.

The results revealed that prospective teachers paid more attention to the actions of the teacher and paid less attention to students' activities. Their attention to the task was predominantly about the cognitive level of the task and almost always focused on the errors they noted. The prospective teacher noticing using the power and participation lens was not clearly delineable from the teacher lens, because most instructional activities that led to more participation were teacher actions.

Science teaching efficacy beliefs has two constructs: personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE). The PSTE scores were very high at 4.46 out of five on the pretest, and 4.41 on posttest. There was a decrease in the mean scores, but

the change was not significant. There was a statistically significant increase in STOE (M=1.78, *SD*=5.8 *t(40)*=2.802 *p*=0.008) and an overall increase in the self-efficacy beliefs. The teacher profiles showed that prospective teachers drew from specific examples from the multimedia cases as well as learned from a gestalt interpretation of the teaching and learning activities in the clips that were shown.

From these results, I discuss how prospective science teachers' self-efficacy beliefs are altered in the process of watching multimedia cases. Their beliefs about knowledge start to change from absolute ownership to shared and co-constructed knowledge in class, as seen in the decrease in the personal teaching outcome expectancy (PSTE) and an increase in noticing of students' role in learning.

THE EFFECT OF MULTIMEDIA CASES ON SCIENCE TEACHING SELF-EFFICACY BELIEFS OF PROSPECTIVE TEACHERS IN KENYA

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This dissertation is evidence that words are a seed that people plant into our hearts. When there was no dream, when the roadmap became foggy, when there was no more energy to continue, when the weather was harsh and serenity turned to loneliness, when my skills felt inadequate and I felt like it was time to give up, my motivation came from words that you have said to me. Your humor, compassion, dedication, and sustained guidance give a new meaning to advising. Professor Joanna O. Masingila, I am eternally grateful to you for being the best advisor anyone can ever have. I want to thank you, but no words can say enough. The best I can do is to make the seeds you have planted in me to grow.

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List of Abbreviations

ASEI	Activity, Student, Experiment, and Improvisation
AU	African Union
BSCS	Biological Sciences Curriculum Studies
CIR	Critical Incidence Reflection
CRO	Cathode Ray Oscilloscope
CRT	Cathode Ray Tube
CUE	Commission of University Education
EBD	Emotional and Behavior Disorder
EFA	Education For ALL
IMF	International Monetary Fund
KBS	Kenya Bureau of Statistics
KCPE	Kenya Certificate of Primary Education
KCSE	Kenya Certificate of Secondary Education
KUCCPS	Kenya University and Colleges Central Placement Service
LIA	Letter of Interim Authority
MDG	Millennium Development Goals
MMC	Multimedia Cases
OAU	Organization of African Unity
OBE	Outcome Based Objectives
P1	Primary one
PDSI	Plan, Do, See, and Improve
PSTE	Personal Science Teaching Efficacy

PT	Prospective teacher
SAP	Structural Adjustment Program
SMASE	Strengthening Mathematics and Science Education
SSA	Sub-Sahara Africa
STEB	Science Teaching Efficacy Beliefs
STEBI	Science teaching Efficacy Beliefs Instrument
STOE	Science Teaching Outcome Expectancy
TP	Teaching Practice
UNESCO	United Nations Educational, Scientific and Cultural Organization
US	United States

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Chapter 1: Introduction

Background of Study

The year 2015 marks the expiration of the timeline set for achieving Education For All (EFA), the Millennium Development Goals (MDG) and the onset of fresh agendas for development and education (Winthrop, Anderson & Cruzalegui, 2014). According to Winthrop et al. (2014), many educational stakeholders have called for a reformulation of the spirit of the EFA agenda from merely access, to access *plus* learning. This fresh approach places more emphasis on the teacher's actions in class. Many studies have established that the teacher is the most influential factor in students' learning (Boonen, van Damme, & Onghena, 2014; Bressoux & Bianco, 2004; Darling-Hammond, 2006), and educators are looking to teacher education programs to improve the quality of student learning.

The traditional teacher-training in Sub-Sahara Africa (SSA) model was based on the craft methodology, where a certain established body of knowledge was imparted on the student, who, upon receiving this knowledge, became a master of the craft (Moore, 2004). The implied theory of teacher education was, therefore, that the university provided the theory, methods and skills to prospective teachers (PTs), the schools were the settings where this knowledge would be practiced, and the PT provided the effort required in applying the knowledge (Bouwer & Korthagen, 2005).

Current approaches to teacher education, however, recognize teaching as a profession, complete with all the elements of a profession: autonomy, service delivery focus, self-governing and a unique specialist-specific knowledge base for practice (Sockett, 2008). Developing countries have had challenges catching up with the rest of the world in terms of access, quality

and relevance of their education systems. Sub-Sahara Africa (SSA) particularly lags behind in all indicators of attainment of the MDGs and EFA goals (UNESCO, 2010). To better understand the historical circumstances that preceded this situation, I will discuss the context of SSA, first describing why it makes sense to group these countries together, and then using colonization as both a periodization event and also the most influential event in SSA's history.

Education in SSA

What is Sub-Sahara Africa? Africa, with 54 countries, is the second largest continent and second most populous after Asia (World Atlas, 2014). In 2010, approximately 815 million people lived in Sub-Sahara Africa (SSA), representing 11.8% of the world's population of 6.9 billion. The population of the region is young, with 43% under the age of 15 and growing at a fast rate of 2.4% annually (UNESCO, 2010). Seven northern African countries of Arab heritage (Algeria, Egypt, Libya, Morocco, Sudan, Tunisia, and Western Sahara) do not categorize themselves as African even though they geographically habituate the African continent (Ekwe-Ekwe, 2012). Countries that are south of these Arab nations are generally referred to as Sub-Sahara Africa.

Pan Africanists have expressed displeasure with the use of the term sub-Saharan Africa, especially after the emergence of the African Union (AU). Ekwe-Ekwe (2012) opined that the term Sub-Sahara Africa is a geopolitical signature that aims to represent the imagery of the desolation, aridity, and hopelessness of a desert environment. The African Union was created out of the Organization of African Unity (OAU) in 2001 as a reaction to neo-colonialism, and primarily focuses on political stability and sustainability of the African economy (Edo & Olanrewaju, 2012). The spirit of pan-Africanism is a recognition that "Africans have been divided among themselves, that they constantly compete with each other, are deprived of true

ownership of their own resources, and are inundated with paternalistic external actors" (Murithi, 2007, p. 2). Paternalism manifests as aid with benign and benevolent intentions, while in reality it perpetuates a status quo that inhibits empowerment of African nations. Though this argument is valid, the reference to these countries as members of the African Union deconstructs the boundaries that have been created by identical post-colonial circumstances for the countries in the region referred to as SSA in the present study.

The term, African Union is therefore a geopolitical signature that represents the pan-Africanist recognition of a set of identical factors and a need to develop home-grown solutions for Africa's economic and political growth. However, for the purpose of this document, SSA refers to the African-centered scholarship and more general acknowledgment of identical circumstances that have influenced the growth and development of the countries in the sub-Saharan region of Africa region. The term SSA does not imply proximity to the Sahara desert, and recognizes that there is no generalizable effect of the desert on the climate, social, economic or political organization of the SSA countries; rather, it is a noun used to refer to the 47 countries south of the Sahara.

Sub-Sahara Africa socio-economic and political profiles are quite varied across each country. Thompson (1981), however, delineated four common characteristics for the approach of grouping the countries together as SSA. The first is the fact that by common measurement standards, such as per capita income, all the countries in the region are less developed than most other countries in the world. Second, most of the individual countries are inhabited by subgroups that differ culturally. Each sub group possesses its own vernacular language, a unique pattern of religious beliefs, moral and aesthetic values, social institutions, customs, codes of behavior, and uses differing strategies and technologies to explore resources. Third, all SSA countries are

committed to national development, and are seeking to balance the idea of harmonizing the diversities inherent in the subgroups to create a national culture, while at the same time trying to preserve as much as they can from the indigenous ways of life (Urch, 1992). Last~~ly~~, all countries are going through a far-reaching process of social change whether inevitably or through careful conscious planning.

The one event that probably had the most significant impact on the development of education in SSA is colonization. Chisholm and Leyendecker (2008) acknowledged that the legacies of colonialism and post-colonialism held and continue to hold powerful influences on all facets of life in the continent, including education reforms and policy. Most SSA countries are approximately 50 years old, having gained independence in the early 1960s (World Atlas, 2014). It is these very similar circumstances that justify the treatment of the SSA countries as a group.

When discussing issues of SSA as a group, attention needs to be paid to the heterogeneity of their national heritage, country demographics and economic resources (Thompson, 1981; Urch, 1992). Moreover, each country, by virtue of being independent, has a unique government system, political ideology, and international outlook (Lewin & Akyempong, 2009).

Education in the Pre-colonial Era. The descriptions made about Africa's traditional education system take two distinct stances: the outsider's viewpoint initially espoused by early European visitors to Africa, and the viewpoint recorded by early Afrocentric ethnographers. The common agreement about the pre-colonial education system is that it qualified in all ways as informal (Fafunwa, 1982; Hopkins, 1977; Sifuna, 1980; Weeks, 1969), a categorization justified by the absence of a well-documented curriculum and progressive path.

Education in Africa before colonization consisted of well-structured, small-scale apprenticeship practices that were handed down from one generation to another within the

families and communities (Fafunwa, 1982, Hopkins, 1977). The education system emphasized social responsibility, job orientation, political participation and moral values (Minnis, 2006; Sifuna, 1980).

The curriculum evolved from issues in the community and was therefore very relevant for addressing the problems in the community as well as sustaining the delicate social, political and economic balance. Knowledge was passed on from one generation to the next, and the laws of nature and science were stated in the form of beliefs that were occasionally enshrined in mystery (Indire, 1982; van Gennep, 2011). Teaching was done by a master craftsperson through a scaffolded process of exposure to the knowledge, skills and practices needed to master the craft. After graduation through initiation ceremonies, initiates were allowed access to higher levels of community privileges (van Gennep, 2011).

If this system was evaluated against its ability to meet the needs of a particular society at any given time, then the African traditional education was excellent. However, judged by any other consideration suitable for a dynamic and growing society, the education system was lacking (Fafunwa, 1982). It was sustainable but not progressive. Conflicting perspectives emerged between the missionaries and the early ethnographers. Early missionaries saw the African culture as barbaric and thought of the traditional African person as one in need of enlightenment through formal schooling. The early ethnographers called for more precautionary research on how to graft formal schooling to the traditions of the African communities, and strongly detested the notion that missionaries would know what was good for Africans. (Indire, 1982; Kallaway, 2012). Both sides of the argument understood the need for formal education, but may not have agreed upon how it would best be implemented.

Education in the Colonial Era. Colonial era education had three distinct phases that can be demarcated either by the two World Wars or by the actors in the education sector. Before World War I, missionaries controlled education. Between World War I and World War II, the colonial government took charge of education in the colonies. After World War II, there were multiple groups that influenced the educational policies in Africa, including the colonial government, American philanthropists, and the immigrants who had settled in Africa.

Education before World War I. The scramble for colonization of Africa was triggered by sociopolitical and economic factors outside Africa. Boddy-Evans (2014) explained how the abolition of previously predominantly shoreline-based slave trade and rising capitalism in the west led to exploration of inland Africa in search of profitable raw materials. Private merchants funded early explorers, such as David Livingstone and Stephen Morton Stanley, to lead expeditions into inland Africa. The European countries, seeking to expand their influence, relied on the same explorers to secure treaties with African chiefs. These explorers were also recorded as the first early missionaries in Africa (Boddy-Evans, 2014; Indire, 1982; Murfin, 1996).

In the early 1900s, the first Christian missionaries had started making inroads into Africa. By 1920, there were more than 10,000 missionaries of various sects and denominations representing various countries including Britain, France, Germany and the United States (Neu & Ocampo, 2007). The missionaries started a form of education that focused on making the African an improved servant through practical training for proficiency in domestic and social duties so that they would assist the missionaries in their work (Diptee & Kleinm, 2009). The main focus of the curriculum was reading, writing and arithmetic. Afrocentric literature reports that education was only given to Africans who were willing to convert to Christianity (Fafunwa, 1982). Other studies say that missionaries had medical, educational, and administrative missions that attracted

Africans to Christianity (Neu & Ocampo, 2007). Whatever the case, few Africans were enrolled in the early missionary schools.

The first trained Africans were given jobs as clerks and mission assistants (Kallaway, 2012). Schooling and intelligence were measured in terms of knowledge of reading and writing in English, arithmetic and religion. The long-standing depiction of Sub-Sahara Africa as underdeveloped started when the definition of knowledge and development started to refer to comparative forms of schooling and wealth, completely discounting any skills that were not formally taught in schools (Rodney, 1972).

The intellect of Africans was disparaged heavily in missionary reports that were sent back home. For example, Kallaway (2012) reports that a missionary, Leroy of the Holy Ghost Mission, thought that the Africans were inferiors in intelligence, credulous, shallow and retarded. Sacleux, a linguist, wrote that the pagan African was intellectually inferior to the Arab. Africans were seen as having nothing to teach and everything to learn (Kallaway, 2012). The rhetoric of such reports would not be important were it not for the effect it had on the teaching approaches that were used in the schools at the time. A teacher–learner relationship that would become the first form of apprenticeship-of-observation (Lortie & Clement, 1975) was brewed in these circumstances. It is not uncommon to find teachers to date within SSA, who still subscribe to the *tabula rasa* epistemology.

Education in the period between World War I and World War II. After World War 1, the German Empire collapsed and mandated Britain to oversee education in a number of its colonies (Windel, 2008). Most colonial governments sought to consolidate their influence on the African colonies and saw education as one of the ways to achieve these goals. Initial efforts had been informed by the experience and knowledge of missionaries, district administrators and

colonial officials, but there was increasingly more shift towards research and scientifically-based policy decisions (Kallaway, 2012).

By then, the racial dynamics had changed; there were more settler populations in Africa: (a) white settlers whose interests were in commercial farming of tea, cocoa, and coffee, as well as the mining of copper and gold, (b) Arab settlers whose interests were in trade, especially along the shorelines, and (c) Indians who had been brought in from India to build the railway and were establishing trading centers along these railway lines. These communities, alongside the indigenous Africans, had different educational needs. So unlike in the pre-World War I, when race was not an issue, the colonial governments had to address divergent educational needs of all these communities (Berman, 1971).

The first effort to use research-based evidence to formulate an educational policy was the establishment of the American-funded Phelps-Stokes Commission on education in Africa (Berman, 1971). The commission visited over 25 colonies in Africa to evaluate and advise the colonial governments on the effectiveness and directions for future education policies in education (Berman, 1971; Kallaway, 2012). The commission recommended, among other things, the partnership of government and missionaries in education. The idea of using commissions to seek opinions of stakeholders before formulating policy was later brought into the new millennium by independent African governments.

It is also important to note that lobby groups in Western countries, including the Anti-Slavery and Aborigines Protection Society, required the trustees of education in Africa to live up to the trust of civilization and extend the same treatment demanded for freed slaves and marginalized groups in the west to the Africans in their colonies (Wolf, 2008). The Phelps-Stokes Commission, therefore, recommended the establishment of a Directorate of Education,

the development of a curriculum that is relevant to the people, training teachers, as well as increased funding to education for Africans (Lewis, 1962).

With such changes, even though the curriculum predominantly continued to create labor for the settler farms, numeracy and literacy became increasingly important for getting better blue-collar jobs. With this in mind, some communities in Africa started giving land freely to missionaries to set up schools (Windel, 2008). The demand for education by African communities was increasing as education became synonymous with good jobs. This demand continues to present day, driven more by a desire to get a good job or a pay rise, than for the innate value of education.

Education after World War II. The effects of World War II reverberated around the world, including in Africa. There were sharp criticisms of racism, all forms of supremacy and oppression (Spies, 2011). During the 1950s, policy makers and donors recognized that the gap between the developed and developing countries was widening and that developing nations needed assistance with their development endeavors (Nieuwenhuis, 1997). Donor aid started in the post-World War II era, at a time when massive funds were needed for the reconstruction of national economies abroad. An elite group of Africans were also clamoring for a more participatory approach to decision making. The European and African teachers did well together in the few schools that had been established and even sent Africans for further studies abroad (Windel, 2009). The teachers gained recognition and respect, as they were seen as the ones who held the key to success.

Towards the end of the colonial era, massive rearrangements took place in a number of countries in what would be called “Africanization” - the transfer of political, social and economic structures to Africans (Seepe, 2000; Wiseman & Charl, 2014). Afrocentric literature

suggests that the colonial governments were preparing their African procurators to take up positions (Rodney, 1972), while others call this phase preparation for independence (Minnis, 2006). The labor market was robust and those who got an education were readily absorbed (Seepe, 2000). There was a larger need for skilled workers than the education sector could churn out. Even those who had the ability and opportunity to advance their education opted to stop their pursuit of education and take up jobs in the Africanized governments.

The schools existing in SSA at this time were offering unequal education. Schools that were set up for settler communities were advanced, expensive and well managed, with a curriculum focused on preparing students for further studies abroad (Sifuna, 1992). Other schools that had large African populations were offering basic vocational training and preparing their students for manual labor skills. An even larger population of Africans was out of school. The main challenges in education going towards independence were therefore access, quality, equity and relevance.

Education in the Post-colonial era. Most African countries gained independence in the early 1960s. Most SSA governments identified and started to wrestle in earnest with the challenges of access, equality and quality in education during this period (Nieuwenhuis, 1997). Young and inexperienced, governments struggled to find mechanisms to fund and expand the education system in order to cope with the increasing demand for education, both as a service to the increasing population, and to service the higher-end labor needs of the economy. Scholars argue that understanding the forces driving education reforms in post-colonial Africa is an important component of any future attempts at curriculum reform. Such attempts need to exploit the accumulated evidence and experience derived from the years of educational reconstruction in Africa (Jensen, 2003; Tabulawa, 2003).

A number of the initial post-independent reforms in several countries were informed by research. However, the implementation of such reforms were occasionally a political decision first, usually rushed and unplanned, and mostly implemented faster than the school system could take up, and then later rationalized by research whenever challenges emerged. For example, the implementation of outcomes-based education (OBE) in South Africa (Jansen & Christie, 1999) and the integration of Information Communication Technology in Kenya (Waema, 2005) were political decisions that did not take cognizance of the abilities of the school systems to take up such reforms.

Most agendas espoused in the early education reforms were pertinent to the overall improvement of education. I will, however, focus on the attempts that were made to create a learner-centered approach to teaching and learning not because the other issues in the reform agenda are not important, but to sustain the argument that the quality of education is significantly influenced by the actions of a teacher inside the classroom. This is consistent with the argument of scholars in SSA education that to effectively address the issue of quality and access, a focus on pedagogy and corresponding teacher education ~~training~~ implications need~~s~~ to be placed at the core of education since it has the largest effect sizes for students' retention, progression and learning outcomes (Alexander 2008; Aslam & Kingdom 2007; Hardman, Ackers, Abrishamian & O'Sullivan, 2011; Stuart, Akyeampong & Croft 2009).

Reforms Towards Learner-centered Pedagogy

The initial attempts toward~~s~~ a pedagogical shift in the schools cannot be understood without appreciating the role of foreign donors in education in SSA. Western consultants advising the donor community were the first to recommend learner-centered approaches in education, citing empirical evidence that such an approach yielded better results, including

liberal and democratic citizens. These recommendations were communicated and adopted in most SSA countries, but there were serious implementation gaps that were never addressed (Tabulawa, 2003). I will briefly describe the aid environment to identify the lessons that need to be carried into subsequent efforts towards learner–centered approaches.

Donor-funded education reforms. Prior to independence, aid to Africa was in the form of grants to support sectors that were deemed crucial for development. Thus, the first official decade of assistance (1960-1970) was marked by an appreciable increase in development loans to developing countries. During this period, a concessional element was introduced in loans to enable African countries to borrow more (Nieuwenhuis, 1997). There was also a shift from bilateral aid (e.g., from Britain to Kenya) to multilateral aid (e.g., from lending countries to the World Bank then to Kenya) and eventually an institutionalization of development aid (de Haan, 2010). The conditions for these grants were generally uniform. The donor support was in the form of funds directly injected into government budgets to offset budgetary deficits and was intended to spur growth and development. The African governments appropriated and prioritized expenditures in their annual budgetary allocations. Basic education and health were prioritized and provided without cost to the citizens in a number of African countries (Banya & Elu, 2010; de Haan, 2010). The challenge was that not everyone could access these services. The schools that were already established, as well as the reach of government aid for new schools, was still limited to urban and politically relevant areas. At this early stage of the independent governments, providing free education and health meant most money was spent on recurrent budgets and very little was left for development. The government, therefore, needed a loan to just sustain the status quo. Improvement in infrastructure was a discretion of government officials who, unfortunately, applied the dependency model to create sycophancy and consolidate

their control on the citizens. Western foreign donors recommended learner-centered pedagogy as one way that the population would be liberated by education. Meanwhile, the SSA governments amplified their rhetoric about the three enemies they christened ignorance, disease and poverty, and kept seeking more donor funding for these same three problems for the better part of the rest of the millennium (Oiro, 2002).

The second development decade (1971- 1981), as declared by the United Nations, was negatively affected by the world oil crisis of the early 1970s, an increase in the external debt of SSA countries, and the world economic recession (Nieuwenhuis, 1997). Although generally the flow of aid in the developing countries declined, aid to education increased, driven by the understanding that human resource development and economic growth were closely linked (Godfrey, 1979; Nieuwenhuis, 1997; Psacharopoulos, 1990). Even then, there was stunted growth in education as the funds were re-appropriated to other sectors the government supported. Different countries had different ways of addressing this gap in education funding. In Kenya, cost sharing in schools was introduced, and communities joined together in building schools through *Harambee* (Swahili for pulling together) (Bradshaw, 1993). Essentially, this showed that the responsibility for having an education was no longer a government-only initiative.

In the following decade, the World Banks' annual allocation of aid to Sub-Saharan Africa for all purposes – including education – was higher (Nieuwenhuis, 1997). The decade was also marked by bi-polarism in international relations (Tabulawa, 2003). A string of neo-liberal education reforms linked to fiscal austerity and structural adjustment programs (SAPs) started to lock non-conforming governments out of the lending circuit (Novelli, 2010). Eventually, this shifting policy of the structural adjustment programs became the induction of SSA to self-reliance. To brace for the hard times, many countries started the privatization of governmental

organizations, cost sharing in both basic and secondary education, suspension or decrease of university subsidies and granting autonomy to universities (Lewin & Akyempong, 2009; Oketch, 2003). This was seen as a temporarily setback to the gains that had been made in education, especially due to the decline in enrollments (Omwami & Keller 2010), but it can also be looked at as a springboard for a different approach to education. Two words that brought shivers to the hitherto indomitable political leaders in SSA were introduced by the World Bank – accountability and transparency. These words had a large impact on public policy management in many SSA countries. Both external and internal forces conspired to enforce adherence to good governance. The external forces froze aid until certain conditions were met. The internal forces agitated for leadership changes.

At the close of the millennium, a study by Stanford University scholar Samoff (1999) summed up the situation of education in Africa: "Governments cannot cope. Quality has deteriorated. Funds are misallocated. Management is poor and administration inefficient. Notwithstanding the diversity of the countries studied, the recommendations (made from various studies) too, are similar" (Samoff, 1999, p. 249).

Samoff (1999) explained how the process of sector analysis had been done only in the context of aid and noted that,

> the process has remained driven by the agendas and procedures of the funding and technical assistance agencies, with constrained national participation, limited national control, and very little sense of national ownership. To shift its center of gravity toward Africa, the process itself requires major restructuring and reorientation, from conception through completion. (p. 249)

This implies that even sound and research-driven reform agendas risk failure if they are not

homegrown and managed efficiently.

The failure of the curriculum. The curriculum and pedagogical changes that were proposed by consultants showed no regard for the local context. Jensen (2003) had already observed that the curriculum failure seen in most SSA countries resulted largely from an inadequate consideration of both the practical and political contingencies, which impact curriculum. Moreover, when adopted from the top down, policy changes in education do not necessarily affect the way teachers teach inside classrooms. So, scholars recommend while placing pedagogy and its training implications as a central focus, the international agencies urging developing countries to adopt 'best practices' for teacher professional development ought to recognize the everyday realities of the classroom, and the motivations and capacity of the teachers to deliver such reforms (Alexander, 2008; Hardman et al., 2011).

One characteristic of the foreign aid was that a large portion of the funds was allocated to technical assistance in the form of consultancies for foreign experts. In essence, the multilateral donors, especially the International Monetary Fund and the World Bank, provided employment opportunities and fellowships for their own professionals in African countries (Nieuwenhuis, 1997). The experts recommended policies that would change teaching approaches and improve the quality of learning in schools. They specifically emphasized a departure from the prevalent teacher-centered approach and a shift towards learner-centered approaches (Altinyelken, 2013; Letiche, 2010). The expert advice was often discussed at top policy levels in Africa's best state lodges and boardrooms, and was expected to trickle down to the classroom, alongside the balance of the foreign funds allocated for such policy change initiatives (King, 2007). Where consultants recommended materials to accompany the curriculum reforms, it was not uncommon to have these materials supplied from the foreign donor country as part of the financial assistance

(Srivastava & Oh, 2010).

Another characteristic of the donor funding towards education was the overlap of activities and lack of focus and coordination in the disbursement of donor funding. Foundations and faith-based donors desired to fund initiatives that were relevant to their mission (Colclough, King, & McGrath, 2010). These organizations were perceived as an advantageous way of financing and delivering education in developing countries, with the general belief that partnerships with and philanthropy by private foundations were politically neutral and procedurally effective and efficient (Srivastava & Oh, 2010). The success achieved from these faith-based initiatives created disdain for public education in favor of institutions controlled by churches, not only in education but also in the health sector. This exacerbated the inequalities in schools that have continued to date.

At the turn of the millennium, China's and Japan's foreign assistance were, and still are, seen as unique in that they have no regard for international lending concerns and their technical assistance is more participatory. China, particularly, remained hesitant about using the donor discourse (King, 2010). This came at a time when several traditional Western donors had become preoccupied with the challenge of aligning and harmonizing their aid in the spirit of the Paris Declaration on Aid Effectiveness (2005) and the Accra Agenda for Action (2008) that demanded social, political and economic austerity, as espoused by their insistence on accountability and transparency as conditions for lending (Colclough, King, & McGrath, 2010). For example, Japan signed a bilateral technical cooperation pilot project with the Ministry of Education in Kenya in 1998 for capacity building in mathematics and science education to train teachers in new approaches to teaching mathematics and science. The project, referred to as Strengthening Mathematics and Science Education (SMASE), was geared towards making the teaching and

learning of science student-centered. The project focused on two core principles: Activity Student Experiment Improvisation (ASEI) and Plan Do See and Improve (PDSI) The ASEI principle focused on hands-on teaching strategies that use available materials from the local environment in mathematics and science instruction. The PDSI principle encouraged mathematics and science teachers to use reflective approaches of teaching that monitor and assess students' learning and thereby constantly improve their lessons (Mutahi, 2010; Ng'asike, 2012; Njoroge & Njiru, 2014). Though these practices are characteristic of the popular Japanese lesson study approach, one can notice that considerable effort was put to domesticate these practices including giving them locally adoptable acronyms, as well as allowing for inadequate resources by introducing improvisation. These initiatives, once developed, were implemented top-down without providing adequate justification to the teachers of the need for a shift in teaching approaches.

With regard to relevance, research shows that the education system in SSA is producing vast numbers of people with qualifications for which there is no demand, while industry cries out for scientific and technological skills (Godfrey, 1979). Relevance is not merely whether the holder of certain qualifications can step into an existing job in an existing organization, but whether he or she can perceive new opportunities, innovate, and organize human and material resources to carry them to a successful conclusion (Nieuwenhuis, 1997). To achieve this kind of education system, resources must provide learners with inputs that guarantee a form of literacy that extends beyond the classroom to lifelong and meaningful learning. The most crucial input in this endeavor is the teacher.

Challenges for Teacher Education in SSA

Ndawi (1997) argued that the responsibility of introducing learner-centered initiatives lie

with the teacher educators, who ought to align the teacher training programs to the challenges of quality, quantity and relevance, especially within the frameworks of broad government initiatives like Education for All. Darling-Hammond (2006) argued that to improve the education system of a nation, interventions at the teacher education program level show the most significant impact. Teacher education programs are seen as being of poor quality within the SSA region. They do not seem to prepare teachers adequately for the conditions they face in the field (Hardman, Abdi-kadir & Tibuhinda, 2012).

The question of preparing a teacher is a demanding task considering the unpredictable classroom environment that they work in. However, literature on teacher education offers some suggestions. Elliott (1993) proposed the “hermeneutic paradigm” (p. 17) of teacher education, which emphasizes situational understanding of the role of the teacher in the school and classroom. Based on the premise that each teaching situation will be unique and the problems unpredictable, the hermeneutic paradigm trains the teacher to make intelligent responses in practical situations, which are complex and cannot be specified in advance. Teachers trained along this model could be expected to survive in the unforeseen circumstances typical of the modern training needs of learners in SSA (Tabulawa, 1997).

In light of the challenges that previous policy implementation strategies have faced in education, interventions in the education sector need to be initiated at the point of teacher development where pedagogical approaches can be safely evaluated and used to inform the teaching philosophy of the teacher from the onset. The teacher education program provides a suitable ground for PTs to evaluate and critique the current modes of teaching and develop strategies that align with best practices.

In summary, I have explained that the indigenous African education was craft-based and informal. An apprenticeship model of training was adopted in the colonial government to supply labor for initial missionaries and settlers. After World War II, research-based reforms and donor funding informed the initiatives for reforms in education, but the lending conditions and the implementation process, as well as absorbing capacity of most governments, made realization of reforms challenging. Next, I provide a brief summary of the education system in Kenya, with a view of describing the differences in categorization of schools, progression paths, and introducing the nomenclature used in Kenyan education system.

Focus on Kenya

In some ways, teacher education in Kenya mirrors the challenges that are inherent in most SSA countries. For example, as in the case of studies that focus generally on SSA, Hardman et al. (2011) explicated that the pedagogy of "best practices" and its implications on training are central to the development of education. There are risks of failure if change agencies ignore the everyday realities of the classrooms and the motivations of teachers to implement such reforms in Kenya. This points towards the need for home-grown remedies to address the challenge of quality of instruction.

The Education for All development agenda has seen more students than ever before in history enrolled in schools throughout SSA. At the same time, the numbers of trained teachers, instructional materials, and infrastructure development have not kept pace with the heavy demand (Kajunju, 2015; Mohamedbhai, 2006). The trends of enrollment in Kenyan schools, especially following the declaration of free and compulsory basic education in 2003 and free day secondary education in 2008, have made Kenya a good case study for dealing with large classes, especially since there are simultaneous efforts to increase transition across these tiers of

education. The main challenge for the quality of teacher education is the inadequate field experiences that are critical to teacher development. Prospective teachers in Kenya and at Central University do not have any field experience (e.g., observation, working with individuals or small groups, teaching a few lessons) prior to their student teaching (teaching practice). Thus, prospective teachers in Kenya do not have opportunities to reflect on and critique teaching practice of actual Kenyan secondary teachers.

The focus on Kenya in this study is informed by two factors: First, Kenya is at the fore in innovation on education and therefore needs to keep rethinking pedagogies, especially since success in Kenya can easily be replicated to other countries. Secondly, Kenya and Central University at the time of this study, were easily accessible to me and had established ground work for conducting such a study.

In Kenya, success has been reported in the sustained professional development initiatives of the JICA-initiated and Kenyan-modeled Strengthening of Mathematics and Science Education (SMASE) project. The professional development model of the SMASE project was piloted in 1998 in a few selected secondary schools from five of the 47 districts in the country. It was launched nationally and reached all secondary schools in 2003, and expanded to include primary schools in 2009. By 2013, this model of sustained professional development had expanded to 27 other African countries (Bett, 2016).

Kenya is very competitive in terms of human capital. The quality of education in Kenya, measured by student achievement has been placed above that of her counterparts in East Africa. (Uganda, Tanzania, Rwanda, and Burundi). This finding has been consistent in most annual reports generated by *Uwezo*, an educational research and social change organization that releases annual literacy reports across East African countries. In one such report, Ruto and Rajani (2014)

reported large differences in learner achievement among the East African countries, with Kenya performing the best. Additionally, adult literacy rate in Kenya is fourth in Africa, but is ranked the best in East Africa at 87 percent, followed by Uganda at 73.2 percent, Tanzania at 72.9 percent, Rwanda at 70.7 percent and lastly Burundi's literacy rate is 66.6 percent (The African Economist, 2013)

In terms of investing in education, and in comparison to other East African countries, Kenya had the highest public expenditure in education at 17.7 percent between 2008-2009 and 2011-2012, compared to Uganda, which spent an average of 10 percent. Kenya also ranks on top in terms of enrollment of students in higher education, followed by Uganda and then Tanzania. The Global Competitiveness Index (GCI) 2013-2014 ranks Kenya 44th in quality of education out of 148 countries, and the best in East Africa. By comparison, Rwanda ranks 51st, Uganda 82nd, Tanzania 100th, and Burundi 143rd (Kimenyi & Kibe, 2014). These statistics support the argument that Kenya is at the fore in innovation on education, that it needs to keep rethinking pedagogies, and that such innovations possible provide a framework for change in other countries in the region.

The other reason for selecting Kenya, and especially Central University, is that there already existed a suitable ground work for doing this study. First, Central University had benefited from an institutional linkage with a US-based university that among other things held professional development workshops with teacher educators at Central University. In one such workshop series, the teacher educators were introduced to case-based teaching using multimedia cases filmed in Kenya. The presence of these multimedia cases and the enthusiasm of the teacher educators to see multimedia case-based teaching succeed was an enabling environment for this study.

Further, as a graduate assistant, I had worked with the principal investigator in the partnership project to develop the videos into multimedia cases. This process entailed transcribing the videos, subtitling them and preparing the facilitator's guide questions. I also participated in the professional development workshop at Central University as a co-facilitator and as a research apprentice. I therefore had adequate preparation in creating multimedia cases, facilitating them and conducting research with cases.

Before conducting the study, I obtained formal institutional affiliation with Central University. The affiliation meant that I would be allowed access to conduct research under the cooperating teacher educators. The engagements with the teacher educators before the study created a comradery that made it easy for them to allow me access to their classes, including allowing me to engage with their prospective teachers. Lastly, Central University is 17KM from my home and given that I was going to collect data over multiple times. It was very convenient for me to access the University on short notice, and multiple times in a month. This also meant that I could sustain one-on-one relationships with the teacher educators.

Positionality

I was born, educated, and worked in Kenya in the period prior to this study. I worked in various high schools for 17 years. In the last five years of my high school teaching career, I worked in one of the leading national school and had been assigned responsibilities that included: allocation and scheduling of teaching assignments to the teachers, strategic management of academic goals of the school, and management of student's welfare as a dormitory master.

Assigning of responsibilities to teacher and maintaining high standards often meant making decisions about whether the school will allow prospective teachers to join the staff as student teachers. Over time, this responsibility made me believe that PTs are at rudimentary and

varying level of readiness ranging from completely unprepared to almost prepared. Furthermore, the level of preparedness would usually be the same for each university, for all prospective teacher, for all the years. This means that the universities have never been given feedback about their teacher preparation program, hence there were seemingly no improvements on the quality of PTs. Central University had the best prepared of all the PTs, but I knew their preparation could be improved if they were provided with better preparation for their student teaching.

As a Dormitory master, I had personal non-academic relationships with students in the school. In some of the discussions, students were linking their performance of certain subjects to the attitudes they had about certain teachers. From numerous such discussions, I had drawn the conclusion that teachers who exhibit a highly professional behavior inspired students the most. Professional behavior included careful preparation of lessons, diligence in time management, as well as firm and fair treatment of all students. The two extremes of this professionalism were teachers who missed or were late for lessons, came unprepared and made up for their sloppiness with harshness. The other extreme was the kind of teacher who would be kind, compassionate, entertaining and would occasionally give students free points in an examination. Going to this study, therefore, I thought of an effective teacher as one who is able to temporarily adopt a teacher character, one that is devoid of personal character traits, for the purpose of executing a teaching task and revert back to his or her natural character for not teaching tasks. I therefore felt that effective teaching is more of a nurture process than a nature process.

During the intervention process, I had the dual role of moderating the discussions and conducting the research. As a teacher, I knew that a robust discussion would entail listening to varied opinions and arguments and probing areas of academic inquiry that open up during the discussion. As a researcher, I needed to have the PTs think about the issues we were discussing,

and note them down on worksheets since that was what would comprise the data set that I would analyze later. Being torn between facilitating robust discussion and collecting data by suppressing the discussion to give room for writing on the worksheet placed me in a position that may have affected the findings in this research.

Schooling in Kenya. The Kenyan education system is commonly referred to as an 8-4-4 system. This means that students go through eight years of primary school, four years in secondary school, the combination of these being equivalent to the K-12 system in the U.S., and then do a degree course at the university for four years. Students enroll in the first grade when they are 5-6 years old. Since 2003, education at this level has been free and compulsory. At class eight the students do a national examination called Kenya Certificate of Primary Education (KCPE) in five subjects: Mathematics, Kiswahili, English, Science and Social Studies. The examination is graded by the Kenya National Examination Council, and results released by the Minister of Education. The grade that a student gets in this examination, determines if they will advance to secondary school, and also the kind of school they will go to.

In secondary schools, students take 11 subjects in the first two years and select eight of these in the final two years. At the end of the four years, students take a comprehensive national examination Kenya Secondary Certificate of Education (KCSE) that determines if they will get admission to a university, and also the course that they will be admitted to. Once admitted, the students take four years to complete a bachelor's degree certification. Some professional degrees like medicine, engineering and law have an additional year for students to complete professional requirements.

Schools in Kenya are either government owned or managed as private business enterprises. In primary school, the private schools charge the students a fee, recruit and pay their

teachers and usually report better results in KCPE examination. The government owned schools are free and usually overcrowded. There are very few private secondary schools probably due to the high initial cost of providing such a wide curriculum, especially since secondary school teachers are trained in subject specific areas. The few private secondary schools have a very diverse infrastructural capacity, with some set up in exquisite neighborhoods with lavish amenities, and others in make-shift, squeezed up, and dilapidated environments.

The secondary schools are classified into national, county, district and private schools. National schools are well established and have a tradition of performing well. They were mainly set up in the colonial era. These schools are modeled as centers of learning excellence and are allowed to pick the top students from each corner of the country using a quota system. They, therefore, have boarding facilities that host students through a school term. The national schools charge a high school fee to cater for the boarding and maintenance. The county schools admit the next tier of students based on performance. These schools admit students from their respective counties and usually have boarding facilities. The district schools admit students from the areas they are located. They rarely have boarding facilities and students go to school each morning and return home in the evening. Such schools are referred to as day-schools.

Boarding schools in Kenya admit students of the same gender but day schools admit both boys and girls. The government pays tuition fees for all students, and so those in boarding schools only have to pay for boarding. The amount paid in each school is negotiated by the management of the school and the parent's association of that school. Inability to pay the agreed school fees causes students to lose the chance to study in the school.

It is common to have more than one class for each cohort of students. The cohort in each year is referred to as a form. Each year form one students automatically proceed to form two and

so on until they reach form four, when they do the national examination in that school. Some national schools have up to seven streams for each form, while some day schools have one stream. The students sit in a home-class and the teachers go to teach in these classes.

Kenya has a joint university admission service called Kenya University and Colleges Central Placement Service (KUCCPS). When placing students in the universities, the service considers students' preferred courses and the specific admission criteria of each course. Students who do not meet the minimum entry requirements for university may be enrolled in a diploma course, usually a two or three-year certification program in various fields. Primary school PTs are trained in such a program and graduate with a teaching certification called P1. The selection of university courses is done before the KCSE examinations, but revision of selected courses is allowed once the results are released. Once admitted to a certain course, students cannot easily change their majors. Admitted students are eligible to apply for higher education loans that may include living expenses. Students who do not get admitted through this process, or those who can afford to pay for an alternative course other than the one they were placed by KUCCPS, can apply to enroll as privately sponsored students subject to meeting the qualifications set in the department they wish to enroll.

Students enrolled in the four-year bachelor of education program train to teach two subjects at the secondary school level. They study two university level content courses and one education course. Each year, PTs take 12 units, with each equivalent to 36 hours of instruction. The PTs also take one secondary school term (3 months) of field practice usually referred to as teaching practice (TP). During their TP, the university allows, and often assists, the PTs to select schools where they would be comfortable doing their practice. The teacher educators, with assistance from other faculty in the University visit the schools to assess the PTs.

Site of the Study

The site for this study is Central University (pseudonym) physics and chemistry methods courses. Central University is a large university located 23 kilometers from Nairobi city center, the capital of Kenya. The University's main campus sits on an 1100 acres piece of land, and as evidence of robust expansion efforts, numerous new buildings have been completed and others are coming up throughout the University. The first batch of 200 students were admitted to the University to pursue a Bachelors of Education degree in 1972, in what was then a constituent college of another University. In 1978, the University was the only one offering undergraduate and graduate-level teacher-training courses in the country. Eight years later in 1985, it became a full-fledged University and started offering other degrees.

In 2014, the university had over 70,000 students in 18 schools distributed in 12 campuses. Though the actual number of students enrolled in the school of education is not easy to find, the Kenya Bureau of Statistics (KBS), (2014) shows an enrollment of about 30% into the School of Education in the 2013/4 academic year. Central University has more students enrolled in its teacher training program than all the other Universities in the country combined. The collaborating teacher educator for physics and chemistry told me that they have a cohort of 135 and 400 students respectfully in the 3rd year undergraduate subject-methods classes. In this case study, I will focus on the physics and chemistry PTs in Central University doing subject methods course in the academic year 2014/2015. The participants of the study will only include those that complete the pretest, attend the intervention lesson, and complete the posttest.

Statement of the Problem

The challenges that are facing teacher education programs in SSA are identical in many ways. Wanzare (2002) identified and stated the challenges of teacher education in Kenya as: (a) a

wide teacher preparation curriculum that does not offer sufficient time to master the knowledge and skills taught, (b) low enrollment requirements for PTs thereby attracting mainly unmotivated students, (c) over enrollment of students in these teacher training programs, and (d) inadequate teaching and learning resources.

Even as there is increasing awareness of the central role of education in uplifting the individual and societal standards of many nations in Africa (Akindutire & Ekundayo, 2012), large class sizes have been apportioned the largest piece of the blame for the deterioration in the quality of graduates, especially in teacher education programs in SSA. The strain this puts on resources, both financial and human, has negated the efforts aimed at uplifting the quality of graduates from these programs (Mohamedbhai, 2008). In the teacher training programs, teacher educators have had to adopt instructional methods that not only de-emphasize critical thinking and problem solving among the PTs, but also de-professionalize the faculty (Foley & Masingila, 2013). Whenever class size becomes a challenge to the instructors, the most immediate resolution is to rely on lecture methods for instruction. Shulman (1992) argues such traditional lecture and textbook methods breed “inert ideas fated to clog and suffocate good minds” (p. 1) of learners. Studies that focus on teacher education attribute the low quality of teachers graduating from these programs to (a) the predominantly lecture–based instructional practices, (b) examination-oriented teaching culture, (c) obsession with paper qualifications (Hardman et al. 2012), (d) a very theoretical curriculum, and (e) the inadequate supervision of practical field experiences by teacher educators (Akyeampong, Lussier, Pryor & Westbrook, 2013). It, therefore, seems that pedagogical skills are studied for examinations and not for application. This has the effect of creating a large gap between theory and actual classroom practice.

Teaching practice (TP) for prospective teachers has become more problematic with an increase in the enrollments of PTs in teacher education programs in Kenya. Masingila, Ochanji and Pfister (2004) highlighted the complex challenges that PTs face during their teaching practice. First, having good placements is a challenge due to the limited number of high quality, reform-based classrooms available for PTs. Secondly, PTs lack the experience necessary to observe and understand the "complex and rapid interactions" (p. 270) that takes place in classrooms. And finally, being in different classrooms, the PTs lack common experiences upon which to reflect with their peers on their emerging practice.

It is this increase in enrollments, coupled with limited resources, that makes it difficult to expose PTs to authentic and practical learning environments in the field. In designing a strategy that would have a significant impact on the classroom practices of PTs, it is important for teacher educators and PTs to jointly examine the current practices of veteran teachers. Teacher education programs, therefore, may be a promising sites for pedagogical re-designing.

One of the best ways to make the practice visible to novice teachers is through exposure to field experiences (Darling-Hammond, 2006). Limited resources may problematize collaboration with school classrooms as sites for investigation. But the representations and approximations of classrooms can be brought into methods courses through video-recorded lessons. Such lessons can then be prepared as multimedia cases and used as sites for examining and reflecting on teaching practices. The challenge, therefore, is to provide empirical evidence that the use of multimedia cases would be a more effective way to increase the efficacy of PTs.

Purpose of the Study

The main aim of this research was to determine if and how multimedia cases would support the PTs' learning. This was done by assessing the ideas that they notice and attend to

from multimedia cases, the changes in their teaching self-efficacy beliefs, and finally inquiring about what they drew on from the episodes when they went for their teaching practice.

To achieve this, I used a descriptive, mixed-methods study design. I determined the STEB scores before and after using the multimedia cases in a methods course. I used the STEB instrument developed by Enoch and Riggs (1990) that has been validated in many studies (Bleicher, 2009; Hechter, 2011; Swackhamer, Koellner, Basile & Kimbrough, 2009). During the process of viewing the case, I determined what the prospective teaches noticed and/or attended to by tracking their ideas on a worksheet. When these PTs went for teaching practice, I interviewed them to establish if the multimedia cases helped them in their initial teaching experiences, and what specifically they drew on from the MMCs while doing their teaching practice.

Research Questions

The purpose of this research study was to investigate what PTs noticed and/or attended to while viewing an episode of multimedia teaching case. The study also measured if there were changes in science teaching efficacy beliefs (STEB) of PTs who used multimedia cases in methods classes and if these changes were sustained during the teaching practice

The following research questions guided me in the study.

1. What do prospective teachers notice and/or attend to while viewing an episode of multimedia case?
2. What is the effect of a multimedia case-based lesson on the prospective teachers' science teaching efficacy beliefs?
3. What experiences from the multimedia case-based lesson do propective teachers draw on during their initial field experience?

Chapter 2: Literature Review

This study is about the use of multimedia cases with prospective teachers (PTs) in Central University, and the effect of the use of such cases on their self-efficacy beliefs. Central University is a rapidly expanding University and faces the challenge of large class sizes. This literature review will focus on four bodies of literature: (1) attitudes and beliefs of PTs, (2) the use of multimedia cases in teacher development, (3) the development of multimedia cases, and (4) the context of large classes. This review focuses mainly on the studies that have reported an effect on the attitudes and beliefs of teachers.

Beliefs, Knowledge and Behavior of Prospective Teachers

In this section, I discuss the connection between beliefs, knowledge and behavior, and then give examples of studies that have reported correlation of high self-efficacy with student outcomes.

Bandura (1977) stated that beliefs are the best indicators of the decisions that individuals make in everyday life, better than knowledge and motivation. He argued that knowledge alone could not account for the behaviors that are observed in human beings. Teacher education scholars have placed teachers' belief system at the center of understanding teachers' actions in their classrooms (Nespor, 1987; Pajeras, 1992). More specifically, the study of teachers' self-efficacy beliefs has gained recognition as an outcome of teacher education (Bandura, 1986). Gibson and Dembo (1984) argued that there are important behavioral differences between teachers who have different levels of self-efficacy beliefs and therefore posited that the understanding of beliefs is critical to teacher education programs. Other studies on teachers' beliefs and teachers' knowledge concur with the assertion that teachers' beliefs are stronger predictors for their behavior than teachers' knowledge (Ewijk & van der Werf, 2012; Kagan,

1992). Kunter, et.al. (2013), from a study of German 10th grade teachers, reported that teachers' general cognitive abilities are unrelated to their instructional behavior, implying that being a smart student does not automatically make one a smart teacher. Kunter et al. argued that it is the professional-specific aspects of competence that really count when it comes to teaching. They reported positive effects of professional-specific aspects such as, pedagogical content knowledge, enthusiasm for teaching, and self-regulatory skills on instructional quality.

Shulman (1986) isolated a particular type of knowledge - pedagogical content knowledge - that teachers need to have to effectively teach domain specific content to their learners in ways that are appropriate to the students' level. According to Shulman, pedagogical content knowledge is knowledge, "which goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge for teaching" (p. 9). The main focus of teacher education programs is therefore to support PTs in developing this knowledge that, alongside the knowledge of content, teachers need to have to be effective in their practice. The notion of pedagogical content knowledge has undergone a significant re-evaluation that has resulted in modifications that inextricably link it to the context of the learners (Grossman, 1990), the dynamic process through which the subject, context and assessment of learning interact (Magnusson, Krajcik, & Borko, 1999), the day-to-day experiences developed during interaction with the learners (Davis, 2004), and more significantly, the self-efficacy beliefs that teachers assimilate into their instructional repertoire through reflective practices, and which also shape their instructional strategies (Park & Oliver, 2008).

While the training of teachers focuses on acquisition of this specialized pedagogical content knowledge, some scholars have argued that it ignores the fact that teachers' knowledge is "perspective-bound and belief-generated" (Tillema, 1995, p. 292) and what is more vital is the

belief change that is likely to alter the perspectives and orientations of PTs. Kagan (1992) described such beliefs as “tacit, often unconsciously held assumptions about students, classrooms, and the academic material to be taught” (p. 65). Beliefs encompass both attitudes and subjective norms. This makes it difficult to disentangle teachers’ cognitive knowledge from teachers’ individual preferences and opinions on how things need to be (Ewijk, & van der Werf, 2012). Therefore, teachers can gain new knowledge in their methods classes, but still remain greatly influenced by their beliefs, especially when deciding whether they accept the new knowledge and apply it.

Beliefs that teachers hold are formed even before they embark on their teacher training. Shilling-Traina and Stylianides (2013) gave examples of teachers’ beliefs that are prevalent in teacher training and that influence the behavior of teachers, irrespective of the knowledge they have about student learning. When PTs believe that the efforts of students are not very important in their success, they will not focus on creating reading and comprehension skills within the students. Another example is that when PTs believe that teaching well depends on making school work interesting, they will reject as irrelevant parts of their methods course that focus on teaching students to use metacognitive strategies. The most prevalent belief about teaching involves the use of the traditional lecturing approach as a primary vehicle for communicating a teacher’s enthusiasm for subject matter. Such teachers react negatively to ideas for cooperative learning. Prospective teachers bring with them to teacher education these beliefs about the nature of teaching and learning. These beliefs then interact with the content and pedagogy of their teacher education courses to influence what and how they learn (Anderson & Bird, 1995).

The beliefs that teachers bring to teacher education programs are quite resistant to change. Ewijk and van der Werf (2012) argued that it is only if teacher beliefs are proven

unsatisfactory when challenged that the individuals will be motivated to change them. The resistance of beliefs is also espoused in the study by Shilling-Traina and Stylianides (2013), who argued that the main mechanism for such change is the creation of cognitive dissonance that challenges the emotional quality of the held beliefs and provides new information that can be integrated into the individual's belief system to either modify existing beliefs, replace held beliefs with new ones, or develop alternative parallel beliefs.

This view is consistent with the assertion that beliefs are the greatest predictors of behavior (Bandura 1977; Pajeras, 1992). Bandura's social cognitive theory postulates that individuals have the ability to determine their own destiny. This is supported by his observation that human beings have five unique abilities: (1) the ability to symbolize - this enables them to store information in ways that guide their future actions, (2) the ability to plan alternative strategies – this enables them to have forethought and anticipate consequences of actions without engaging in the action, (3) the ability to learn through vicarious experience by observing and selectively engaging in desirable behavior, (4) the ability to self-regulate – this enables them to direct changes in behavior, and (5) the ability to self-reflect – usually by exploring their own cognitions, evaluating and adapting their behavior accordingly. These abilities provide human beings with the means by which they are able to influence their own environment, and by extension, provide teacher educators with the mechanism through which they can influence the beliefs of PTs.

Beliefs are a kind of knowledge that is not easily influenced by reality, but are a better indicator of behavior than knowledge. Nespor (1987) argued that beliefs draw their strength from previous episodes and events, more than from cognitive knowledge. In another study about the structures and functions of teachers' belief systems and spanning two years, Nespor (1985)

described “a critical episode” (p. 165) as a significant factor in creating “retained ways” (p.173) that influence the way that teachers organize their instructional activities, their assumptions about students, and how they see their subject matter. This view complicates the endeavors of teaching pedagogical content knowledge, especially using lecture and examination methods that are prevalent in large classes. Such classes provide few opportunities for analyzing new teaching episodes and reflecting on them. In such cases, passing the examinations may not necessarily reflect the ability to teach well.

The measurement of ability to teach well, especially for PTs in programs that do not have quality field experiences, may lie in a subset of beliefs about an individual’s self-judgment of their own abilities to execute behaviors that have desirable outcomes. Bandura (1977) defined this subset of beliefs as self-efficacy – the belief that one has the power to produce an effect by completing a task or activity related to that competency. For this sub-set of beliefs to effectively impact learners’ outcomes, teachers need to have knowledge and skills of executing such pedagogical approaches, as well as the knowledge of a set of outcomes that result from such an approach. Self-efficacy is therefore said to encompass two constructs: personal teaching efficacy and outcome expectancy (Bleicher, 2004; Riggs & Enoch, 1990).

Some studies that have sought means to measure or improve science teachers’ self-efficacy beliefs have used an instrument called the Science Teaching Efficacy Beliefs Instrument (STEBI) to measure changes in efficacy beliefs after an episode of teacher learning. Onen and Kaygisiz (2013) reported that the self-efficacy beliefs of science teachers from a teacher-training program in Istanbul were good at the beginning, and they increased after doing their first practicum. Knoblauch and Hoy (2008) also reported from their study that teachers’ self-efficacy beliefs increase significantly after students’ teaching. This study found a positive correlation

between the self-efficacy of the cooperating teachers and the PTs, which is in line with the concept of modeling alluded to in the Social Cognitive Theory. The gain in self-efficacy beliefs was not so high when the PTs went for their field placement in more challenging urban schools. This shows that practical field experiences provide an opportunity for PTs to acquire mastery experiences. Such mastery experiences are said to have the greatest influence on self-efficacy (Pajeras, 1992).

Other studies have reported that high self-efficacy is related to a higher level of job satisfaction among teachers and also student achievement (Caprara, Barbaranelli, Steca, & Malone, 2006). Self-efficacy is also greatly influenced by contextual factors, such as the teaching resources available to the teachers, as well as interpersonal support available. These findings have a strong bearing on teacher training environments that have teachers with low morale, lacking adequate resources, and without well-organized support mechanisms for PTs' initial field practice. The authors reported that the absence of mastery experiences for these teachers made the impact of such contextual factors more salient (Tschannen-Moran & Hoy, 2007).

Tanel (2013) reported that physics teachers with low conceptual understanding of the topic, "Force and Motion," reported self-efficacy beliefs that are not correlated with their conceptual understanding of the topics. However, after going through a teaching sequence that improved their conceptual understanding of the topic, the teachers' self-efficacy beliefs were strongly correlated to the conceptual understanding of the topics. This study demonstrated that measurement of self-efficacy beliefs at a certain point in prospective teacher's career may not reflect sound conceptual knowledge of teaching. In other words, the self-efficacy may be high when teachers actually express confidence in incomplete conceptual knowledge.

In summary, the teaching of pedagogical approaches in the methods courses does not guarantee an improvement in teachers' instructional knowledge or behavior. The beliefs that teachers have need to be challenged by creating a cognitive dissonance that will cause them to reflect and adopt more appropriate approaches. The self-efficacy beliefs of teachers reflect their perceived confidence in using an approach that they believe will yield better student outcomes.

The studies on teacher beliefs show that creating cognitive dissonance and modeling of good practices is necessary for influencing teachers' beliefs. Next, I will review some studies that show that multimedia cases can be used to create a cognitive dissonance and can be used as exemplars of practice, characteristics that are vital for belief and attitude modifications, as well as providing vicarious experiences that enhance the self-efficacy beliefs of PTs.

Multimedia Cases in Teacher Preparation

In this section, I first discuss case studies and case methods, and then discuss the conceptual changes, beliefs and attitude modifications that have been reported from studies that use multimedia cases (MMCs). I next discuss the methods that have been used with MMCs, specifically the use of assistive tools in exploring MMCs and the most common analysis frameworks.

Cases and Case Methods

Although using a case study approach has been documented in professional education such as medicine, business and law since the late 19th century, it was not until the 1990s that the use of cases in teacher education began to gain considerable attention (Mersyth, 1991). In 1985, in his presidential address to the American Educational Research Association (AERA), Lee Shulman introduced the idea of using cases in teacher education. He noted that cases represent a "knowledge of specific, well documented, and richly described events" (Shulman, 1986, p. 11).

Shulman (1992) later added that cases are more engaging, more exciting and stimulating, and therefore likely to bridge the gap between theory and practice of teaching.

Mersyth (1996) defined a case as a descriptive research artifact based on a real-life situation that attempts to convey a "balanced multidimensional representation of the context, participants and reality of a situation" (p. 726). Mersyth recognized that cases have gone beyond text representation to incorporating promising innovations, like the use of other media, including video and computers. Such technological innovations allow developers to present the case materials through multimedia or hypermedia.

Written cases are presented in a linearly sequenced text structure, as opposed to hypertext, which is a non-linear environment for organizing and displaying texts (McKnight et al., 1996 cited in van Den Berg & Visscher-Voerman, 2000). Unlike in the linearly presented written cases, there are nodes of information in the hypertext format that are linked in a dynamic manner. Hypertexts have advantages over linear texts in that they encourage more robust exploration of the cases. This enables students to see a sub-task as part of a whole task, while at the same time allowing students to adapt material to their preferred learning style. When audio, video, graphics, or animations are used together with the linear or hypertext media, the case is referred to as hypermedia or multimedia case. Mersyth (1996) used the term multimedia cases to refer to cases presented in a variety of media, and hypermedia to refer to a variety of media linked in innovative ways. The capacity for multimedia to preserve the attributes of a written case, while at the same time involving more than one sense, makes them more promising in holding the learners' attention as well as being more accurate representations of practice (van Den Berg & Visscher-Voerman, 2000).

The pedagogical approach that uses such cases has been referred to as case methods (van Den Berg & Visscher-Voerman, 2000). The terms *case methods, case-based instruction,* and *case studies* have been used interchangeably to refer to the process of teaching with cases. It is important to distinguish the use of the term *case study,* as commonly used in qualitative research, from case methods as envisaged in this study. Creswell (2009) described case study as a type of research that focuses on intensive and holistic description of an event or a social unit. This kind of a case study is a methodological approach, different from case methods – the use of short episodic descriptions of actual or fictional events to represent a teaching situation. Mersyth (1996) defined case methods as the many ways that cases are used in teacher education to frame conversations between mentors and novices, stimulate reflection, and enrich field experiences or orient novices to particular ways of thinking. Shulman (1986) defined case methods as pedagogical techniques employed in conjunction with teaching cases. This reference to teaching cases by Shulman does not discriminate the format in which the brief episodes of teaching cases are represented. Case methods is a valuable and valid pedagogy because it allows students to individually develop their own knowledge bases and pathways on a subject such that it is both relevant and important to them (Levin, 1999).

This study will focus on the use of multimedia cases in teaching PTs, and therefore I am using case methods to refer to the pedagogical approach that uses these multimedia cases as platforms for initiating conversations about teaching, reflection and modeling of teaching practices.

Conceptual Changes in Attitude Towards Teaching

In the following section, I discuss some of the studies that have reported conceptual changes towards teaching, and beliefs and attitude modification of PTs following the use of MMCs in methods courses.

Research on the use of MMCs with PTs has shown promising gains in equipping novices with skills to meet the demands of 21st century classrooms. Various studies have discussed how the use of cases has shaped the epistemological evolution of professional knowledge and skills as well as the beliefs of professionals. For example, MMCs have been reported to cause cognitive dissonance that is prerequisite for conceptual change and attitude modification (Fitgerald, 2011; Koury et al., 2009; Pfister, White & Masingila, 2006), lead to acquisition of knowledge and skills (Malesela, 2009; Thomas & Reid, 2011), as well as scaffolding the debut classroom teaching (Fulei, 2010; Masingila & Doerr, 2002). Other studies reported an increased transfer of theory to practice (Bencze, 2009; Firtgerald, 2011; Masingila, Ochanji & Pfister, 2010).

Fitzgerald et al. (2011) followed PTs who utilized MMCs during their course work in preparation for teaching students with emotional/behavioral disorders (EBD). The purpose of the study was to examine the extent to which knowledge, problem-solving skills, and attitudes and beliefs gained through teacher preparation programs were maintained following course work with cases and transferred to classrooms with students having EBD. From the semi-structured interviews, and the standardized concept maps that the participants created pre instruction, post-instruction, and at the end of each of the semesters, analysis revealed that conceptual changes on teaching attitudes occurred between pre-instruction and the first follow-up stage. These changes were maintained for at least one year into practice. Participants reiterated these changing attitudes and dispositions during interviews, and linked these changes to learning from the cases.

Malesela (2009) investigated how trainers in South Africa used case studies to facilitate critical and reflective thinking and lifelong learning. He found that the use of cases fostered appropriate personal and professional attitude modification. He asserted that the case methods encouraged students' involvement and provided substantive data essential to analyzing a specific

situation while allowing them to recognize the complexity and the ambiguity of the real practical environment. He concluded that cases have the capacity to improve the acquisition of knowledge, skills, and attitudes as well as extend the applications of these to practice.

Pfister, White and Masingila (2006), drawing on Belenky et al.'s (1997) work, grouped PTs' "ways of knowing" (p. 948) into four categories: absolute knowing, transitional knowing, independent knowing and contextual knowing. Their study focused on 36 PTs who were engaged with two different MMCs: one on class instruction and the other on classroom management. The findings showed the PTs shifted towards independent and conceptual ways of knowing, which was evidence of greater confidence in themselves and their teaching methods. The study also posited that if the PTs were to make meaning from their experiences together, then they required common experiences on which to build the shared and heightened understandings. MMCs were seen as a powerful tool for teacher educators to provide their students with these common experiences. The authors recommended that, as an instructional practice, teacher educators should design opportunities for PTs to discuss classroom events among their peers with the guidance of a facilitating teacher educator. Otherwise, on their own, the PTs reverted to the absolute and transitional knowing realm, which the authors considered as displaying lower confidence in themselves and their instructional practices.

Prospective teachers' initial teaching experiences can be scaffolded through the use of MMCs (Fulei, 2010). Conducting initial teaching practice by injecting PTs straight into schools where they experience teaching and learning contexts is comparable to teaching people how to swim by throwing them into the deep end of a swimming pool. The study by Fulei postulated that, in such a case, the PTs, in order to survive, will adapt to traditional perspectives and practices – mainly teaching the way they were themselves taught. Fulei suggested that PTs can

learn how to teach by first observing practicing teachers through a MMC, a safe environment that will allow for observations, reflections and discussions of teaching practices in a community. These engagements via MMCs are a meaningful and critical opportunity that, like in Pfister et al. (2006), needs to be facilitated by a teacher educator.

Koury et al. (2009) reported moments in their study when learners' instincts were enhanced by using methods that deconstructed previously held beliefs. Their research entailed profiling courses that used case methods and then evaluating the relationship between the time PTs spent working with cases and learning outcomes. They reported positive correlation between the amounts of time spent working on the case and the resulting cognitive dissonance that preceded the change in beliefs. Lundeberg (1999) also said that using MMCs led to metacognition about practice among PTs that caused them to re-examine their own beliefs and therefore achieve epistemological growth.

Thomas and Reid (2011) sampled over 20 journal articles whose research involved a collection of 625 participants. They sought to explore how to effectively operationalize cognitive learning theory and blend it with emerging technologies. The study found that when case methods were used there was a higher mastery and understanding of the jargon used in teacher education programs. The videos presented a challenge to students' thinking and created cognitive dissonance, which the authors noted as a prerequisite to conceptual change. The study reported superimposition of beliefs on already existing ones, as participants were unable to accommodate the challenges purposefully posed by the videos. Through the use of cases, there was a conceptual change, with participants revising their thinking about classroom management from largely punishment-based, negative reinforcement strategies to proactive and positive behavior reinforcement strategies.

In summary, these studies show that when MMCs are used with PTs, their conception about teaching, their attitudes and beliefs are shifted towards a more meaningful understanding of classroom practices.

Multimedia cases and knowledge acquisition. I now discuss some of the studies that show how multimedia cases have led to acquisition of teaching knowledge, and highlight the aspects of case methods that are required for effective teaching by discussing the facilitation tools that have been used in some studies, as well the theoretical underpinnings of some frameworks that are used to direct the focus of PTs.

Apart from being used to shape the teaching practices of PTs, Masingila and Doerr (2002) reported that cases could also be used to analyze and assess the emerging practices in the professional development of PTs. This, they argued, is necessary for reinforcing beliefs and practices that will be practiced in the field. In their case study with nine prospective mathematics teachers who had enrolled for a joint seminar concurrent with their student teaching, Masingila and Doerr reported that the shared experience led the PTs to focus on more complex issues above ordinary classroom management, and to refer to the lessons from the multimedia case to support the analysis and reflection of their own practice. The PTs were also able to frame, adapt and extend the knowledge they learned from the cases to practice.

The use of cases by teacher educators has also been described as the boundary agent that bridges the gap between the representation of the practice and the actual practice (Bencze, 2009). This assertion was made from observation that the probability of PTs implementing what they have learned when cases are used is higher than when traditional methods are used. These findings are from a study of a professional development workshop that used a series of cases designed around a concept with which the teachers experienced difficulties. The PTs made

positive comments from their reflections and were self-critical and enthusiastic to improve on their practice going into the future. The main observed trend after the workshop was an increase in the adoption of the teaching strategies demonstrated in the video cases. This shows the potential for MMCs to act as a less intimidating and effective strategy for showcasing teaching, deconstructing previously held beliefs, scaffolding emerging teaching techniques, acquisition of new skills, and anchoring innovative strategies.

Multimedia cases promote acquisition of appropriate pedagogical knowledge and skills in ways that are practical and visible. To illustrate how cases are able to achieve this, van Es and Sherin (2002) developed a framework for Learning to Notice from analyzing the feedback from teachers watching a video lesson. The framework is consistent with reform agendas in the education sector, which has at its core the ability of teachers to actively notice and value the presence and contribution of students in classrooms.

The concept of teacher noticing as used in the framework, is a domain specific reference to Goodwin's (1994) idea of professional vision. Goodwin described professional vision as the specific ways that members of a profession develop perceptual frameworks that enable them to view complex situations in particular ways. Teacher noticing is the professional vision that determines the way that teachers selective isolate and attend to some activities from rapidly changing multiple interactions in a teaching and learning episode. van Es and Sherin (2002) argue that the interaction of teachers and students should involve listening to each other carefully, and that the teacher ought to adapt instruction based on the ideas that students have. Teacher education programs, according to van Es and Sherin, need to, not only focus on showing teachers how to act, but also show them how to interpret classroom interactions and adopt flexible instructional strategies in their classrooms.

In their framework, van Es and Sherin (2002) posited that noticing espouses three areas:

a) Identifying what is important or noteworthy about a classroom situation and making what they described as a "call out" (p. 573). This skill involves selecting from the many interactions in class what is important for a particular learning environment and focusing on it.

b) Connecting such classroom interactions to the broader principles of teaching and learning that they represent. This ability to connect specifics to broader principles is what delineates novices and experts.

c) Applying what one knows about the context to reason about the classroom interactions. This implies that noticing is contextualized, and what one knows about the subject matter, students' thinking and local context influences what and how they notice and react.

In developing the framework, van Es and Sherin (2002) gave a rationale for their decision to use video. They explained that videos offer a permanent record of classroom interactions. They therefore can be reversed, paused and replayed, offering the opportunity to look at each segment with different perspectives. Furthermore, the videos can also be collected and edited in different formats depending on the area of focus, be it the teacher, specific student interactions, or focusing on a single learning behavior. When using videos with teachers, the teachers are able to remove themselves from the demands of classroom and focus on teaching and learning. Similar views were expressed in a study by Bloomberg et al. (2013), who demonstrated that videos make practice available to novices in manageable chunks and provide a cushioned view into the complex classroom practices without the strenuous demand of responding to teaching situations in real time.

Other researchers have used the concept of noticing using strategies to guide novices through the interactions in the videos. van Es and Sherin (2002) developed a software tool called *VAST* (Video Analysis Software Tool) to scaffold teachers' attempt to notice interaction in their own classes. The tool is in the form of an interactive layered page with tabs that are subtitled to prompt teachers to look at (a) students' thinking, (b) the teacher's role, and (c) discourse in the class. The selection of these three prompts is due to their importance in reform pedagogy. On each of the tabs, the tool further prompts the teachers watching the video to write what they notice, provide evidence by marking the video or attaching the transcript of the video segment, and then interpret the events they notice. The authors argued that using a scaffolding software tool, such as the one they designed, helps teachers gain larger incremental progression in their ability to notice noteworthy interactions in class, interpret such interactions and reason about them using what they had learned about pedagogy during their university classes.

In another study, Brantley-Dias, Dias, Frisch and Rushton (2008) used a tool called the Critical Incidence Reflection (CIR) protocol that engages the observers in identifying critical incidents that the authors described as the "oops," "ouch," "aha," or "oh" moments during a teaching episode (p. 4). These moments reflected the point when there was something amusing, annoying, typical or atypical. It therefore allowed the participants more leeway to watch a lesson and independently identify the moments to which they want to attend. The moments that interest teachers is what is referred to as a "call out" in Sherin and Han (2004). Participants were then asked to write a detailed reflection on the selected moment from the point of view of all the actors (students and teachers) and finally linked these up with the National Science Teachers Association Standards (National Science Teachers Association, 2003).

Stockero, Zoest and Taylor (2010), in a study involving beginning mathematics

secondary school teachers, used the concept of a Pivotal Teaching Moment (PTM) to describe the idea of noticing. Their study acknowledged that there is a cognitive demand of noticing as described in vans Es and Sherins' (2002) Learning to Notice framework that increases as teachers gain more expertise. They based their choice of beginning teachers on the fact that novice teachers have a slower response time—slow enough that, although the thinking process itself would not be visible, the fact that they were making a decision would be. They, therefore, sought to identify moments when the beginning teachers modified their instructional practices. These researchers identified the PTMs as the instances that there was (a) a verbalized attempt by the students to make sense of the content being taught, (b) an erroneous or contradictory deduction by students, and (c) apparent confusion among the students. The spectrum of the decision that the teachers in the videos made ranged from ignoring or dismissing it, to using it as an opportunity to extend or enhance the planned lesson. From viewing the video teacher's decision, the PTs learned that a teacher's decision could have an impact that spans the whole spectrum from significantly increasing student-learning opportunities to having a negative impact on students' learning.

To establish if viewing MMCs results in meaningful teacher learning, van Es and Sherin (2002) identified three stances that can be taken by PTs as they discuss MMCs: describing, evaluating and interpreting. These stances progress in the listed order as teachers gain more experience and expertise in noticing classroom interactions. McFadden, Ellis, Anwar and Roehrig (2014) stated that using expert teachers in videos provide novice teachers with tacit knowledge of expert teachers rather than provide then with reflective and analytic skills. They argued that it is important to understand the contexts that underlie the decision that the video teacher makes. They, therefore, proposed to modify the stances proposed by van Es and Sherin to

include a fourth element: explain. This addition becomes necessary for the unique situations where: (a) the teachers viewing the videos have no prior knowledge of the context of the lesson, (b) the group of teachers discussing the video did not watch it together, and (c) the situation where the knowledge available to the video teacher is different from that which is available to the teachers watching the video.

This concept of teacher noticing is similar to what Blomberg, Sturmer and Seidel (2010) referred to as professional vision. Their reference to this term was based on what Godwin (1994) described as the socially organized way of seeing and understanding activities of a teacher, which is a critical part of teachers' expertise that should be developed during teacher education. For teaching, professional vision involves two main processes: (1) noticing important interactions in classroom activities, and (2) knowledge-based reasoning about the interactions. Studies that have used MMCs to develop teachers' noticing have reported a progression on the levels of noticing that follow these two processes.

McFadden, Ellis, Anwar and Roehrig (2014), in their study using video annotations as a tool for developing reflective practices with novice teachers, found that novice teachers adopt lower levels of reflective stances when they view MMCs developed by veteran teachers. They categorized novice teachers' comments as descriptions and explanations. The majority of the novice teachers focused on the video teachers' actions and not students' learning. The reason given for the lower stances was that the teachers lacked a face-to-face interaction with each other during the process of viewing the videos. This implies that joint peer evaluation of videos would result in higher level reflective stances. Also, they reported that they did not share any context of the videos and so the novice teachers did not know the students' backgrounds, the video-teachers' plans, and other contextual details that would be evident from watching the videos.

In another study, Sherin and Han (2004) focused on the professional development of in-service middle school teachers using yearlong video club meetings. Though they had the teachers record the videos in their own classes, the authors noted that learning with videos did not depend on whether the videos were actually recorded by the teachers viewing them or not. Teacher noticing was reported to shift over time in its focus, from discourse on teachers to discourse on students. The authors also reported that the discussion of students' ideas also grew more complex and detailed as time went by. They reported that the discourse on students' thinking eventually focused on the pedagogical issues in mathematics learning. The authors, therefore, claimed that the learning that occurred in the video clubs could be "characterized as development of teachers' professional vision" (p. 179), implying that the teachers were able to attend to particular kinds of events in the classroom and reason about these events in particular ways that were seen as supporting the reforms suggested by mathematics educators.

In the same study by Sherin and Han (2004), the role of the facilitator in steering the locus of discussion from focus on the teacher to focus on the students and to pedagogical implications for the students' thinking was evident. In the beginning, despite prompts by the facilitators, the teachers in the video club kept reverting back to the teacher's actions and alternative pedagogical approaches that the teacher could have used even when prompted to focus on the students' thinking. The videos were, however, seen by the researchers as the catalyst for learning by providing the teachers with a new kind of access to classroom interactions.

The study is consistent with van Es and Sherin's (2003) assertion that scaffolding participants' observations is important in moving what they attend to from teacher actions to student thinking. The study required the teachers viewing MMCs to make comments for each of the stances – describe, evaluate and interpret – and placed the interpretive stance at a superior

level of professional knowledge than both the descriptive and evaluative stances. The interpretive stance became more prevalent in later observation sessions as the year progressed.

Levin and Richards (2011) demonstrated that when noticing strategies are inculcated in teacher education programs from the onset, PTs have the potential to make and reason about meaningful observations of classroom videos. In their study, classroom videos and students' written work from previous cohorts in the teacher preparation program were used to understand what teachers attend to in class, as well as show how it impacts students' learning. The PTs were introduced to understanding students' reasoning through these videos, as well as students' written work, before being asked to analyze their own records (their videos and students' work). Levin and Richards reported that while preparing their own lessons, the PTs' lesson plans bore the students' ideas in mind and they were also able to attend to students' thinking from the beginning. During analysis of their videos, the PTs' reasoning became more sophisticated as time went on and eventually they could regulate their own discussion. This suggests that PTs can identify, interpret and evaluate students' thinking when pedagogy courses are designed to draw their attention to this concept from the outset.

One other way that PTs have been scaffolded to attend to both teacher actions and students' thinking is by the use of two video cameras, one focusing on students and the other on the teacher. Snoeyink (2010) reported that after PTs watched videos of themselves and their students, they strongly believed that it was an effective tool to help them notice classroom interactions. This kind of noticing was described as increasing the "withitness" (p. 101) - the ability of a teacher to have a keen awareness of what's going on in the classroom, notice signs of understanding or confusion, respond to individual students personally and directly, and make students aware that he or she knows what's going on. The PTs also noted that the video analysis

helped them look at their instructions from the students' perspective. While the study reported the video analysis acted as a means to notice and reduce annoying mannerisms and improve classroom management, a primary finding was that the PTs were able to notice how well students understood and thereby became more conscious about their actions.

Caution when Using MMCs

Using MMCs requires different kinds of teaching and learning resources as well as a different teaching approach. This may complicate the use of case methods among educators and learners. Shulman (1992) posited that cases are complicated, expensive and time-consuming to produce. Van den Berg and Visscher-Voerman (2000) noted that richly described cases might lead to cognitive overload if the reader must process too much information at one time. They, therefore, advocated for less complicated cases whose design includes the role of the teacher educator, the particular tasks of the PTs, as well as the relationship of the case methods lessons with other theories of learning so that there is optimal use of the cases.

Shulman (1992) further observed that case-based instruction is a difficult teaching approach that requires teacher educators to be willing to invest longer periods of preparation time than is typical for most other methods. It also requires a change in beliefs and practice of many teacher educators, as it removes them from the center stage into a position of partnership with students. Shulman noted that cases are inefficient in terms of taking a long time to cover little content. They also are susceptible to overgeneralization, especially when they are seen as demonstrations of desirable teaching practices to be copied and applied as they are.

van Den Berg and Visscher-Voerman (2000) noted that multimedia cases are more difficult to use compared to text and hypermedia because of the technological requirements. Their effectiveness is not supported by as much research as is available for text cases, and the

rich details therein may make it difficult for PTs to “see the wood for the trees” (p. 123). Though multimedia cases cover less content over a long time, there are arguments made for the benefits of in-depth coverage and understanding of the teaching skills over superficial and wide coverage of pedagogical theories.

These studies show that using MMCs results in a cognitive conflict in PTs that is prerequisite for attitude and belief modification. MMCs are also sites for acquisition of skills and knowledge about teaching. Various assistive tools, alongside the facilitator, have been used to help the PTs notice and focus on the rapid interactions in classrooms that are important teaching moments. The use of MMCs, however, requires more elaborate preparation by the teacher educators.

Development of Multimedia Cases

In this section, I discuss the important considerations when designing multimedia cases for instructional purposes. I also summarize Mayer’s (2001) Cognitive Theory of Multimedia Learning, which is an important design consideration.

Merseth (1996) divided cases into three main categories based on the different intentions behind their development: (1) exemplar cases that serve to highlight a principle, a theoretical point of view or an instructional technique, (2) cases that provide opportunities to practice analyses and contemplate action, such as cases that are mainly problematic situations requiring analysis, problem solving, decision making and action, and (3) cases that are stimulants to personal reflection that are mainly developed for personal study and self-reflection. This implies that cases can be designed to take the form of both examples and non-examples to use in methods classes, as well as self-recordings of practice to serve as artifacts for reflection.

Irrespective of the purpose, the cases need to be instructional artifacts that highlight the desired learning points.

Kim et al. (2006) selected and analyzed 100 cases in multiple fields, such as medicine, law, teaching and business (among others) from which they developed a conceptual framework for evaluating cases. Their framework described the attributes of a good case that need to be taken into account when developing or analyzing the appropriateness of a case segment. The attributes are: (1) relevant, (2) realistic, (3) engaging, (4) challenging, and (5) instructional.

Relevance refers to the capacity of a case to sustain interest and motivation to those using it. This is achieved by targeting an appropriate level of learners and considering their backgrounds and the diverse scope of their needs. Relevant cases effectively address the congruence of a learner's goals and the instructor's goals. The setting of the case should be as authentic as possible so that PTs can identify themselves with the context.

Realistic cases are those that approximate a real-world scenario as much as possible. This eases the transfer of skills acquired in one setting to another. Making cases realistic is achieved by incorporating the kinds of tasks, knowledge and problem-solving skills that teachers are likely to need in the field. For example, cases that focus on a topic that is taught in the levels that the PTs will teach may be seen as realistic.

Kim et al. (2006) also suggest that cases are engaging when they have multiple options and perspectives and when the outcomes of a case depend on the prospective teacher's actions. This may be challenging for video cases that are not interactive but can be accomplished in hypermedia.

Cases should be challenging to the learners. This can be as a result of the perceived degree of content difficulty, absent information or ambiguity of interpretations. Prospective

teachers can also be presented with unusual cases or cases whose structure is varied. Kim et al. (2006) suggested presenting multiple cases in a series to either represent developmental trajectories or to reinforce specific episodic features. In doing so, they argued that cases would be perceived as challenging to the learners.

The instructional attributes of a case refer to the capacity for the case to build upon PTs' prior knowledge, a strategy that is often dependent on facilitation. This attribute also implies that cases should have an assessment mechanism where PTs' learning can be tracked either by self-reporting or evaluation of their responses by the instructors. Just as with assessment practices that require feedback, cases should essentially incorporate some form of feedback from the instructor. Instructional cases also need to incorporate some teaching aids like facilitation notes, facilitation guides, lesson background, lesson plan and a display of some of the students' work.

Kim et al. (2006) work focused on making cases more effective. Multimedia cases easily achieve these attributes when they are filmed in authentic situations, and when clips are selected and presented in a way that supports the needs of the methods courses. The specific ways that the use of multimedia cases are different from written cases with respect to being effective tools for learning, can be understood from Mayer's (2001) work on the Cognitive Theory of Multimedia Learning.

Mayer (2001) developed the Cognitive Theory of Multimedia Learning to explain how people learn from presentations that have both visual and auditory streams of information. In this theory, he described multimedia as the representation of a message using both pictures and words. The words can be spoken or written, while the pictures can either be static or dynamic. When used for learning, Mayer described three possible outcomes from the use of multimedia learning: no learning, rote learning, and meaningful learning. These levels of learning are

assessed by retention and transfer tests. Retention tests focus on recall and recognition, while transfer tests focus on testing understanding and the ability to apply the knowledge to solve problems that are not explicitly stated in the presented material. Mayer described no learning as the situation where there is both poor retention and poor transfer. Rote learning is when there is good retention, but poor transfer, while good retention and good transfer characterize meaningful learning.

To promote meaningful learning, Mayer argued that cognitive activity, rather than behavioral activity, plays a more significant role and so when designing MMCs the focus should not be on making cases more hands-on, but rather on priming the appropriate cognitive processing activities. Mayer proposed a cognitive learning theory based on three cognitive science assumptions: (1) the human information processing system has dual channels – the auditory and the visual channels of information processing, (2) each of these channels has limited capacity, implying that humans are limited in the amount of information they can process at a particular time, and (3) humans engage in active learning by attending to relevant incoming information, organizing it into coherent mental representations and integrating the mental representations with other knowledge (see Figure 2.1).

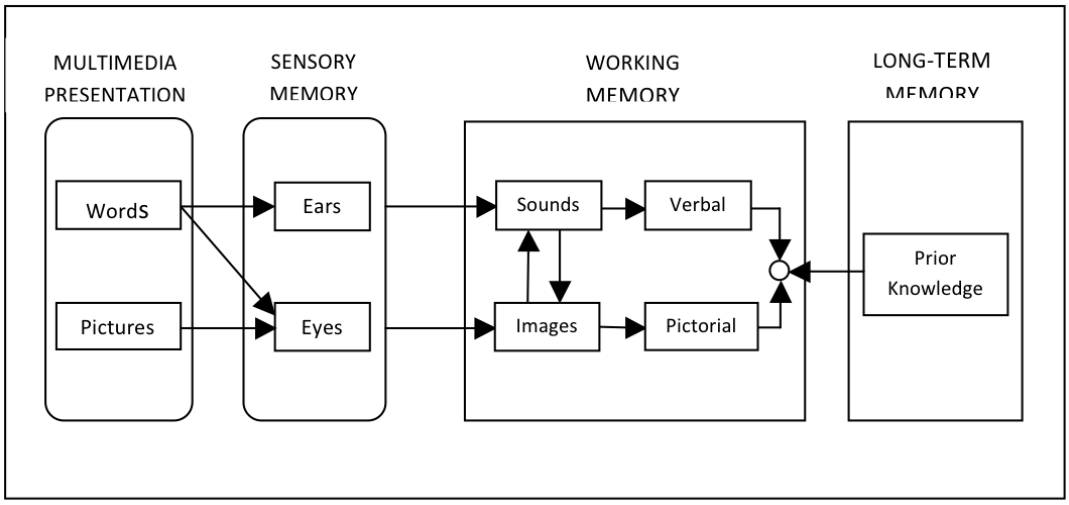


Figure 1.1: Visual Representation of the Cognitive Theory of Multimedia Learning (Adapted from Mayer, 2001, p. 47)

Based on these assumptions, Mayer's cognitive theory of multimedia learning stipulates that for meaningful learning to occur in a multimedia environment, learners must engage in the following five cognitive processes:

a) Selecting relevant words for processing in the verbal working memory. This process starts from the auditory system when spoken words are received or from the visual channel when on-screen words are read. The sensory representations of these words are then changed to knowledge representations in the working memory. Processing limitations at this point determine the prioritization of selected words based on their relevance.
b) Selecting relevant images for processing in the visual working memory. This process starts from the visual system receiving sensory images and then changing them into an internal representation of the visual images in the working memory. This process is also characterized by selectively picking what is relevant and ignoring what is not relevant.
c) Organizing the selected words into a verbal mental model. The input for this step is the

word or sound base - the selected words from the media, and the output is a verbal model - a coherent representation in the learners working memory.

d) Organizing the selected images into a visual mental model. This means that learners organize, from the incoming image base a coherent representation of a picture/video mental model.

e) Integrating verbal and visual representations as well as prior knowledge. This is the most important step in the learning process. The output for this step is an integrated model. It involves the integration of both the visual model and the verbal model with the relevant existing knowledge from the long-term memory. The drawing of information from the learner's knowledge base is seen as a very crucial step in making sense of the multimedia presentation. These processes do not necessarily occur in the order presented.

From these steps, Mayer suggested some design principles for MMCs. First, he suggested that students learn better from words and pictures than from words alone (multimedia principle). The learning is better when the words and the pictures are close together (spatial contiguity principle), simultaneous rather than successive (temporal contiguity principle), without extraneous information (coherence principle), and when words are spoken rather than written (modality). Mayer further pointed out that these design effects are stronger for "learners who have low rather than high prior knowledge, as wells as for learners who have high rather than low spatial abilities" (p. 189).

The framework for the attributes of good cases by Kim et al. (2006), as well as the Cognitive Theory of Multimedia Learning by Mayer (2001), have been incorporated in the design of the multimedia cases used in this study, as well as the design of the intervention for using the case method.

The Context of Large Classes

In this section, I discuss the context of large classes in general, and then explain the enrollment situation in Kenya. This will help illuminate the context in which the multimedia cases will be used.

There is no clear definition in the research literature on what can be called a large class. Some studies have attempted to assign a particular number of students to demarcate small and large classes. Glass and Smith (1978) distinguished between large and small class size based on the student population above which there was a change in achievement scores. They roughly categorized a class size above 20 as large in the context of United States (U.S.) elementary schools. Harfitt (2012) categorized a large class as one having more than 40 students using a similar criteria. These studies focused on students at different developmental levels.

Foley and Masingila (2013) reported large classes within SSA universities as having between 400-1,000 students. Some other studies have used the concept of instructor-student ratio as a measure of class size (Mohamedbhai, 2006; O'Sullivan, 2006). Policy documents in Kenya give recommendations of class size based on instructor-student ratio (Commission of University Education (CUE), 2014). Hourigan's (2013) reference to a large class as one with such a large number of students that it is not possible for an instructor learn all their names in one semester, though somewhat hilarious, is a reasonable expression of the amorphous depiction of large classes. In Sub-Saharan Africa universities, it is not uncommon to find introductory classes with 1,000 students. Mathematics and science methods courses in Central University have between 135 and 400 students taught by one teacher educator per course. The large class size is a product of a gradual process of education financing reforms that is typical for most universities in SSA. (Banya & Elu, 2001).

Sub-Saharan Africa governments started experiencing the problems of rapid increase in student population in higher institutions after the World Bank and International Monetary Fund (IMF) introduced structural adjustment programs (SAPs) that consequently decreased direct foreign funding to government budgets. The cost sharing policy introduced during these SAPs forced governments to decrease funding to universities, and the universities in turn sought ways to share the financial burden with their students. Most governments, at the same time, also required universities to broaden access to higher education in a bid to boost the skill levels of the respective nation's work force.

In Kenya, these changes were also accompanied by a new development in 2003 that the president of the country was no longer the ostensible head of all public universities. This heralded an era of greater autonomy, growth of knowledge, new patterns of funding, as well as an increased pressure for internal accountability (Mugenda & Mwangi, 2014). Kenyan universities responded by increasing enrollments of the fee paying students. The high enrollments necessitated opening new constituent colleges and campuses, especially satellite campuses situated in the catchment areas of the fee-paying students. These developments further compounded the problems with large classes by introducing challenges of governance, regulation and management (Gibbs & Jenkins, 1992; Hayward, 2006; Newman 2013). The hiring of faculty members has not kept pace with the rate that the enrollment is increasing (Mohammedbhai, 2008). This means that the students' population is increasing disproportionately with the teaching and learning resources, especially the human resource.

The first teacher education program in Kenya began in 1964 at the University of Nairobi's constituent college called Kenyatta College (Kafu, 2011). The first professional teaching degree (Bachelors of Education) in Kenya was offered starting in 1970. In keeping with

the trends in many SSA countries after independence, the Kenyan government appointed commissions that made recommendations that focused on making the education system more relevant and accessible (Abagi, Nzomo & Otieno, 2006). In higher education, the enrollment was not large at the beginning. For example, there were 570 undergraduate students and three graduate students in Kenya's only university at independence in 1963. By 2000, there were 50,000 undergraduate students and 5,000 graduate students enrolled in six universities (Gudo, Olel & Oanda, 2011). In 2014, about 325,000 students were enrolled in over 40 universities (see Figure 2.2). In 2014 alone, enrollment at the universities rose by about 35%.

To date, there are 22 public universities, 17 chartered universities, 12 universities with Letters of Interim Authority (LIA), and two registered private universities in Kenya. Among these, there are over 40 approved academic programs that train teachers and offer a bachelors certification (CUE, 2014). Though there are guidelines for the kind of degrees offered in each university, there is no regulatory professional body that monitors the standards of teachers graduating from the teacher education programs. This has implications for the quality of teaching, the nature of teacher education curricula, as well as the present image of the teaching profession in the country (Kafu, 2011). Kafu further noted that the status of facilities and resources used in these programs is not adequate for the skill levels desired of the graduating teachers. Beginning teachers in Kenya experience challenges fitting into the classroom, and they mainly blame this on their teacher preparation program (Indoshi, 2003).

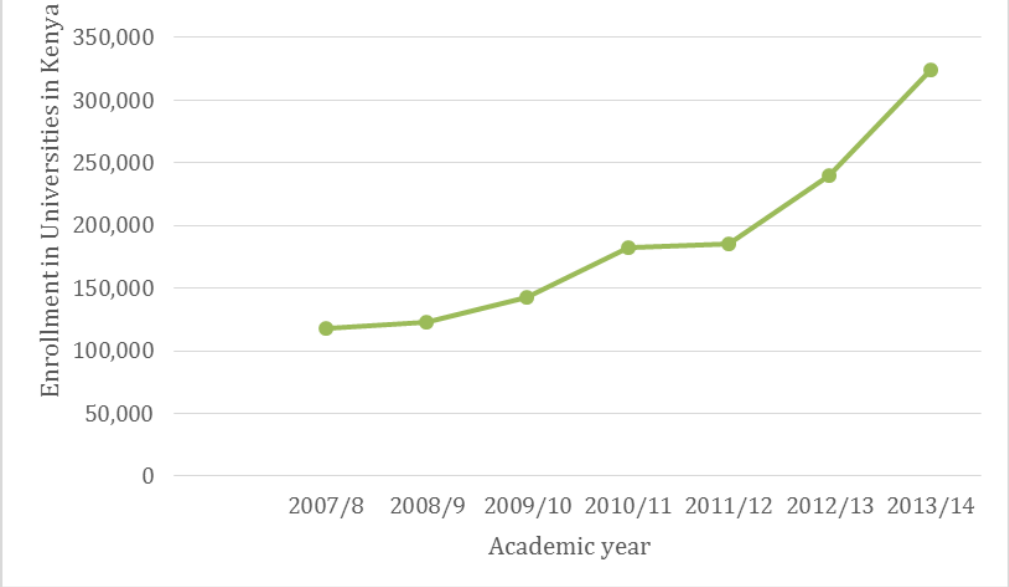


Figure 2.2: Enrollment trends in Kenyan Universities between 2007/8 and 2013/14 (Kenya Bureau of Statistics, 2014).

Teaching practice (TP) for PTs (PTs) has become more problematic with an increase in the enrollment of PTs in teacher education programs. According to the Kenya Bureau of Statistics (2013), there were 34,660 PTs enrolled in teacher education programs in the year 2011/2012 in Kenya. Approximately half (17,993) of these PTs are at Central University. Assuming that the students would be distributed equally through each of the four years in the teacher education program, a quarter of these students would seek teaching practice placements in the 8,800 secondary schools in Kenya (Kenya National Bureau of Statistics, 2014). Due to infrastructural challenges, half of these schools are not accessible to supervisors. This means that the cohort of PTs seeking placement into classrooms to do their teaching practice each year from just one university is beyond what the secondary schools that are appropriate for training in Kenya can effectively and efficiently absorb.

To cope with these numbers, universities adopted systems that maximized the time and space available. The academic year that usually had three semesters was shortened to have two semesters, and a long holiday for the students. The holiday allowed the university to admit

another cohort to start their semester, in a move christened “marathon” learning (Kafu, 2011). It is rare to have refresher courses, or recess or sabbaticals for the faculty members. The infrastructure is overloaded, as many students compete for the reading space and materials in the libraries, and faculty members strain to put up with the tasks of teaching large classes. This rapid increase in the number of universities has been seen as one of the causes of the decline in quality of higher education (Indoshi, 2003; Kafu, 2011).

Studies that focus on teacher education attribute the low quality of teachers graduating from these programs to the predominantly lecture–based instructional practices, examination oriented teaching culture, obsession with paper qualifications (Hardman et al. 2012), a very theoretical curriculum, and the inadequate supervision of practical field practice by the teacher educators (Akyeampong, Lussier, Pryor & Westbrook, 2013). It seems that pedagogical skills are studied for examinations and not for application. This has the effect of creating a large gap for PTs between theory and actual classroom practice.

Multimedia cases have the ability to bridge the gap between theory and practice, as well as provide approximations of practice. This may provide a practical way to mitigate the challenges that teacher education programs face. The rate at which the enrollments are increasing means that more creative ways have to be explored to expose the PTs to the increasingly complex classroom practices.

Summary

In summary, the education system in SSA is characterized by a demand that exceeds the capacity of its institutions. The resulting large classes have compromised previous attempts to adopt more robust pedagogical practices. There are insufficient resources to meet this demand for education, and at the same time improve the quality of learning in institutions in SSA. The teachers that graduate from the teacher education programs are inadequately prepared for

teaching since even the teacher education programs themselves have infrastructural challenges due to large enrollments. These beginning teachers revert to teaching methods that are not appropriate for the 21st century classrooms, mainly teaching the way they were themselves taught.

Teachers hold beliefs about teaching and learning that are resistant to change. These beliefs are the strongest indicators of teacher behavior. Prospective teachers without prior field practice experiences are yet to have mastery experiences that would reinforce their beliefs. This makes teacher education programs suitable sites for modeling appropriate teaching and thereby reinforcing appropriate beliefs about teaching and learning. Modeling teaching practices creates vicarious experiences that increase the self-efficacy of PTs. Teachers with high self-efficacy show a strong will to succeed even when faced with challenges.

Multimedia cases have been shown to cause a cognitive conflict that is prerequisite to beliefs modification. MMCs are a safe and appropriate site for PTs to jointly reflect on their emerging practice, acquire new skills and challenge existing beliefs about teaching and learning. The considerations that are made when creating cases to make them more instructional, as well as the tools that can be used to facilitate MMCs, have been considered in this review. In this study, MMCs were presented to PTs in one teacher-training program in Kenya, and the changes in their self-efficacy, as well as the effect of these changes on the teaching practice experiences, were studied.

Chapter 3 Methods

I used a descriptive mixed-methods research design for this case study. The participants were secondary school science prospective teachers (PTs), specifically those studying at Central University to become chemistry or physics teachers. I collected data through questionnaires, field notes, and interviews, and analyzed the data using quantitative and qualitative methods.

Research Methodology

In this section, I will provide a rationale for using a descriptive mixed-method research methodology. First, I explain my goals in the study, and how these goals are achieved by combining both quantitative and qualitative methods. Then I explain the ideas espoused in each of the research approaches, and finally, I explain why I used mixed-methods.

In this study, I used multimedia cases in methods classes that had not used such cases before. My goal was to investigate if using such cases would make the PTs better prepared to teach. I also wanted to gain insights into the new instructional strategy- multimedia case-based teaching. Therefore, I formulated three research questions. The focus of the first question was the ways that PTs engage with the videos. I collected data using a worksheet that I asked them to write on during the lesson. The focus of the second question was to reveal if such ways of engagement better prepared PTs to teach. To answer this question, I measured quantitatively, their changes in their self-efficacy beliefs. The third question was to confirm if the use of multimedia cases actually helped the PTs when they went into the field. I collected data for this question using qualitative interviews.

A descriptive research design is used when the variables are known, but the relationships between the variables are not clear (Levy & Ellis, 2011). In this study, I assumed that PTs' self-

efficacy beliefs can be affected by use of multimedia cases in the methods class. I also assumed that when the PTs go for their field practice, they will draw from some of the ideas discussed from the multimedia cases. However, it was not clear what this effect would be, neither was it known what PTs may notice and/or attend to from a lesson using multimedia cases. This study will describe the ideas noticed during the intervention lesson, their effect on self-efficacy beliefs, as well as the application of the ideas gleaned from multimedia cases in the teaching practice. I used a mixed-method research methodology that combines data collection and analysis techniques from both quantitative and qualitative research methods.

A mixed-methods design is one that incorporates both quantitative and qualitative data. According to Creswell (2008), mixed methods are suitable in the instances where one of the methods is not in itself sufficient to comprehensively understand the research problem, or when one desires to further extend the understanding of a problem beyond that which can be generated from using one of the methods. Mixed methods study provides both a greater depth of understanding of the research problem from a qualitative component, and better objectivity and generalizability from a quantitative component (Caruth, 2013; Venkatesh et al. 2013).

Proponents of quantitative research methods aim to reduce empirical indicators to deduce an objective truth that exists independent of the observer. The method uses a sample of participants to represent populations that the findings can be generalized to. The quantitative methodological purist's argument further posits that the philosophical understanding of quantitative techniques is founded on positivism: the understanding that there is an empirical reality out there that needs to be measured, and that, though this reality may vary for subgroups (e.g., by gender, education levels, etc.), its interpretation is independent of the observer’s intervention and interpretation. To ensure that this method is accurate, scientific and

generalizable, large and often randomized samples are selected and the responses are restricted. The findings are reported in domain specific language that is impersonal and passive (Brannen, 2007; Johnson & Onwuegbuzie, 2004).

Qualitative purists, on the other hand, argue that quantitative methods cannot access the lived experiences that a researcher might be interested in (Bryman, 2006). Qualitative researchers adopt a constructivist and interpretivist philosophy, which contends that multiple realities are possible and truth is an interpretation that is negotiated during the process of data gathering, analysis and reporting. The reporting is done in a rich, thick emphatic, and somewhat informal language (Brannen, 2007; Bryman, 2006; Johnson & Onwuegbuzie, 2004). Qualitative samples are not meant to represent large populations, but rather “purposeful samples of articulate respondents are used because they can provide important information” (Sale, Lohfeld, & Brazil, 2002, p. 45). This implies that sampling techniques for both methods serve a different purpose; qualitative methods strive to gain depth, while quantitative methods strive to gain breadth.

Allwood (2012) see the attempts to set apart qualitative and quantitative research as unclear, poor and of limited value. Some mixed-methods proponents take the position of rejecting the either-or dogma of these methods, and argue that the two methods are united by a “shared commitment to understand the human condition for practical use” (Sale, Lohfeld, & Brazil, 2002, p. 46). More recent attempts have categorized the various reasons advanced for selecting mixed-methods as either eclectic, principled eclectic, or innovative (Riazi, 2016). Eclectic reasons have been advanced by researchers who are more concerned with answering research questions using qualitative and quantitative data and analysis methods without adhering to any paradigmatic orientation. Riazi (2016) refers to this orientation as "a-paradigmatic" (p. 34). Riazi categorizes principled eclectic reasons as the rationale given by researchers who mix

the methods of collecting and analyzing data, but differ from the a-paradigmatic researchers in that they subscribe to pragmatism as the underlying world view for mixing their methods. Such researchers see mixed-methods research as a research method and not as a methodology. Innovative mixed-methods research studies are those that have a "clear purpose and logic" (Riazi, 2016, p. 38), for mixing the methods, and are able to draw on relevant epistemic perspectives to conceptualize research problems, innovatively select methods to fit the conceptual model and mix relevant data and analysis procedures. In such a case, mixed-methods is seen as a methodology, not as a research method.

In this study, I sought to explain practical solutions to the theoretical nature of methods courses at Central University. The selection of research methods follows a logic that makes sense to mix the methods of data collection and analysis.

Intervention

In this section, I describe the intervention lessons conducted with the chemistry and physics group of PTs. The lessons were planned with consultation with the cooperating teacher educators. The teacher educators provided the objectives of the lesson, while I suggested the clips that would best represent the objectives. The teacher educators and I reviewed the clips and once consensus was reached about the appropriateness of the clips, we planned the lessons by exchanging ideas over emails and finally agreed on a two-hour lesson plan for both groups.

The Chemistry Lesson

The two-hour chemistry intervention lesson featured four short clips from the same video lesson, where the teacher posed various questions. The chemistry cooperating teacher educator, Professor Orion (pseudonym), told me that he would like the intervention lesson to focus on questioning strategies as a part of his broader goal to teach instructional strategies that lead to conceptual ways of knowing. The objectives of the lesson were: to expose PTs to low-order and

high-order questions, demonstrate strategies for posing questions and, illustrate how questions contribute to learning. In our discussion, Professor Orion said his expectation is that PTs would choose to use less low-order questions in preference of high-order questions. This, he said, would help him in the discussions following the intervention lesson, where he hoped to link low-order questions to rote learning, and high order questions to meaningful learning. He therefore asked me to select clips from one multimedia case that show questions that are both low-order and high order, and lead the discussion with the PTs who volunteered for this study.

I selected clips to form a progression from an easy questioning strategy to more robust and complex questioning strategy, and also from low-order to high-order questions (Lord & Baviskar, 2007; Yip, 2004). Yip (2004), using Bloom's taxonomy, described low-order questions as those that involve recalling factual information and explaining a phenomena or process. High-order questions are those that involve analysis, evaluation and synthesis of concepts. The questions were posed in a lesson about "classification of substances" presented to form 2 (grade10) students. The teacher described classification in one half of the lesson and went on to discuss the use of chemical symbols in the second half.

Selected questions. I selected the clips, each approximately two minutes long, such that they show questions that make the cognitive engagement on the student explicit. By this I mean that the camera had to be on the teacher when he was posing the question, and then turned towards the student when they were responding to the question. The first question was: "What is matter?" It was posed at the beginning of the lesson to elicit prior knowledge pertinent to the lesson. This was a simple recall question because the science curriculum in Kenyan primary schools requires learners to know this definition. It was expected that in secondary school learners can recall the definition.

The second question was “which of these is a solid, liquid or gas? The question required learners to identify from three illustrations one each that represents a solid, a liquid or a gas. This was a pattern recognition question that required learners to use what they know about solids, liquids and gases and match it with a model derived from the kinetic theory of matter. This may be seen as a high-order question compared to the first, since it required learners to analyze parts of an illustration and match them with their knowledge of matter. However, it is also an elementary level of analysis and therefore, may also be considered as a low-order question, since learners already knew about it and may just recall from their primary school science lessons.

The third question was: “what is a pure substance?” This was an open-ended probing question that required learners to infer meaning from everyday use of the words “pure” and “substance” and apply it to define purity in chemistry. Purity of substances is important in chemistry and therefore articulating a clear definition is an essential learning goal. After posing this question, the multimedia case teacher went on to lead a discussion that gave learners multiple chances to respond. This question therefore highlighted the strategy of using probing questions to seek deeper meaning from students’ initial responses.

The fourth question was: “what is the formula of Bromine?” The teacher had discussed a pattern of naming chemical elements using chemical formulas. He asked learners to extend that pattern to come up with the formula of the element “Bromine”. He asked the learners to think about it, then share their thought with their peers and finally with the whole class (think-pair-share). The teacher then led an extended discussion that gave the learners a chance to not only give divergent views, but also to offer rebuttals to their peers’ responses. This question was high-order since the learners had to construct a new idea from studying patterns and drawing generalizations.

Lesson implementation. Before the chemistry intervention lesson, professor Orion invited volunteer participants to the study and had them complete the pretest questionnaire. Those who returned enrolled to attend one of two identical lessons. The decision to have two sessions was so as to have approximately 35 PTs per session in a small boardroom that had the infrastructure to support multimedia case-based teaching. There were a number of unplanned incidences that occurred during the actual implementation days. These incidences affected the way that I obtained the sample for the chemistry group for this study.

The first incidence was that about 50 PTs came for the first session and made the room quite crowded. We still managed to have the lesson discussions, which I noted in my memo as fruitful, interesting and academically riveting. I noted that given a chance to speak in class, PTs made a point and provided arguments to support their positions. Most often, the next comment from a PT countered what the previous one had said and again was followed by an argument to support the counter position. This trend created two schools of thought that polarized the class discussions and got most PTs eager to state their position or take a side. For example, when discussing the first question “What is matter?”, one PT said that everyone knows what is matter, and so the teacher ought to have asked the students for an example instead of a definition. Another PT said that as a teacher, one should not assume that students know everything and should ask for definitions before he asks for examples. For about five minutes the next set of PTs took alternating positions debating whether the example should come before a definition. In some cases, I stopped moderating the discussion to allow for the most urgent ideas to be stated in the ensuing exchange, while at the same time trying to listen for suppressed opinions. In other instances, I muffled the discussion to allow for jotting down of ideas on the worksheet that would comprise the data set.

The effect of this discussion may have triggered the attendance on the following day. During the second session, there were over 100 PTs trying to fit into the room. Many of the PTs could not get space inside and had to be turned away. The first 20 minutes of the lesson were spent managing the class size. At this point, it was not possible to determine and give priority to the PTs who had completed the pretest questionnaire. In my reflection, I thought that the PTs may have been attracted to the second session by the fact that there was a new instructor for the two sessions, and they had heard from the PTs who attended the first session that it was enjoyable. Another reason may have been that they enjoyed and learned well from using multimedia cases and therefore sought to learn more.

In each of the sessions, I used van Es and Sherin's (2002) framing to support PTs' noticing of the interactions in the video clip. The framework required the PTs to describe what they saw, then evaluate, and finally interpret what they noticed using what they know about teaching and learning. Professor Orion and I described this framing to the PTs and gave them a worksheet, where they wrote their description, evaluation and interpretation for each of the four clips. We did not give the background information about the lesson, the school, or the teacher in the video. We also did not discuss our rationale for selecting the questions we were going to show. Our reasoning was that the PTs just needed to focus on the question itself, as well as the questioning strategy, independent of the context of the video.

I played the clip one time and allowed two minutes for the PTs to make a description. I supported this process by posing the question "What did you notice?" After the two minutes, I asked several PTs to share what they had written. This process helped to reveal the possibility of multiple incidences in an episode of teaching. I then told them that I would play the clip a second time. I asked them to now focus on adding to their descriptions about the clip, especially if there

was something they missed the first time, and also to evaluate the clip. After playing it the second time, I allowed three minutes for making thicker descriptions and an evaluation. I again asked them to share by reading from their worksheets what they had written.

In the sharing sessions, the PTs discussed various viewpoints about the clips, and became emotionally engaged with the teaching episode. I insisted on them reading what they had written on their worksheets, besides reacting to another PT's idea. This not only brought out multiple perspectives, but their need to support their standpoints made them draw more from theories they had learned in the teacher preparation courses.

I then explained that their evaluation should be based on what they know about teaching and learning. I asked the PTs to interpret their evaluations based on the theories of teaching and learning. Initially this was difficult, and so I asked them to write a rationale for their evaluation. Since this seemed easier, I substituted the word "interpret", as used in the Learning to Notice framework, with the word "rationale". The meaning and intentions remained the same; use what you know about teaching and learning to provide a rationale for your evaluation. This process was repeated for the other three clips.

The Physics Lesson

The collaborating teacher educator for the physics group of PTs, Professor Polaris (pseudonym), asked PTs who were interested in participating in the study to collect and complete a questionnaire at the end of one of his earlier lessons. He then announced that a visitor would help teach the lesson on "lesson introduction" and encouraged those who have completed the questionnaire to stay after the intervention lesson to complete the posttest questionnaire. I carried out the intervention lesson in the usual class time and so attendance was required, though participation in the study was voluntary. During our planning meeting, Professor Polaris and I identified two clips from a sample of six multimedia cases, one exemplar and the other a non-

exemplar lesson introduction. In reaching this decision, Professor Polaris explained that a good lesson introduction needs to meet the criteria of being engaging, as described in Biological Sciences Curriculum Studies' (BSCS) conception of a 5E lesson plan (Goldstone et al., 2013). A 5E lesson plan starts by accessing the learners' prior knowledge and helps them engage with the lesson through the use of activities that promote curiosity and organize students' thinking toward the learning outcomes. Professor Polaris identified the tenets of the first E (Engage) in a 5E lesson plan as one that: (1) has clear objectives of the lesson shared by both the teachers and the learners (2) connects to the life of students as a way of arousing curiosity and relevance, and (3) seamlessly connects to the main lesson.

Exemplar lesson introduction. In the exemplar video clip, the video teacher outlined the objectives of the lesson, its relevance to learners, and linked it to what was already known about cathode rays in a way that was engaging. The video clip was the first 4.07 minutes of a 40-minute lesson on cathode ray tube (CRT) that was taught to form four students (grade 12). Professor Polaris said that he wanted the video played first and followed by a discussion of what they noticed. The focus of the discussion was to lead the PTs to identify the tenets of a good lesson introduction.

Non-exemplar lesson introduction. In the second clip, another video teacher was introducing circuits to form two students (grade 10). The clip was the first 3.30 minutes of a 40-minute lesson. In selecting the clip, we considered that first, the teacher appeared more focused on student management, including what students ought to write down and how they should answer questions. Second, his choice of words was somewhat confusing, and made it difficult for students to follow the lesson, especially at the introductory part. According to Professor Polaris, it appeared as if even when the students are apparently unable to follow the lesson, the teacher

did not notice. Professor Polaris felt that the teacher's movements in class, the tone of his voice and poise came across as condescending.

At the end of the lesson, Professor Polaris's expectation was that the PTs would be able to glean exemplar practices from the exemplar video, and use these to make suggestions for improvement on the non-exemplar case. The worksheet was therefore designed to include a suggestion for improvement. We showed the first clips using the same framing of Learning to Notice and followed a process that was identical to the chemistry group.

At the conclusion of the physics intervention lesson, a number of students were talking to their instructor, Professor Polaris, about the possibility of another lesson using multimedia cases. He consented to an extra lesson. The extra lesson, which focused on teacher demonstrations, may have had an effect on the interview data that I collected when they went for their field experiences, but had no effect on the self-efficacy scores reported in this study. This is because the self-efficacy posttest was done right after the intervention lesson in March 2015, while the interviews were conducted in June 2015.

Sampling Procedures

Respondents for this study were prospective secondary science teachers in the areas of chemistry and/or physics at Central University who were taking chemistry or physics methods courses in spring 2015. I recruited respondents through the sampling procedure described below.

Universe and Population

According to Babbie (1998), a universe is "the theoretical and hypothetical aggregation of all elements" (p. 72) as defined for a study. In my literature review, I described how the education reforms in SSA have been influenced by identical circumstances. The quality of learning in teacher education programs has been affected by reforms pertaining to access and

financing of education. The response of most SSA countries to these issues has been mainly by increasing enrollments in higher education including in teacher preparation. Though this solves the question of access and financing, the quality of learning has deteriorated. Since the elements of this study were PTs in one SSA University, the universe for this study refers to all of the PTs studying in the teacher training institutions in SSA, that have enrollment and financing arrangements identical to those described for Central University. Central University has a rapidly escalating enrollment in teacher education programs, which is not matched with infrastructural and human capacity growth. The huge numbers have especially strained the quality of the already inadequate field experiences.

Babbie (1998) further defines a *population* as a specified aggregation of survey elements. The population in the present study was the prospective science teachers at Central University. This study sampled the PTs in the chemistry and physics methods courses at Central University. According to the cooperating teacher educators, there are approximately 400 PTs in the chemistry methods course and approximately 130 in the physics methods course at Central University.

Sample. Volunteers were invited to participate in the study from both the chemistry and physics methods classes. The invitation was a scripted call for participation that was read to these classes in February 2015, as per the specifications of Syracuse University's Institutional Review Board (IRB) in charge of research and integrity. The volunteers were given a pretest questionnaire to complete. There were 76 (n_{chem}=76) completed pretest questionnaires from the chemistry group and 22 (n_{phy}=22) from the physics group (see Figure 3.1). Each of the questionnaires was marked with a cell phone number. The participants were assured that the

number will not be shared with a third party, and that it was going to be used for matching data throughout the course of the study.

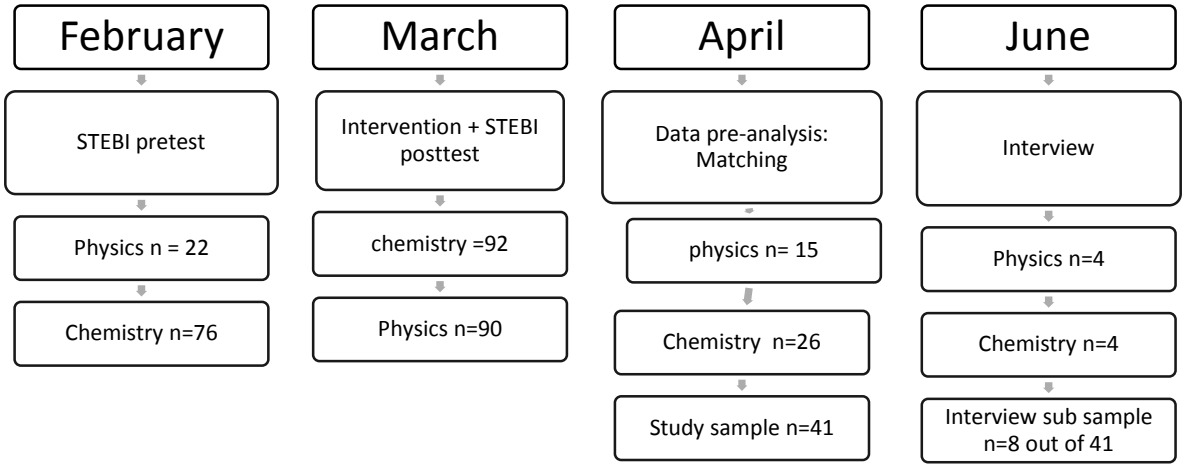


Figure 3.1 Conceptual framework for the data collection and sample size across the stages of the research

The cooperating teacher educator for chemistry, Professor Orion, invited the participants who volunteered (n_{chem}=76) to the intervention lesson on any one of two days in the boardroom of the teacher education department. On the first day of the chemistry intervention lesson, about 35 chemistry PTs attended. On the second day, an overwhelming number of chemistry PTs came for the intervention lesson. It was not possible to filter this group in order to give priority to those who had returned the pretest questionnaires. It therefore makes sense that, though I collected 92 completed posttest questionnaires, I only had 25 of these matched to the pretest questionnaires. This, therefore, was my chemistry sample (N_{chem}=25).

The physics cooperating teacher educator, Professor Polaris, wanted the intervention lesson done with the entire group during normal lecture time. The prospective physics teachers who volunteered and completed the pretest (n_{phy}=22) were to complete the posttest after the intervention lesson. The physics intervention lesson may have increased interest in participation

in the study, since almost everyone stayed to complete the posttest questionnaires. The intervention lesson was concluded and class dismissed to go out except those who wanted to stay and complete the posttest. I collected 90 completed posttest questionnaires. Though those who completed the pretest were especially encouraged to participate, only 16 posttest questionnaires were matched with the pretest. The sample from the physics group was therefore these 16 participants (N_{phy} =16).

Interview sub-sample. In the following semester (May-July 2015), the cohort of PTs who were in this study went for their field placement (teaching practice) in various schools in Kenya. During this time, I selected a sample of the participants for in-depth interviews to determine if there were ideas from the intervention lesson that they drew on in their teaching practice. The sub-sample selected for the interview followed suggestions described in Merriam (2008). First, the participant's eligibility criteria were that they needed to have participated in the intervention lesson, and completed both the pretest and posttest. The participants also needed to give consent as described in the institutional research board's (IRB) research and integrity protocol.

I then used Creswell's (2008) maximum variation sampling strategy to select eight participants who "differ in some characteristic or trait" (p.214). Central University's office of teaching practice keeps a list of the schools where the PTs go for their teaching practice. I obtained this list and created a spreadsheet of the schools where all 41 participants were teaching using their phone numbers. Then, I checked the schools that would be accessible within the available timeframe. I therefore identified the PTs who were in Nairobi, Kiambu and Embu Counties and created a short list of these PTs. These Counties are geographically accessible, the schools location is familiar to me and they had enough schools with sufficient variation in their

categorization. I called and sought consent with these participants for an interview. Since they all consented, I confirmed and made appointments for interviews with 8 participants. Since Nairobi is the largest country, I allocated it four participants, two male and two female. Both female participants were in the chemistry intervention group. I then allocated two each for Kiambu (one male and one female) and Embu (both male) counties such that I interviewed one who was in the chemistry group and the other in the physics group.

Data Collection

Data for this study were collected in two phases. The first phase involved collecting both quantitative self-efficacy data using the STEB questionnaire and qualitative data from the intervention lesson using a worksheet and field notes. The quantitative data involved a pretest questionnaire in the two-week period preceding the intervention lesson. An identical posttest questionnaire was administered immediately after the intervention lesson. The qualitative data was collected through a worksheet that the PTs used to note down their descriptions, evaluation and interpretations of the video clips. The participants' data, therefore, comprised only the matched set of pretest questionnaires, intervention lesson worksheet, and the posttest questionnaire. At the end of each intervention lesson, I sat in the car and recorded my reflections of the lesson on a voice recorder. Transcripts of these reflections formed another data set.

The second phase of data collection involved the in-depth interviews that I conducted with PTs in Kenyan schools during their field placement period (May- July of 2015). These PTs were selected from among the completed data set of 41 participants. I asked the PTs to share with me their prior schooling experiences, their teaching philosophies, as well as the ideas from the multimedia cases that they think could have impacted their current instructional practices or

their outlooks about teaching. These interviews were audio recorded and transcribed. The transcripts formed another data set for this study.

Data Analysis

I analyzed the data to answer three research questions. The first question was: what do PTs notice or/and attend to when viewing a multimedia episode of teaching? To answer the question, I analyzed the worksheets that were completed during the intervention lesson as well as the field notes I made after each lesson. First, I developed a survey tool on Qualtrics, a survey and data analysis software free to Syracuse University's members. I then entered each of the worksheets as a survey. My design of the survey instrument and analysis of the worksheets followed a framing by Roth McDuffie et al. (2013). Roth McDuffie's framework categorizes participants' noticing into four lenses: (1) teaching, (2) learning, (3) task, and (4) power and participation. In choosing the framework, I first considered the fact that filming and editing the videos may not always make it possible to focus on the teachers and the students simultaneously, and so the interactions that are visible are limited by the lens of the filming camera, as well as the final editing of the clip. Secondly, the framing allows a comprehensive analysis of data that is collected by watching clips even without other components of the video lesson, such as robust background information of the clip, knowledge of the context of students, and the original instructional objectives of the teacher. Thirdly, the framing comprehensively reflects the stated interests of teacher educators in the study: the teacher's activities (teaching), learning activities (learning), demonstrable content mastery (tasks), and class control (power and participation).

I typed the excerpts from the handwritten worksheets into the Qualtrics survey tool and rated a small sample with another researcher to establish reliability in the coding. As one of the raters, I based my decisions on my 17 years' experience teaching chemistry and physics in high

schools in Kenya, while the second rater based her decisions on her six years' experience teaching physics and mathematics in Kenyan high schools, and an additional four years teaching mathematics methods course of a teacher preparation program in a large Kenyan University. The rater and I first discussed the framework to carefully understand the limits and delimits of the categories before we started the rating process.

Based on our understanding of the framework, we decided to apply the teaching lens code when a participant gave a description of what the teacher was doing and had the teacher as the subject of the sentence. This category excluded the actions that were directly related to affording students the opportunity to participate in class discussion, including a teacher's action to engage students in answering questions (e.g., the teacher selected one of the student to answer the question). We reasoned that such actions are a teacher's decision to use his power to enhance participation and therefore decided to code such excerpts as taking the power and participation lens. We applied the student's lens when the excerpts described the things that learners were engaged in during the lesson as a way to advance the students' own understanding of the task. The task lens was applied when the excerpts described the appropriateness, or lack thereof, of the task in the context of the lesson. In other instances, the teacher's or student's action were included in this category if the subject of the excerpt was the task itself. For example, the excerpt "the teacher kept rephrasing the question and ended up asking different questions" talks about both the teacher's actions and the effect of that action on the task. For this kind of a statement, the PT's concern was taken to be the task since it was the subject of his or her comment. The lens on power and participation was assigned for all excerpts that implied noticing of the shared platform for participation. The triadic dialogue inherent in most question and answer sessions (question-

answer-evaluate) (Lemke, 1990), was expressed in a number of excerpts and were seen as a teacher's way of using his classroom powers to control participation.

After coding some excerpts, we made another decision about the unit of coding. We considered two options: The first option was whether to make the sentence the unit of coding. In this case the whole sentence had to be categorized as being in one category. While this makes it easier to see the patterns that would emerge from the codes, and thereby help to interpret the progression of PTs' noticing from one clip to the next, the multiple interpretations that such a unit of coding would elicit compromises the reliability of the findings. For example, the excerpt "The teacher poses a question, 'what is a pure substance?' and gives many learners the opportunity to respond" was categorized as taking a teaching lens by one rater, and taking a power and participation lens by the other rater. To resolve this problem, we considered a second decision; making a phrase the unit of analysis. This allowed a sentence to be broken up into meaningful phrases that would unambiguously fall into one lens, whenever possible. Merriam (1998) defined a unit of data as any meaningful piece of data that is able to give the smallest piece of information. In this case, "the teacher poses a question 'what is a pure substance?' " was coded under teaching lens, while "gives many learners the opportunity to respond" was coded as taking a power and participation lens.

We coded 20 excerpts from four clips in four iterations of five excerpts each. Each iteration started with coding five excerpts independently and then examining and discussing the differences in the coding. The discussion made the subsequent coding iterations clearer. The coding rules were modified and agreed on after each iteration. Initially, the inter-coder concordance decreased from 85% to 75% and then 70%, but finally reached 90% in the final iteration. In all cases, total consensus was reached when the unit of analysis was changed to a

meaningful phrase instead of a sentence. At this point, my coding schema had been calibrated in a way that there were minimal variations in classification of the excerpts. I, therefore, coded all the other excerpts using an identical pattern.

My second research question was: Is there a significant change in the self-efficacy scores of PTs after a multimedia case~~s~~ based lesson? To answer the question, I analyzed the quantitative self-efficacy data collected with the science teaching efficacy beliefs (STEB) instrument. The STEB instrument is a 23-item, 5-point Likert Scale instrument that measures PTs' Personal Science Teaching Efficacy Belief (PSTE) from 13 items (items 2, 3, 5, 6, 8, 12, 17, 18, 19, 20, 21, 22, 23) and Science Teaching Outcome Expectancy (STOE) from 10 items. The negatively worded items on the scales were reversed and all items assigned a score (SA=5, A=4, UN=3, D=2, SD=1). I then calculated the internal reliability alpha coefficient for each of the subscales.

I determined that there was no statistical difference between the chemistry and physics groups and therefore treated the chemistry and physics group as one sample. I therefore determined if there was a statistical difference in pretest and posttest scores for personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE) for the combined group using a paired sample t-test. Sprinthall (2000) explained that t-tests allow researchers to compare the differences in mean between two groups.

The third research question was: What experiences from the methods course do PTs draw from during their initial teaching field experience when they had used multimedia cases? To answer this question, I analyzed the data from the the in-depth interviews with the PTs. First, I transcribed the recorded interviews and read them over and over to gain insight into the structure and content of the data. I then used content analysis (Glaser & Laudel, 2013) to place the texts from the transcripts into the predetermined categories. I defined each of the categories using

three rules: (1) content of each category (2) the scope of each category, and (3) the character of each category. The first category was the background of participant. This comprised the schooling background, their academic performance in that school, and the category of school where they were doing their teaching practice. I limited myself to their secondary schools before joining the university. The code comprised information that would shed light on whether the PTs graduated at the top of their classes or otherwise, as well as if teaching was their career aspiration or the next best alternative.

The second category of the code was their teaching philosophy. This code included information on the PTs' beliefs about students, students learning, teaching, curriculum as well as concordance of the teacher preparation with their teaching experiences. I sought to explore the motivation of the PTs towards their instructional strategies. This category enabled me to create a a narrative that can explain each PT's general philosophy about teaching and learning

The final category comprised the ideas that the PTs learned from MMCs in the intervention lesson and were relevant to their teaching during teaching practice. I excluded the ideas that the PTs recalled from the cases, but did not see any application to their teaching. This information helped me make conclusions about the ideas in the intervention lesson that were relevant for teaching practice. I then developed profiles for each of the PTs.

Chapter 4. Results and Findings

In this chapter, I present the results and findings that answer my three research questions. First, I highlight what the PTs noticed and/or attended to during the intervention lesson. Then, I report the effects of the intervention lesson on their science teaching self-efficacy. Finally, I discuss what the PTs draw on from the intervention lesson during their teaching practice.

Prospective Teacher's Noticing of Classroom Interactions

The first research question was: What do PTs notice and/or attend to when viewing clips of MMCs? I summarized the results from analyzing the write up that PTs produced as worksheets during the lessons, as well as my reflections of the intervention lessons. I conducted two separate lessons to answer this question: one with the chemistry PTs and the other with the physics PTs. The chemistry lesson featured four clips of lengths varying between one and a half to and three and a half minutes. The physics lesson focused on two clips of between three and five minutes; one intended as an exemplar and the other as a non-exemplar of lesson introduction.

In this section, I present the results and findings from the chemistry and physics group. I also summarize the main ideas coming from comments that PTs made about both questioning strategies in the chemistry lesson and lesson introduction strategies in the physics lesson.

Chemistry Intervention Lesson

I present results from the chemistry intervention lesson by highlighting the themes that emerged in the description, evaluation and interpretation of each clip. I categorized the descriptions according to the four lenses in Roth McDuffie's (2013) framing. In each of the four lenses, I describe the major ideas and give some examples in a table.

Chemistry video clip 1: What is matter? The question "What is matter?" was posed at the beginning of the lesson. I analyzed a total of 42 comments from the 26 participants. (Some participants made more than one comment about what they noticed, and some comments had more than one distinct phrase). Of these comments, I categorized 14 as taking a teaching lens, two took a students' lens, 20 had a task lens, and six had a power and participation lens.

The video clip was 3:15 minutes long. Below is the transcript of the video clip:

Teacher: I wanted us to just learn something on classification of substances. The topic is constituents of matter (*The teacher then changes the presentation to full screen and displays a slide written "Constituents of matter". Below it there is a single bullet on the slide that reads "Matter is anything that has mass and occupies space". He glances at it and walks off the cameras focus, the camera stays on the slide*). When we talk about classification of substances, this is not anything new to any one of us. All of us, as human beings we are also classified as either boys or girls. Isn't that so? Therefore, when it comes to chemistry the substances that we have always… they are also classified into various classes. Therefore, today I want us to look at the "constituents of matter". Therefore, if I may ask, what is matter? (*The teacher, who is now in the center of the camera's focus, leans forward looking at the students who are seated in a class set up like a theater. He looks around and fixes his eyes on a student on the left of class)* Yes!

Student: (*Faintly)* Matter is anything that occupies space and has mass.

Teacher: Matter is anything that occupies space and has what?

All students: Mass.

Teacher: (*Turning to the screen and reading the slide)*. Matter is anything that has mass and occupies space.

Prospective teacher's descriptions of chemistry video clip 1. I categorized PTs descriptions on the teaching lens into three categories. The first category of comments dealt with raw description of the process that the teacher went through to pose the question. The statements were brief and devoid of anything other than what the teacher said or did. The second category of PTs comments was a comparison of what the teacher did or said with what the PTs know about teaching. The third category was about the interpretation of the actions of the teacher based on the repertoire of PTs teaching and learning theories. Some of the comments insinuate that the

teacher's actions and students' learning are interlinked. In some instances, the comments identify the absence of this linkage and are worded as what the teacher ought to have done. The number of comments in each category, as well as examples of such comments, is shown on Table 4.1.

Table 4.1

Description of chemistry clip 1

Lens	Category	Frequency	Examples of PTs comments from the worksheets
Teaching	Raw descriptions of the process	5	The teacher introduces the topic and then poses the question "What is matter"? He then asks one student to respond.
	Comparison of teacher's action with teaching and learning theories	10	The teacher starts from known to unknown.
			The teacher ought to have described what matter is first ask then ask the students if they can recall. The teacher introduces the topic and subtopic of the lesson just to prepare the students for the lesson.
	Interpretation of teacher's intentions	6	The teacher probes the students about what they already know about matter.
			The teacher makes an assumption that the students know what matter is.
Students	Aiding recall	1	The teacher begins by checking whether the learners know what matter is. This helps them to recall.
Task	Teacher's error	10	It was not necessary since the answer was already there. The answer was displayed even before posing the question.
	Cognitive demand of question	10	The question is not technical. The question is high order and students were involved in giving the answer. The question is relevant. It tested research skills (ability to read ahead of days' lesson).
Power and participation	Teacher's control of who talks in class	6	The teacher nominates one student to answer. The students raise up their hands, and then the teacher selects one student.

Only one comment in the first clip took the student's lens. This may be because the PTs Only one comment in the first clip took the student's lens. This may be because the PTs lacked the skills to notice students' learning. According to Professor Orion, the cooperating chemistry teacher educator, the PTs are required to prepare student-centered lessons. The questions that the teacher poses at the beginning of a lesson help learners link the day's lessons to what they already know, bring to the attention of the teacher students' prior conceptions, as well as aid in recall of phenomena deemed relevant for the lesson (Good & Brophy, 2000). In the first clip, only one person alluded to the importance of a question in aiding recall. This means that it is not immediately noticeable how students participate in a lesson from watching a video clip unless their attention is focused specifically on the students' actions.

There were 20 comments that took the task stance. Half of these comments were the PTs' reaction to an error the teacher made about asking the students the question, while at the same time displaying the answer on the slide. The second category of comments were about the cognitive demand of the task. Some of the participants saw the question as low-order while others thought that it was relevant, especially since it was posed at the beginning of a lesson.

The participants who made comments based on a power and participation lens, focused on the teacher's actions that control who was going to talk in class. I had used the term "nomination" before the clip was shown as an introduction to this intervention lesson on questioning strategies. I used the term to imply the teacher's action of selecting one student from among those who volunteered to respond to a question. Most of the comments in this section used different words to highlight how the teacher controls who will be able to participate through a nomination process. The student's gesture of raising hands was seen as their way of volunteering for nomination.

Prospective teacher's evaluation of chemistry video clip 1. The participants used various ways to voice their approval or disapproval of both the question and the way it was posed in the video clip. The diverse evaluative remarks included numerical assignment of a score on a scale, affective remarks like "I (don't) like the question" and also some remarks that could not be judged as either approval or disapproval. Moreover, most participants gave multiple evaluative stances with a rationale for each stance. Based on the evaluation stance and the rationale given, I categorized the remarks as either positive, neutral or negative evaluations. I focused on the rationale the PTs gave for their evaluative stance.

The participants who expressed positive evaluative stances based their judgment on: (a) the timing of the question that came at the introductory part of the lesson, (b) the positive motivation of an easy-to-answer question, and (c) the significant prior knowledge that the question could elicit. Those who wrote a neutral evaluative stance described the teacher's intention in a way that it could not be possible to designate the remarks as positive or negative. The negative evaluative stances were predominantly based on the low cognitive demand of the question. Overall, there were 19 comments that were positive, as compared to six and three that were neutral and negative, respectfully. A number of the PTs did not make any evaluation, I think partly because they found it challenging to justify their evaluation based on teaching and learning theories learned in their teacher preparation programs. A few examples of the comments are listed on Table 4.2

Table 4.2

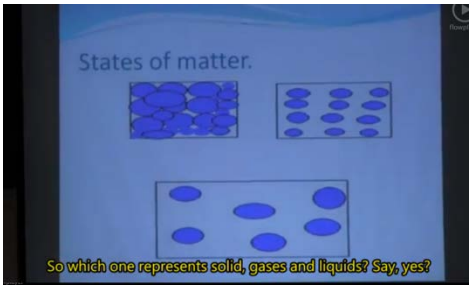
Examples of PTs' evaluation comments of chemistry clip 1.

Positive evaluations	Neutral evaluation	Negative evaluations

Simple questions motivate learners to learn. The teacher gets to know the background knowledge of students with respect to matter and at the same times draws their attention.	The teacher is testing the reading skills of the students. The teacher wanted to know if the students are attentive in class.	It was not a valid question. The question is low on blooms taxonomy. The question is not good for testing cognitive engagement.

I guided the PTs through a discussion as a whole class to share some of the ideas that they had about clip 1. In this discussion, it emerged that the definition that the students gave of matter was not a demonstration of conceptual understanding of matter. The PTs, building on each other's ideas and responding to prompting questions, suggested that it would have been better if the teacher brought an example of a bottle half-filled with water as a teaching prop, and ask the students to use the prop to identify what matter is. That way, the bottle itself, the liquid inside and the air above the liquid would have been good examples that would illustrate conceptual understanding of matter as anything that occupies space and has mass. Another suggestion was to ask for an example of what would not count as matter. This discussion made the PTs feel that the teachers question was not a good question one. I advised them not to change their comments, but use ideas from the discussion to make comments about the next clip.

Chemistry Video clip 2: Which of these is a solid, liquid or gas? In the next clip, the teacher established that matter is classified into three categories: solids, liquids and gases. He then says he is going to show what solids liquids and gases look like. Below is a transcript of the classroom conversation. Figure



4.1: Slide showing solids, liquids and gases

Teacher: Therefore, let's see how liquids look like, solids and gases. (*The teacher then advances the slides to reveal a common model of particles, with circles packed at varying densities as shown in Figure 4.1).* So, which one represents solid, gases and liquids? (*The camera now focuses on students, most of whom have their hands raised as shown in Figure 4.2. The teacher poses for about 15 seconds as he selects a student*).

Teacher: Let's see. Yes! *(Pointing to one student).*

Students: The first one represents solid.

Teacher: The first one represents what? Solids! This one represents what? Solids. Why do you think this is solid? (*Many students raise up their hands*). Yes

Student: Because the particles are packed together.

Teacher: Because the particles are packed together. Because the particles are very closer to each other. Are we getting that? They are closely packed, that means that there are forces that are holding these particles together, closer to each other. Are we getting that?

Students: Yes.

Teacher: Now liquids? *(Camera now focuses on teacher, he leans forward with a friendly smile and point to another student at the front row).* Yes!

Student: B.

Teacher: Yes! What is B?

Student: The second one on the right!

Teacher: The second one on the right. Isn't that so? That one represents what, liquids. Why do you think this represents liquids? (*Many hands up again and camera on students*) Yes!

Student: Particles are loosely attached to each other.

Teacher: Because the particles are loosely attached to each other. The particles are loosely attached to each other. But also the lower one, the particles are loosely attached to each other, (*pausing like he is unsure if the first answer was incorrect).* Yes?

Student: They are closer to each other, but not as solids.

Teacher: Closer to each other but not as solids. And they are actually in a certain pattern, are you getting that? They are actually in a certain pattern. Now the last one, automatically, is which one?

Figure 4.2: Many students raising up their hands

Student: Gases.

Teacher: Gases? Are you getting that?

Students: Yes.

Teacher: Therefore, we found out that the particles are very far away from each other. Are you getting that? Therefore, the forces holding the particles are very weak. Are you getting that? So, that the particles can actually move in various directions. Are you getting that?

Prospective teachers' descriptions of chemistry video clip 2. After showing PTs the clip, I asked the PTs to describe what they saw as comprehensively as they could. Fifteen comments were made from the teaching lens, three from the students' lens, 13 from a task lens and 14 from power and participation lens. In all, 44 comments were made and I grouped them into various categories as shown on Table 4.3.

I grouped the comments that were made from the teaching lens into two categories. Seven comments made raw descriptions of the actions of a teacher as the process of what he said or did. The PTs placed more emphasis on the activities that built up to the question than they had for clip 1. They noted that the displayed illustrations and the comments that the teacher made before the question was posed served the purpose of building up to the question. Another six comments were about the perceived intentions of the teacher. Some saw the questioning as achieving secondary goals for the teacher, other than merely seeking to ask students to match the states of matter with the model.

The three comments that the PTs made under the students' lens paid attention to the visible actions that they could see among the students, such as raising up hands as a way to volunteer to respond to the question. The PTs also were able to infer that the students were

attentive or motivated. These are not directly observable behaviors and so I think it reflects an interpretation of observed behavior based on what the PTs know about teaching and learning.

Six of the comments that the PTs made based on the task lens situated the question in the context of states of matter and were categorized as describing what the question entailed. Only two comments evaluated the cognitive demand of the question and both agreed that it was very low. Other comments ascribed descriptors to the question such as “simple,” “nice,” or “open-ended.” One prospective teacher noted that the question did not specify how students were supposed to identify the model that represented each of the states. During the classroom conversation featured in the video clip, the fact that the choices were unmarked did not appear problematic until a student identified one of the diagrams as “B” even when none of them was labeled “B”.

Prospective teachers who described the clip using a power and participation lens focused on motivational issues and the apparent fairness in the nomination process. Six excerpts commented on the need for the teacher to know students by their names and give positive reinforcement when a student responded. They also noted that the distribution of opportunities to participate was not fair, since the teacher only seemed to select students from the front row, and also no consideration was given to the students whose hands were not raised.

Table 4.3

Prospective teachers’ noticing for chemistry clip 2

Lens	Category	Frequency	Examples of PTs comments
Teaching	Process of building up to the question	7	The teacher displays some diagrams showing states of matter and asked students to match with the states. The teacher introduces states of matter to the learners. He projects the diagrams representing the three states and asks the class to classify them.

	Perceived intentions of the teacher	6	The teacher kept the students attentive by asking questions The teacher involved the students in teaching, He tested observation skills.
Students	Engagement of the students	3	The students were motivated and attentive. They are active in the learning process. Many of the students lift up their hands.
Task	What the question entailed	7	Questions should have featured real examples of substances at the three states
	Descriptors of the question	3	The question was nice, The question is too simple. The question involved chorus answers.
	Cognitive demand of the question	2	Question is solely on observation skills. The question does not enhance cognitive skills
	Errors in the question	3	The teacher does not provide a criterion through which the students would identify the three states of matter. The teacher asks how solids look like but shows how particles in a solid should be arranged.
Power and participation	Teacher's required to provide motivation	6	The teacher does not know students by names. The teacher discourages students by not saying that an answer is correct.
	Distribution of opportunities to participate	8	The teacher nominated only those seated at the front. The nomination criteria are not fair. Teacher did not pay attention to those students whose hands were not raised.

Prospective teacher's Evaluation of clip 2. Like in the previous video clip, the words PTs used to evaluate the question posed in the clip varied across the participants. I use the same categorization of positive, negative and neutral. There were no comments that I categorized as neutral. I categorized 17 comments as positive and 19 comments as negative. The positive

comments were focused on (a) the cognitive engagement of the question, and (b) the teacher's ability to get students involved. The negative evaluation comments were based on (a) the perceived bias of selecting participants, (b) the fact that the teacher had not taught that subject matter before asking the question, and (c) an unsatisfactory cognitive level of the question.

Table 4.4

Evaluation and rationale of clip 2

Positive	Negative
The question had high cognitive engagement and stimulated the student's attention. The teacher had good classroom management and had students give individual answers instead of chorus answers.	Passiveness is encouraged; the learners who are at the back assume they are not part of the class. The teacher should have explained, and then posed the question in order to test if they exactly understood. The question should have focused on understanding of matter not identification.

The discussion in the first clip influenced what was said in the second clip. The need to see real examples used in a question dominated the comments that described the task. The PTs wanted the question to be situated at a higher cognitive level, seeking a deeper conceptual understanding, not just identification of the illustration that represents each state of matter. The PTs also became critical of the nomination process and started questioning if it is enhancing active or passive participation, and if it is fair to all students. Despite me selecting this question for being better than the first, the evaluation stance taken by a majority of the PTs was split between positive and negative. This could be because the discussions in the first clip made the PTs more critical of the question in clip 2, and the threshold for judging what is good could have been more stringent.

Chemistry video clip 3: What is a pure substance? Students know the meaning of the words "pure" and "substance" as separate words. In their elementary school science, they had

never been required to give a definition of a "pure substance" in the context of a chemistry lesson. The teacher wanted to categorize pure substances as elements as or compounds, but before that, he sought to know if the students understood what he meant by that term. So he asked them this question. The video clip is transcribed below.

Teacher: Now, pure substances also can be classified as what? Pure substances... But before we go to pure substances what do you understand by the term a pure substance. A pure substance… *(5 seconds pause, camera focuses on the students, and about 5 hands are raised up. Teacher points to one student seated at the back*) Yes?
Student: Pure substance is a substance that has no impurities …,
Teacher: That has no impurities. Yes, that's a trial (sic). (*Pointing to another student)* Yes?
Student: A pure substance is a substance that cannot be broken down into any smaller… *(Inaudible)*
Student: No!
Teacher: No! Your friend is saying no. (*Pointing to another student from the front*) Yes?
Student: A pure substance is a substance that contains only of one the particles. It has no contamination. It is not mixed with anything. It is just ONE (*emphasizing with one finger gesture)* element.
Teacher: Aha, that is a good trial (sic). Yes? (*Gesturing students to keep responding with his hands*), Yes,
Student: A pure substance is a substance with a constant boiling point and melting point
Teacher: Constant boiling point and melting point. Not really, it's not coming out very clearly. Yes?
Student: A pure substance is the one that has its original properties,
Teacher: Has its original properties…
Student: An element that cannot be separated into more constituents that are different,
Teacher. So all of you have given a wonderful trial. Can you clap for yourselves? (*All students clap*) So anything that has… (*Stated slowly*) one substance only is called what? A pure substance. Are you getting that? Anything that has one substance is called a pure substance. Are you getting that?

Prospective teachers' descriptions of chemistry video clip 3. When asked to describe what they noted, the PTs made more robust notes describing this question than the previous question. Their descriptions demonstrated both a clearer understanding of the expectations and a deeper engagement with the video clip. By the third clip, the PTs were able to notice and describe multiple teachable moments from one episode. For example, one participant wrote:

> The teacher constantly nominates the students who are in front. He tells the students who give the right answer that it's a good trial (power and participation). The way the learners raised their hands they look as if they are not sure (students). Some of the learners gave a correct answer and the teacher's final answer is incorrect (task). (MMCs Chemistry worksheet, 2014)

The comment describes: the teacher's control of the power to participate in class using a verbal reward strategy, learner's actions including the PT's interpretation of that action, and the accuracy of the content both from the students' perspective and the teacher's perspective. This reflects an understanding of the multiple interactions inherent in an episode of classroom discussion. For this clip, I analyzed and categorized 49 excerpts: 16 on teaching lens, five on students lens, 14 on the task and another 14 about the power and participation in the class.

I placed the comments on teaching lens into three categories. Five comments gave a raw description of what the PTs saw or heard. Another nine comments interpreted the actions of the teacher using what the PTs know about teaching and learning. A number of such comments saw what the teacher did as motivating, while others explicitly noted that that the teacher misled the students by giving an answer that was not accurate. The one PT whose comment focused on interpretation of the teacher's action saw his decision not to take the students' responses as correct as a lack of interest in students' knowledge.

By the time the PTs viewed the third clip, their ability to notice using students lens had improved and they made comments that demonstrated this advanced noticing. I categorized five comments as taking the students lens. Some of the comments showed that the PTs were able to make sense of the students' body language. The PTs were able to relate the body language to the level of confidence of students when responding to the question. For example, the PTs inferred that the students lack confidence by looking at their half-raised hands. The PTs were also able to connect this lack of confidence to the clarity of the task.

I grouped the comments under the task lens into two categories. The first category involved eight comments that represented the perceived correctness of the student's answers and incorrect teacher's answer. The others comments that used the task lens were about the cognitive level of the question. These comments were worded to imply that the cognitive demand of the question was at a level that learners cannot reach, while other comments demonstrated an understanding that high cognitive level questions are generally better for student learning. Some of the PTs said that the students lacked sufficient knowledge to answer the question, even when they saw some of the learners making considerable effort to give an answer that finally was close to what the teacher sought.

Three of the comments on power and participation lens focused on the perceived lack of fairness in nominating a students to respond. Another five comments focused on motivation that was inferred from the teacher's affirmation of the student's response, even though some of the PTs felt that not knowing the students names makes it demotivating for students to participate in class discussions. The other comments noted that the teacher allowed some wait time in class to give students an opportunity to think, and also the decision to allow more than one student to try to give a response was noted and commended by the PTs (see Table 4.5)

Table 4.5

Descriptions of chemistry clip 3.

Lens	Category	Frequency	Examples of PTs comments
Teaching	The process of posing questions	5	Teacher poses question, few students raise up their hands, teacher nominates students and evaluates. He then gives a correct answer[1].

[1] I coded some comments under multiple lens using a phrase as a unit of analysis, but in this example I give the entire comment from one PT to illustrate the fact that they noted the entire process of posing the question.

	Teachers (de)motivation to students	9	The teacher does not call students by names. The teacher tells wrong information The teacher motivated the learners.
	Teachers final answer	1	The teacher collected answers from students at random and lastly gave the definition, which means that he is not taking interest in the knowledge that the learners have.
Students	Learner's confidence	3	The way learners raised their hands looks as if they are not sure. One students tried to think so hard, but the idea is not clear. Many students did not have an understanding of the question.
Task	Clarity of the response	8	The teacher uses the same word to give a definition. The teacher ignores the best answer from one of the students. The teacher wanted an exact definition.
	Cognitive level of the task	5	The question asks of students' ability to memorize. Students don't have sufficient content knowledge to answer the question asked. The clip was of a higher level.
Power and Participation	Encouragements to participate	10	Teacher is encouraging; Students who fail to give good answers he tells them good trial.
	Deterrents to participation	5	The teacher's feedback to the students is not motivating especially when he says no.

Prospective teacher's evaluation comments for chemistry video clip 3. The PTs who positively evaluated this clip based their comments on the teacher's actions and the effect of such actions on student cognitive engagement. Negative evaluative comments were based on what the teacher did not do right, especially the response he finally gave as the definition of a pure substance. In total, 14 comments were made for the positive evaluation compared to 20 comments that were negative evaluations (see Table 4.6).

Table 4.6

Examples of the rationale given for an evaluation.

Positive	Negative
The teacher encourages, collects appreciates responses from all corners. Brainstorms the students' minds (sic), helps students think, teacher controls the class well.	Question was above learners' level. He finally gives a confusing answer after rejecting more appropriate answers. Teacher not fully prepared with a good answer. He uses the same word to define what he asked. The teacher's response to the learners' is not good. When one of the learners responds, the teachers says "no", which is not motivating to learners. The question is very high order.

I selected this clip because the question was open-ended and the teacher allowed multiple reactions from the students. The question required learners to create and voice a definition from what they know about purity of substances, rather than from recall, which is a high-order learning level. I also assumed that the PTs would notice that the question was not part of what the teacher planned to ask. The teacher had started using the term and may have noticed that learners needed to understand what the word refers to.

The evaluation was not what I anticipated. I expected this clip to get better evaluation comments than the previous ones. However, the PTs may have become more critical of the teacher's question, as they continued to gain insights into questioning strategies and, so used a higher bar for evaluating what entails a good question.

Chemistry video clip 4: What is the formula of bromine? In the fourth clip, the teacher posed a question that required learners to apply the pattern he had discussed about chemical symbols to come up with the chemical symbol of Bromine. He allowed students to discuss in buzz groups and elicited various reactions from the students. The question also gave the students a chance to offer rebuttals on other students' comments. The transcript of the conversation is as follows:

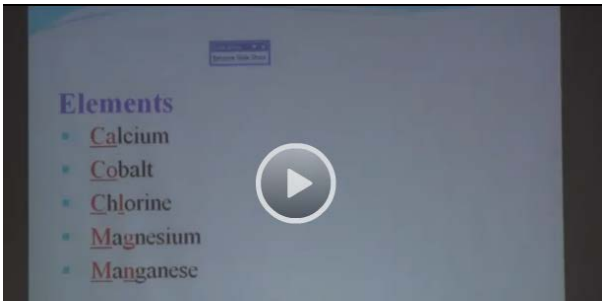


Figure 4.3: The answers students gave were read off from the slide.

Teacher: (*The teacher had shown a list with names of elements. The names had some letters highlighted in Red* (see Figure 4.3). *These letters are the chemical symbols of the elements. He was now beginning to highlight names that would need an extra letter to distinguish between elements with the same first letter. He specifically said that one uses the first letter, and any other letter in the name. He used an example of calcium and starts by highlighting the difference between C and a*). So basically this is what you were supposed to note that the first letter was supposed to be a capital letter and the second letter a small letter. Are you getting that?

Students: Yes

Teacher: Cobalt, chemical symbol for cobalt. (*Many students raise up their hands*) Yes? (*Pointing to one student),*

Student: Capital C and small o.

Teacher: Capital C and small o (*he repeats each student's answer for all elements*). Chlorine? Yes
(Each time, many students raise up their hands to get a chance to respond. They can see the highlighted letters on the board, the teacher points to one student each time from a different corner of the class)

Student: Capital C and small l.

Teacher: magnesium yes,

Students: Capital M and small g.

Teacher: Lastly, manganese.

Student: Capital M and small n.

Teacher: *(repeats student's answer).* Are we getting that? Now with your friend, just discuss and give the chemical symbol for bromine. Just discuss with your friend and give a chemical symbol for bromine.

Student: Bro?

Teacher: Bromine. (*He now goes to the board and writes down the name BROMINE*) You have to discuss just talk among you ok. *(He then allows 32 seconds where there is a buzz of low tones as students talk).* That enough. Hands up! Bromine. Yes?
Student: B, o.
Teacher: It is B, o? Your friends are saying no. Not me, it's your friends. Why are you saying no?
Student: We have been told that it's either its first letter or another letter, and looking at the word Bromine there is no other element's name with the letter B and r so it's supposed to be Br.
Teacher: He says there is no other element
that starts with Br, so Br is
automatic.
Student: There is!
Teacher: Which one?
Student: Boron.
Students: Boron starts with a B.
Teacher: Boron is B or Bo?
Students: B.
Teacher: Does that mean he is correct (*referring to the student who said Br*)?
Students: YES! (One voice said No)
Teacher: Why are you saying no?
Student: Because of bronze.
Students: Bronze is not an element.
Student: What about beryllium?
Student: Beryllium is Be.
Teacher: He is correct clap for him. (*Referring to the student who said Br)*

Prospective teachers' descriptions of chemistry video clip 4. When asked to describe what they noticed, PTs made numerous comments that were grouped as follows: 18 comments took a teaching lens, four on the students lens, 13 on the task and six on power and participation.

Unlike in the previous clips where the PTs described the sequence of activities leading up to the question, they now focused on the ideas that they found relevant. Fifteen of the comments on teaching focused on actions that either conform or differ with the repertoire of the PT's understanding of teaching and learning theories. For example, the presence of biology notes on the chalkboard seemed to irk some of the PTs see Figure 4.4. Blackboard practices comprise part of the skills that are taught in the methods courses. The majority of the comments had a

description of the action of the teacher and a reason why this was either acceptable or not. For example, when one PT said that the questioning technique was poor, he or she added that there was no reinforcement (taken to mean a teacher's appraisal of the student's response). Other than these comments, two made an overall assessment of the teacher's capabilities.

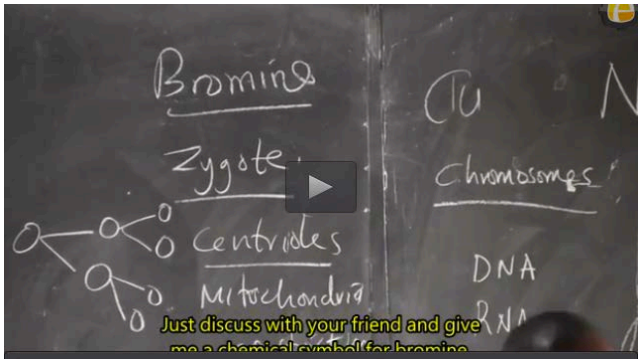


Figure 4.4 Teacher wrote the word "Bromine" on the board that had other writings from another subject.

The fourth video clip featured more student interaction than the others. I anticipated that this clip would demonstrate more meaningful student engagement than had been seen in the other clips. However, only two comments were made from a student lens. Some PTs saw the struggle the learners went through to come up with a response for the question as a problem with the task and not as an opportunity to extend the thinking about chemical formulas. These feelings may be a flawed perception of classroom discussion. One other prospective teacher described how learners offering rebuttals to their peers' responses is not an appropriate classroom practice. This means that he or she noticed the student-student interaction, but do not approve of it.

The comments about the nature of task all focused on the cognitive level of the task. Again, the PTs felt that this question was above the level of learners. The teacher demonstrated a pattern that guided the students to get the correct formula and tasked them to talk in pairs and then share in class what they had discussed. Eventually, the students in class came up with the correct response and refuted all other possible formulas. Despite seeing this, the PTs made 13 comments that clearly concurred on the fact that the question was beyond what learners would know.

The majority (five out of eight) comments on the stance of power and participation expressed the satisfaction that the PTs had with the decision to allow a class discussion in the clip. Most comments not only noted the chance this gave to the students, but also evaluated this method very positively. The other comments that focused on the teacher's reaction to the students' answers pointed to the perceived weaknesses that they saw with the teacher. Some examples of PTs' comments are shown on Table 4.7.

Table 4.7

Examples of descriptive comments from clip 4

Lens	Category	Frequency	Examples of PTs comments
Teaching	How teachers actions agreed or differed with teaching and learning theories	15	The blackboard had writing from the previous lesson. The teacher's body movement was very relevant. Teacher gave high cognitive questions without illustrating.
	Overall teacher evaluation	2	The teacher is not organized in content delivery. He did not rub (erase) the board and writes within biology notes.
Students	opportunity to offer rebuttal	1	Other learners were given a chance to evaluate other's responses, which **is not right.**
		1	Students are keen in class during the discussion.
Task	Cognitive demand of the task	18	Question beyond what the learners can answer.
Power and participation	Opportunity to discuss and share	5	Kudos, the teacher he used a discussion as a method of teaching and also he is able to control the class.
	Teacher not personable	3	The teacher rejected answers without justification. The teacher calls up students by force to give an answer. He says "hands up!"

Prospective teachers' Evaluation of chemistry video clip 4. The positive evaluative stances for this question commended the teacher's decision to use group work, his encouraging feedback to students, and the high cognitive engagement inherent in the question. The negative evaluative stances focused on the perception that the teacher ought to have given students the content knowledge before asking the question. Others saw the level of question being above what is fair for the learners. A total of 14 comments were positive, and 16 comments were negative. Some examples of the rationale given for the evaluation stance taken by the PTs is shown on Table 4.8.

Table 4.8

Examples of the rationale given for an evaluation

Positive	Negative
Learners given time to discuss. Teacher first introduces the symbols then poses the question. Does not pass judgment on the student's responses- not evaluative - but encourages all responses. High cognitive engagement	The level of the question was above the learner's abilities. The teacher should have taught the rules of naming and have students design names of things before coming to the chemical symbols.

I anticipated that this clip would be evaluated very positively. The clip featured multiple moments that would provide PTs an opportunity to observe what the teacher educator described as exemplar practices. The demonstration of Think, Pair and Share in answering questions that are cognitively challenging and requiring students to apply what they have discussed and create a new type of content knowledge were illustrated well in the clip. However, the PTs were more drawn to the errors that the teacher made and reacted sympathetically to the cognitive challenges that the learners faced, and negatively to the rejection of some responses by both the teacher and the other learners.

Trends in prospective teacher noticing from chemistry clips. From these comments, I looked for some general trends about what PTs notice as a teachable moment from viewing a multimedia case of teaching. In preparation for their initial field practice, I asked the PTs what they would like to take forward from the multimedia case based discussion about questioning strategies. I asked them to note down the most significant take home message. I considered these comments, together with reflection notes I made at the end of the lesson in making generalizations in the following section.

Learning is teacher-driven. Prospective teachers pay more attention to teacher's actions in class than they do to students' learning, the task at hand, and the distribution of power and participation opportunities in class. As much as the teacher's role is crucial in directing class discourse, it appears challenging to direct the PTs' way of thinking about teaching and learning to focus on anything other than the teacher. The following two examples of a take home message illustrate this trend, one focusing on the teacher's action and the other on the task.

> Statement 1: Teachers should pose questions clearly, provoke students to think, explain why answers are incorrect, allow all answers and motivate students for trying as this helps get students ideas.
> Statement 2: Good questions helps reveal what learners know, as well as arousing their interest and drawing their attention.

Most comments were worded like statement one. The statement shows the teacher as the controller of learning, and does not pay attention to the quality of task and its impact on student learning. The PTs see it as a responsibility for the teacher to teach students, and then ask them recall questions. When students offer responses, the responsibility of the teacher shifts to evaluation, as he judges such responses as correct or incorrect. Eliciting students' ideas as well as the quality of such ideas are dependent on other things, like the nature of the question posed,

and also on whether the classroom environment supports free participation. This was the idea espoused in statement two.

Prospective teachers' distraction by errors. The PTs consistently paid attention to errors that they observed in the clips. In the first clip, the teacher displayed the answer on the board while posing the question. This error overshadowed PT's ability to notice other teaching moments. Ten of the 20 comments focusing on the task were about the error. In the second clip, a number of comments focused on identification of perceived errors and suggestion of what ought to have been done. In the third clip, the PTs commented extensively on the teacher's use of the word "substance" in the definition of the word "pure substance". In the final segments, although the PTs progressed in terms of their depth of noticing, the teacher, for the first time in the video clip, wrote on the chalkboard but did not erase the other writings from a previous lesson. This became an important moment for the PTs with more than 10 comments on the teacher's action commenting on the poor blackboard skills of the teacher. This shows that the PTs are able to notice moments that the teacher needs to improve faster than they notice exemplary practices. It also shows that PTs notice and attend to the teacher's blackboard practices that had hitherto been taught theoretically.

The evaluative stances taken by the PTs seemed to become stringent as the discussions went on. In my comments, I noted that the PTs liked each video until we held a discussion about it. Those with negative comments were very critical of the clip and may have influenced others who were happy about the clip to start thinking that the questions as well as the questioning strategies were not very good after all.

Inadequate language to support evaluative stances. In general, the PTs were able to critique teaching in a safe environment, though they lacked the skills to justify their negative

criticisms. The theories and ideas taught in their teacher education programs comprised their repertoire of the dos and don'ts of classroom teaching. The PTs have not had any field experiences during their preparation. All they know about teaching comes from both observing their own teachers during their many years of schooling and from teacher education courses. The teaching and learning ideas that were used to justify the stances that the PTs took were gleaned predominantly from Bloom's taxonomy and motivation theories.

Knowing names of students. Another conspicuous trend was the concern that the PTs showed on the need for a teacher to know students' names and using the names to call on students to respond to a question. Once the PTs are in the field, their methods teacher educators require them to learn the students' names. This may make them more personable to their students as it is one way of showing concern for the students. In many instances, the PTs noted that the teacher did not call students by their names.

Off-target estimation of learners' cognitive abilities. The comments about the task focused mainly on the cognitive load inherent in the task. For the same task, some PTs said that it was low while others said it was high with respect to its cognitive demand. However, in other cases, the comments described the task's cognitive demand as too high. I interpreted such comments to imply that the demand of the task is above what learners can cope with. This shows that PTs had problems matching the tasks to the cognitive level of the learners. Since the PTs have not had a chance to go for field placement, they may not be able to know the cognitive abilities of learners, and may draw only from their own experiences as students. It also implies that the PTs determine the cognitive demand of a task based on the ease with which learners retrieve prior knowledge, and not the complexity of thinking required to generate an answer. In other words, PTs think of cognitive activities in terms of retrieval, not generating.

Physics Intervention Lesson

In the following section, I will present the summary of comments made by the physics PTs. The PTs watched two clips: the first was described by the teacher educator as an exemplar demonstration of a lesson introduction, and the second described as a less appropriate example of a lesson introduction. The intervention lesson followed a format identical to the chemistry intervention lesson. The process of viewing episode used the Learning to Notice faming while the analysis of the comments used Roth McDuffie's framing.

Physics clip 1: The cathode ray tube. The first clip, representing what was intended as a demonstration of an exemplar introduction to a good lesson, was about the cathode ray tube. The transcript of the video was as follows:

Teacher: (*The camera is initially set at the back. The teacher appears at the far end of the class, projector hanging from the ceiling at the middle of the class projected desktop image on the screen. There were computers on the sides, and at a television set at the front. On the teacher's table, there is a computer monitor that has been opened, the cover is removed and the tube inside is displayed. The teacher is holding a popular brand of a screwdriver in his hands, possibly from opening the monitor.)* I had promised you an attempt to look at the C.R.T (cathode ray oscilloscope) and CRO (cathode ray tube). We shall look at the CRO later. Many a times you have been meeting items and when I was in class I told you the CRT is not a very special gadget. We have met them before. Our TVs at home, I reminded you that many of the TVs, televisions that we use at home are having that section. The computer screens, which are always on, the market, before the flat screens, before the TFTs came in, they are made of the CRT. So we want to look at the cathode rays and cathode ray tubes. Just as a summary, what we are looking at: we have a presentation, after that presentation we are going to look at the items that are *(point around the classroom to the computer screens).* Where we can be able to find CRTs. In front of me is one of the items we have (*referring to the open monitor*). I have just opened a monitor. A computer monitor is here. We shall be demonstrating the gadgets, which are commonly used or commonly found in CRT. A simple presentation is available here. This one is not having sound but it's a text presentation which is having a summary of the cathode rays and where they are generated (*opens the PowerPoint presentation, a slide that reads "cathode rays and cathode ray tube" is displayed)*. We looked at the spectrum, the E-M spectrum. In the E-M spectrum we have rays of colors of light and other radiations; x-rays, the gamma rays, the ultraviolent rays, the

visible rays, the visible light and others. But we want to see a special kind of ray that is emanated from a point we call the cathode. *(The teacher moves to advance the slide. At this point there is a knock on the door. He responds without turning*) Let him come in. *(The slide now is on focus; it displays the objectives.)* We have a very clear set of objectives. Just the way our expectations are, but by the end of this topic of course this lesson also, we should: (*reading off the slides*)

(1) be able to describe the production of cathode rays,
(2) able to describe, qualitative analysis, qualitative treatment only because we might not go to the tube itself to see this is how they are produced, then
(3) state the properties and
(4) Explain the function of cathode ray tube and the television tube and the relationship of that.

I think for this particular lesson we might only take the first three objectives. The first two objectives and move forward. *(He moves to another slide that has the heading "Introduction" and some information about Tungsten*). Cathode! Eh, a cathode and an anode. In current electricity we always talk of cathodes and anodes, let us remind ourselves, when we talk of a cathode and an anode. What are they? You have met them since form one. Yes? *(Pointing to one student)*

Student: The cathode is the negatively charged terminal.
Teacher: Negative terminal. And an anode? Just continue.
Student: The anode is the positively charged terminal.
Teacher: The positive terminal is the anode and the negative terminal is the cathode. So if we have a section, which is connected to the negative terminal, and we qualify it to be the cathode and it is subjected to very high temperature; you can see that temperature is talking about 2500. We are rarely used to Kelvin in our day-to-day life. How many degrees Celsius are those ones? (*Pauses for some seconds*) Your conversion, what does it give you.
Student: It gives 2227 Degrees Celsius.
Teacher: 2227 Degrees Celsius. You can imagine that kind of temperature. If you put there our normal thermometer in the lab what will happen?

Prospective teachers' descriptions of physics video clip 1. The comments PTs made spread across more than one lens, implying that most participants noticed multiple teaching moments in the video clip. Eleven comments were made about the teacher's actions and a similar number about the task. Four comments were made about power and participation, and two comments were based on student's lens. In all, I analyzed 26 comments under the four areas of focus.

The comments that PTs made about the teacher's action focused on three main areas: (a) the connections that the teacher made of the CRTs to actual television tubes, and also the

apparatus that he planned to use to demonstrate these connections, (b) the statement of objectives of the lesson in the introduction, and (c) the low level of teacher's engagement with students. These comments are consistent with the key ideas that the cooperating teacher educator desired to illustrate in the selected clip.

The two comments that focused on students learning show that PTs were interested in seeing how the learners participate in the lesson. Since they never noticed any form of participation, they made comments about the absence of learner participation. One PT noted that the sitting arrangement of the students could have restricted the movement of the teacher within the class, and that means that he could not engage the learners.

The comments that took the task lens revealed the PTs' concern for two things: (a) how realistic a lesson becomes when there is a connection of the theory in the text book, a physical apparatus and application in real life of the concept, and (b) the pace and affective appeal of the introduction. Some PTs commented on the pace of the teacher as too fast, and based on that, said that they did not like the introduction.

The comments about participation in class were mainly concerned with the way the students are arranged and how that affects the interactions of the teacher and students. Examples of comments that highlight these ideas are given in the table below.

Table 4.9

Descriptions of physics clip 1

Lens	Category	Frequency	Examples of PTs comments
Teaching	Use of connecting examples and apparatus	5	The teacher made the introduction familiar by mentioning TVs which students are familiar with. Teacher uses visual and auditory aids in learning.
	Statement of objectives	5	The teacher has a stated objective, which acts as a guide to his teaching.

	Low level engagement	3	The teacher does not keep in touch with the students. I don't like how he is not concerned with what the students are doing.
Students	Participation in lesson	2	Students did not get a chance to participate in the introduction.
Task	Teacher connects theory-apparatus-gadgets		In the general introduction about CRTS, examples of application were given, and he has an example of CRT, which he plans to use as a demonstration.
	Pace and affective appeal		Introduction is very fast and learners may not be in a position to relate well. The demonstration technique is somehow unappealing. Introduction is very fast.
Power and participation	Poor sitting arrangement and teachers inability to reach students	4	The teacher is restricted in his movements because of the way the students are sitting. I don't like the way the teacher is not concerned with what the students are doing.

Prospective teachers' evaluation of physics clip 1. During the discussion of the clip, I told the PTs to evaluate the clip and say what they liked or did not like and provide reasons. Most of them said that they saw this as a good introduction. The reasons they gave for the evaluation were mainly based on the (1) examples that teacher gave in class to relate the lesson to real life, (2) the demonstration that the teacher planned to show in the classroom, and (3) the statement of the lessons objectives. Beyond these ideas, isolated PT comments mentioned the projection of the teacher's voice, the link that he provided with the previous lesson, and the demonstrated content mastery. Those who evaluated the lesson introduction negatively said that the teacher did not give the learners an opportunity to participate. They also noted that the teacher did not give the meaning of the initials CRO and CRT. One participant described the movement of students as distractions and based his negative evaluation on the inability of the teacher to notice these and take action.

Only one person gave a wholly negative evaluation. All the others gave robust positive evaluations and mentioned one other thing that they did not like about the clip. The negative evaluation was based on an assessment of class management issues, as well as unfulfilled prospective teacher's expectations about student's participation. Science teacher educators require their PTs to have a student-centered lesson, and student participation is therefore a valued aspect of a lesson. Listening to information that a teacher is giving, was not considered as participation by the PTs. Some examples of the rationale given for positive and negative are given on Table 4.7

Table 4.10

Evaluation of physics clip 1

Positive	Negative
Lesson made real by use of apparatus, and real examples, the use of real CRT makes students grasp and connect real things to the syllabus, lesson well introduced. Excellent introduction, various examples and well stipulated objectives	I would give a 3/10, he is an average teacher, he loses of attention of students, which leads students to also lose track, and then, fail to achieve objectives. No clear explanation of the term CRO, the learners should be more involved. Generally, the introduction was poor. Teacher's method of introduction is blunt and lacks attention of the students. The teacher cannot realize the presence of distractions, which limits student's attention.

At the conclusion of the clip, the PTs were asked to suggest how they could improve the introduction that the teacher presented if they were to do the same lesson. They noted their suggestions on the worksheet. Their remarks centered on how they could integrate more student involvement through a question and answer strategy to prepare the learners for the lesson and evoke prior knowledge. One PT wrote that the "introduction should make learners ready to learn, a teacher should ask them the previous content that is relevant" and another said that "the teacher

should use questioning to confirm the previous knowledge of the learners" (MMC Physics worksheet, 2015). Most of the suggestions were about these two ideas, both of which focus on enhancing learners' involvement.

Others suggested how they would enhance the discipline and general management of students especially since there was a knock in the door that was interpreted as lack of classroom order. (The class was held in a computer room and the students had to walk from their usual class) For example, one prospective teacher wrote, "teachers should ensure that the sitting arrangements of students is well designed" while another suggested that "the only thing that could make the lesson more perfect is that the teacher should minimize interruptions" These comments focus on class management issues.

Physics clip 2: Simple circuits. The second physics clip was what was identified as a non-exemplar. The teacher projected a PowerPoint slide on a wall. The power point read "simple circuits". A transcript of the video is as follows.

Teacher:	So we having the topic of a subject physics, and it is current electricity. Can you write there current electricity. (Instructing students to write the heading on their notebooks). Now, we have just gone through the understanding of static charges and how they affect each other. One of the things that we did under the static charges was that when charges are addressed and they happen to be brought near each other there is possibility of attraction or repulsion. Now, can somebody tell us which charges attract? Yes?
Student:	Unlike charges.
Teacher:	A bit louder.
Student:	Unlike charges.
Teacher:	Maybe you can tell us what is your name?
Student:	Francis.
Teacher:	So you are saying what happens to unlike charges?
Francis:	Unlike charges attract.
Teacher:	Unlike charges attract. Isn't? And which one repel? Can you tell us? Yes?
Student:	Like charges.
Teacher:	Like charges do what?
Student:	Repel.
Teacher:	Like charges do what?

Student: Repel.
Teacher: So in this case, we are to realize that there are forces that affect the charges when they come close to each other. So in the making of electrical circuits, we tend to make arrangements, whereby those forces of attraction and repulsion will enable the movement of charge inside the materials that are able to reinforce the flow of charge. So, here we are dealing with circuits and the means by which, we are able to make a setting for us to enable the movement of charge. Is that clear?
Students: Yes.
Teacher: That circuits are used to enable the movement of what? Charge, isn't?
Students: Yes.
Teacher: So can we write that. *(The teacher allows a 30-second pause for students to make notes from what he had said. The students quickly start to scribble on their notebooks. The camera focuses on two students who seem busy writing. It seems like they were not sure of what to write).* Now having taken note of that, I would like to have one of you come here. *(A male student comes up. He is given a broom with a long broomstick).* We shall use this. I would like you to point at this part here. *(The teacher places a mouse on a part of the circuit, which is now displayed on a slide. He wants the students hold the broom and point with the stick on the cell in the circuit).* This part here. Are you seeing that part? Can you move so that others are able to see *(the student holding the broom moves to the side, but is still pointing at the part on the slide he was asked to point).* You see that part there?
Students: Yes.
Teacher: Yes, just remove the stick from there, now that part inside a circuit is called a cell. It is called what?
Students: A cell.
Teacher: A cell, or a source is the part that provides for the force that moves the charge in the circuit. That cell where the source is, is the one that provides for the force that moves charge in the circuit. We got that?
Students: Yes.

Prospective teachers' descriptions of physics video clip 2. After viewing the clips, the PTs became animated and all wanted to share something in the discussion. It was clear that they had much to comment on regarding the clip. Perhaps this was because the previous clip had given them something to build on. However, looking at their worksheets, it appears that most of them wanted to express their feelings about the areas that the teacher needs to improve. The 30 comments that I analyzed spread across the lenses as follows: 12 comments on teaching, nine

comments on the task, seven on power and participation and only two on the student learning lens.

Some of the comments that focused on the teaching were expressions of both affective and academic evaluations of the conduct of the teacher. A number of PTs described the whole lesson introduction in terms of the teacher's action. For example, one said that "the introduction is poor, because the teacher is too fast" while others said that "it was a good lesson introduction because the teacher involved the students". Other comments on the same lens focused on the content of the introduction, specifically highlighting what was included or excluded. The PTs noted the ideas that were part of the lesson introduction in the first clip, and used these ideas as a mental checklist of what comprises a good lesson introduction. When the ideas were not seen in the second clip, most PTs made comments that showed the second clip as deficient.

The comments that were about student learning focused on the struggle learners had trying to cope with note taking and unclear statements. This comment was a reaction to an episode in the clip where the teacher gave an account of what causes the charges to move, and asked students if it was clear. The students said it was clear, and so he asked them to note it down in their notebooks. When the camera zoomed in on two students bent over their notebooks, it appeared that they were not sure what to write.

The comments on the task focused predominantly on what missed in this clip compared to what the PTs had seen on the previous clip. The use of real-life examples was seen as an important thing to have in the introduction in the first clip and so PTs were looking for that in the second clip. The PTs commented that the information presented to the learners was disjointed and lacked coherence. Though the teacher may have been systematic in covering his planned lesson, he also included many other activities not related to circuits, for example, class

management issues (asking students to repeat their responses louder), the making of notes (when he paused for a short instance to allow note making) and systematic participation instructions (where to stand while pointing on the slide). These activities may have been perceived by the PTs as interruptions of a smooth flow of information.

The comments that focused on power and participation were mainly about the ways in which the teacher engaged the students in the lesson introduction and the sitting arrangement of the students in the class. One PT noted that the teacher does not know the students names. He asked them to state their names. This is deflating for learners as they feel like they do not belong to the class, or that they are not significant. A sample and frequency of the comments is shown in Table 4.11

Table 4.11

Descriptions of physics clip 2

Lens	Categories	Frequency	Examples of PTs comments
Teaching	Conduct of teacher	7	This is the worst introduction; the teacher does not have mastery of content. The teacher is not effective. Summary of other descriptors- pace very high/ not competent/poor questioning skills/ insignificant questions/ Poor chalkboard work/ too fast but not eloquent.
	Content of the introduction	5	Teacher could not connect clearly to the new topic. Students were not given real life examples to connect to the lesson. The teacher has reviewed the previous prerequisite knowledge.
Students	Student's struggle	2	Many students were not following since they were looking at each other's books.
Task	Missing from the clip	4	He did not give real life examples, teacher needs to explain key words as well as give objectives.

	Coherence of the content	5	Not specific to the content- jumps around content, unnecessary including in the intro.
Power and participation	Student engagement	4	The teacher engages the students by asking them to point at one of the pictures
	Sitting arrangement	2	Sitting arrangement is good and so the teacher movements in class are also okay.

Prospective teachers' evaluation of clip 2. A majority of the evaluative stances takes on the clip were negative. The PTs noted that: the teacher did not connect the lesson's content to prior knowledge, did not share objectives with his learners, and that his sentences lacked clarity. A number of other PTs based their evaluation on the absence of the ideas they would have expected in the introduction, most of which were gleaned from the previous clip. The positive evaluation was based on the teacher's ability to involve the students, his confidence and the projection of his voice. The PTs saw this as ability to control the class. Examples of comments that highlight these ideas are shown on Table 4.12. Eight comments were categorized as positive, while 14 excerpts reflected a negative evaluation stance.

The PTs' ability to justify their evaluative stances was notably accompanied by some improvement from the previous clip. For example, one participant noted that the teacher does not clearly advance the thinking of the force between positive and negative charges and how this would result to current. This remark reflects a prospective teacher's observation that the teacher gave a surface treatment of the connection of static charges to current electricity, and also shows the PTs understanding of the importance of such a connection in advancing students' mastery of the concept by connecting ideas to what is already known to the learners. Another PT noted that the use of diagrams should not be a replacement for showing actual circuits with wires, batteries and a bulb. This comment is important especially since the uptake of technology in teaching is often seen as a substitute for the important hands-on activities that learners should engage in.

Table 4.12

Evaluation of physics clip 2.

Positive	Negative
He involves learners in the lesson and this makes the lesson lively, participatory and interesting. The teacher used demonstration, which was good. The teacher was in control of the class. The teacher creates room for student participation, which is good. Sound projection is good.	The teacher was too wordy and lacked mastery of content making the introduction ambiguous. No examples, no objectives, little student involvement, I would give it 3/10.The question will charges repel or attract is not significant. I did not learn anything from this introduction. It was full of mistakes. The teacher lacked skills of teaching physics.

After the discussion, the PTs noted down some of the modifications that they would make on the introduction of the same lesson if they were to execute it. A number of these comments said the ideas they would include, are things such as lesson objectives, real examples and a review of the previous lesson. Other PTs suggested that a teacher needs to be conversant with the content in order to teach effectively. One PT said that "the introduction should show a show a good mastery of content and clarity". This means that one would need to be comfortable with the content before going to teach it.

A few PTs identified the modifications they would make and expressed them as suggestions to the teacher. For example, one PT said" the teacher should reduce the pace" and another said that the "the teacher should be sure that learners are aware of what to write down (as notes)" A different PT advised that the teacher "should not lead the learners into the answers but rather let then give the answer in order (for him) to get full evaluation (accurate assessment of learners)". Though these modifications are by all means reasonable, they raise two other questions: why are the PTs not seeing themselves as teachers in this lesson? Do these comments

imply that the PTs see their role as an assessor of the video teacher? Whichever the case, the comments show that the PTs see MMCs as a safe way to critique teaching.

Trends in prospective teacher noticing from physics video clips. From the comments made after watching the two clips, as well as the suggestions for improving the lesson introductions, I looked for the general trends in noticing of teachable moments. I used the objectives that Professor Polaris and I had identified for this intervention lesson to identify the significant trends.

Deductive learning from case episodes. The cooperating teacher educators and I wanted to highlight three tenets of a good and engaging lesson introduction: The lesson introduction should (1) make connections between the present and past learning experiences, (2) highlight the anticipated activities and expected outputs from the students, and (3) be presented in a way that is organized and pleasant. By watching the first video clip, the PTs were able to make comments that show that they valued the connections the teacher made between everyday gadgets that use a cathode tube to the lesson of the day. Five of the PTs noted that the teacher shared his lesson objectives with the learners, and most evaluation comments commended the organized way the teacher outlined the lesson structure at the beginning.

The significance of these incidences was further shown by what the PTs noted that in the second clip, the ideas they had deemed important were missing. This shows that MMCs were used to deductively introduce the three instructional strategies to PTs. It also highlights the importance of using exemplar cases, mixed with problematic cases; one to draw from and the other to apply to the leaned knowledge.

Teacher-driven learning. Just like in the case of the chemistry video clips, most of the comments that the PTs made were about the instructional activities of the teacher. The PTs

focused more on the role of the teacher in driving forward the lessons agenda. Both lessons were done in nontraditional classrooms. Ordinarily, when in their class, students sit behind desks arranged in rows facing forward. The teacher's space is at the front center, next to the chalkboard, and a teacher's class movements are in systematic and organized ways along the aisles. Most common rooms in Kenyan classrooms, such as laboratories and computer labs, are more suited for students to work in groups. I expected that the PTs would notice the enhanced student interactions in the set-ups, but they saw this arrangement only in terms of teacher's convenience. In the second clip, PTs saw that an odd sitting arrangement that makes the teacher unable to control learning. In the first clip, they saw the arrangement as making it easier for the teacher to interact with students. Prospective teachers ignored the evident enhanced opportunity for student-student interaction, most PTs noted how this set-up affected the teacher's instructional activities.

Effect of Multimedia Cases on Prospective Teachers' Self-efficacy

In this section, I answer my second research question: what is the effect of using multimedia cases on prospective science teachers' efficacy beliefs? First, I highlight how I operationalized the variables in this analysis, then I explain and provide results of the pre-analysis operations that measured the reliability and normality of the data. Next I provide justification for treating the physics and chemistry group as homogeneous and then present the results as hypothesis testing using a paired-sample t-test.

Data Pre-analysis

Description of variables. Efficacy determines the choice of activities, the amount of effort one would expend on the activity, and how long one would sustain effort in dealing with a stressful situation (Bandura 1997). Therefore, it is a suitable construct for measuring PTs'

preparedness to teach, especially in environments that do not have effective support and supervision of field experiences. The construct is also very situation specific. For prospective chemistry and physics teachers, I modified the questionnaires to reflect questions that were specific to each subject. However, I will refer to the combination of chemistry and physics scores as science teacher's efficacy beliefs (STEB) to maintain consistency in the naming of the scale that I used, and also to abbreviate the common reference to these two subjects as physical science. This reference to physics and chemistry as "science" differs from Enoch and Riggs' (1990) reference to science as a single subject that is taught in elementary school.

STEB has two constructs: personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE). PSTE is a person's belief in his or her ability to teach science effectively and STOE is the belief that effective teaching will have a positive effect on student learning. PSTE and STOE are independent of each other. Of the 23 items on the STEB instrument, 13 measure PSTE by asking PTs to mark on a five-point Likert scale the extent to which they agree or disagree with a statement about teaching. An example of such a statement is, "I do not know what to do to increase a student's interest in physics" (The negatively-worded statements are mixed with positively-worded statements throughout the questionnaire). The other 10 items measure STOE and include items such as, "The low physics achievements of some students cannot generally be blamed on their teachers."

Alongside the STEB instrument items, I asked the participants to provide some demographic information on the pretest questionnaire. The demographic items included items asking for the gender, age, type of secondary school attended, as well as whether the participant had completed other post-secondary training, other than the teacher education program they were currently enrolled in. The posttest questionnaire, in addition to the 23 items, asked the

participants to gauge on a scale of 1-10 the effectiveness of the MMC-based intervention lessons. In both the pretest and posttest questionnaires, I asked the participants to label their completed questionnaires with a telephone number. I used these numbers to match the pretest and posttest, as well as to recruit for subsequent parts of the study.

Data pre-coding and cleaning. Respondents completed and submitted a total of 98 pretest and 151 posttests questionnaires. I entered the responses on a spreadsheet and developed a codebook for handling the missing data items using methods described in Fox-Wasylyshyn and El-Masri (2005), Little and Rubin (2002), and Newman (2014).

There were three ways that data were incomplete: (1) Missing response at item-level - where there was a random or non-random missing response on a questionnaire (Fox-Wasylyshyn & El-Masri, 2005), (2) missing data on a construct-level - where there were multiple missing responses that exceed 10% of the expected responses on one questionnaire (Newman, 2014), and (3) data missing at a person-level - where a respondent had not completed more than 30% of the expected responses (Newman,2014). Each of the questionnaires with a missing item was retrieved for crosschecking.

Questionnaires with person-level missing data ($N_{incomplete}$=108) in this study were occasioned by a person not completing both a pretest and a posttest. There were also some questionnaires that did not have responses on one full page. Since the missing items were more than 10% of the total expected responses, I deleted these questionnaires from the analysis.

There were questionnaires with randomly missing responses for items 1-23 on the pretest. Since these questionnaires had missing responses at item-level, I entered the mean of the completed responses for that item. This was necessary in order to retain sample size and thereby minimize the attenuation of statistical power (Little & Rubin, 2002). Sample mean substitution

involves replacing a missing datum for each of the cases with the mean for that item calculated from the sample. This method works well when the scores are normally distributed (Fox-Wasylyshyn & El-Masri, 2005; Little & Rubin, 2002). My sample satisfied this condition and hence the mean substitution. Finally, a sample of 41 (n = 41) participants was used in the analysis.

Reliability and normality. Before analyzing the data, I checked the reliability of the Likert-type items. Since the scales for PSTE and STOE are independent, I first evaluated the reliability of each of the scales independently by calculating the Cronbach alpha statistic, and then evaluated the reliability of the whole scale. The Cronbach alpha of the 13-item scale PSTE construct was 0.681. The 10-item STOE construct had a Cronbach alpha value of 0.704. The combined scale for measuring STEB had a Cronbach alpha coefficient of 0.703 (see Table 4.1). Nunnally (1978) suggested that it is important to have high alpha coefficients in basic and applied research but explained that in the early stages of research, it would save time and energy if one considered modest reliability. Nunnally also recommended reliabilities above .70. The overall scale, as well as the STOE scale, meets this threshold.

Table 4.13

Cronbach Alpha statistics

Scale	Number of items	Reliability coefficient
PSTE	13	.681
STOE	10	.704
STEB = PSTE + STOE	23	.703

Demographics of the Sample

In this section, I present a description of the demographic characteristics of the participants and a description of the similarities between the sample and the population (see Table 4.14). I sought the age, gender, type of high (secondary) school attended and if they have had any post-secondary training other than the teacher education progarm. The questionnaires were marked differently for chemistry and physics intervention lessons.

Table 4.14

Demographic characteristics of the participants

Demographic characteristic	Category	Frequency	Percentage
Age	Between 20 and 25 years	40	97.6
	Between 25 and 30 years	1	2.4
Gender	Male	30	73.2
	Female	11	26.8
Intervention Subject	Physics	15	36.6%
	Chemistry	26	63.4%
High school attended	National	9	22.0%
	County	11	26.8%
	District	20	48.8%
	Private	1	2.4%
Other post-secondary training	**Had other training other than the TEP**	**9**	**22 %**
	No other training other than the TEP	32	78%

Prospective teachers' ages were mainly between 20 and 25 years (97.6%). This is consistent with the age demographic of third-year university students in the Kenyan education system. Most

Kenyan pupils enroll for primary school (grade 1) at six years old. Primary school lasts eight years and culminates with a national examination that is used as a basis for placement in secondary schools. Secondary school (grade 9-12) lasts for another four years. Each grade level takes one year and leads to a promotion to the next level, usually with minimal grade repetition. This means that most students graduate from high school when they are 18 years old. Since the PTs in the sample were in their third or fourth year in the teacher education program, their age category would likely be 21-22 years.

The majority of the participants were male (73.2%), which is consistent with estimates given by the cooperating teacher educators. The chemistry teacher educator estimated the class to be 70% male, while the physics cooperating teacher educator estimated the male population at 90%. Since the sample had more chemistry than physics PTs, the observed percentages of gender matches the sample population.

Only 22.0% of the sample attended national secondary schools. The few national schools in Kenya are better quality schools, and have students achieving higher grades in the final national examination than most other schools. They therefore have a higher transition rate to competitive university courses. The PTs who join teacher education programs from national schools are usually those that graduate from these national schools in the lower quartile with only a minimum university entry requirement. Teacher-training programs are regarded as not competitive courses since their admission cut-off point is also the lowest entry requirement for university education (CUE, 2014). The majority of the PTs in this study came from district schools (48.8%). District secondary schools in Kenya have low transition rates to universities. Only a few students from these schools make the minimum university entry requirement. A majority of these are admitted to less competitive university courses. The sample therefore

represents the students admitted to teacher education programs from the lower quartile of national schools and the upper quartile of district schools. The transition rate of the county schools lies in between these two extremes.

Though the cohort that was in session during the intervention lesson was admitted into the university six months after their results of the national examinations were released, 22% reported to have completed a post-secondary program alongside the teacher education program. Seventy-eight percent of the sampled PTs transitioned from their secondary school into the university to start their teacher education program without doing any other training.

Differences between the physics and chemistry groups. To determine if there was a difference in the mean scores of the chemistry and physics groups, I carried out Levene's test of variance for the two subscales PSTE and STOE, and the overall STEB scale. Though, the changes in means for the physics and chemistry groups were different for both the scales after the intervention lesson, this difference was not statistically significant. For example, the personal science teaching efficacy (PSTE) of the physics PTs changed by an average of 0.5 (SD = 3.93), while the mean change for the chemistry group was 0.94 (SD = 3.03). This change was not significantly different (F=1.605 *p*=.213). The mean of the science teaching outcome expectancy (STOE) changed by .67 (SD = 4.17) for the chemistry group and 2.42 (SD = 3.98) for the physics group; however, this change was not significantly different (F=.450 *p*= .506). The mean for the overall science teaching efficacy beliefs changed by 1.67 (SD= 5.8) for physics and 3.37 (SD = 5.53) for the chemistry group. Again the difference in this change was not significant (F=0.033 *p* = .857) (Table 4.14).

Table 4.14

Levene's test for physics and chemistry groups

Scale	Changes in mean between pretest and post test		Levene's Test for Equality of Variances	
	Physics	Chemistry	F	Sig.
PSTE	0.5	0.94	1.605	.213
STOE	0.67	2.42	.450	.506
STEB	1.67	3.37	.033	.857

Levene's test for equality of variance indicated that the observed differences in the changes in mean for both the PSTE and STOE subscales, as well as the combined scale STEB, were not significantly different for the chemistry and physics group of PTs. Thus in the subsequent data analysis, I will take these groups to be homogenous and I will use the term 'science' to refer to both chemistry and physics.

Changes in Self-efficacy on the Questionnaire Items

Next, I computed the mean from pretest to posttest for all the participants on each of the items on both scales. The PSTE scale has 13 items, I ranked these items from the lowest change to the highest (see Table 4.15).

Table 4.15

Changes on the mean score of PSTE

Item no.	**Item wording**	**Mean score PSTE at pretest**	**SD**	**Mean score of PSTE at post test**	**SD**	**Change in PSTE**
17	I will not find it difficult to explain to students why science* experiments work	4.27	0.92	4.02	1.34	-0.25

23	I know what to do to turn students on to science.	4.51	0.71	4.34	0.83	-0.17
12	I understand science concepts well enough to be effective in teaching elementary science.	4.34	0.69	4.24	0.73	-0.10
22	When teaching science, I will usually welcome student questions	4.73	0.50	4.71	0.46	-0.02
6	I will not be very be effective in monitoring science experiments**	4.41	1.00	4.41	1.07	0.00
8	I will generally teach science ineffectively**	4.71	0.72	4.76	0.80	0.05
18	I will typically be able to answer students' science questions	4.24	0.83	4.29	0.90	0.05
2	I will continually find better ways to teach science.	4.83	0.38	4.90	0.30	0.07
5	I know the steps necessary to teach science concepts effectively	4.10	0.58	4.17	0.83	0.07
20	Given a choice, I will not invite the principal to evaluate my science teaching**	4.39	0.92	4.59	0.84	0.20
19	I wonder if I will have the necessary skills to teach science**	4.32	0.82	4.59	0.67	0.27
3	Even if I try very hard, I will not teach science as well as I would most subjects**.	4.51	0.81	4.78	0.42	0.27
21	When a student has difficulty understanding science concept, I will usually be at a loss as to how to help the student understand it better**	4.00	1.07	4.34	0.91	0.34
	Average	4.46	0.77	4.40	0.88	-0.06

- *I am using the word "science" to represent physics and chemistry
- ** The negatively worded items were reverse-coded before evaluating the mean

There were four items with a decrease in the mean score of PSTE. There was a change of less than .01 in six of the items, and four items had a positive change. The overall change in PSTE was -0.06, which is quite small for a scale that ranges from 5-Strongly agree to 1-Strongly disagree. The personal science teaching efficacy of all the PTs is very high, 4.46 (SD=.77) out of 5 at the beginning and 4.40 (SD=0.88) after the intervention lesson. The highest scores were observed in items 2 ("I will continually find better ways to teach science").

I computed the means for the STOE scale both at pretest and posttest to understand the changes across each of the items. There are 10 items on this scale. I ranked the changes from the lowest to the highest (see Table 4.16).

Table 4.16:

Changes on the mean scores of STOE

Item no.		**PreSTOE**	**SD**	**PostSTOE**	**SD**	**Change in STOE**
11	When a low-achieving child progresses in science, it is usually due to extra attention given by teacher	4.24	0.73	4.17	0.97	-0.07
13	Increased effort in science teaching procedures little change in some students' science achievement*	2.78	1.28	2.71	1.06	-0.07
15	Students' achievement in science is directly related to their teacher's effectiveness in science teaching	4.27	0.98	4.32	0.72	0.05
1	When a student does better than usual in science, it is often because the teacher exerted little extra effort.	3.85	1.15	3.93	1.15	0.08
9	The inadequacy of a student's science background can be overcome by good teaching.	4.49	0.68	4.63	0.54	0.14
4	When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach	4.20	0.98	4.39	0.63	0.19
7	If students are underachieving in science, it is most likely due to ineffective science teaching*	3.41	1.36	3.68	1.15	0.27
16	If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.	3.78	1.13	4.07	0.93	0.29
14	The teacher is generally responsible for the achievement of students in science.	3.68	1.17	3.98	1.04	0.30
10	The low science achievements of some students can be blamed on their teachers.	2.12	1.19	2.73	1.16	0.61
	Average	3.68	1.06	3.86	0.93	0.18

*The negatively worded items were reverse-coded before evaluating the mean.

Prospective teachers' science teaching outcome expectancy was not as high as their personal teaching efficacy. This means that although they feel like they can teach effectively, they do not think that their teaching approaches will produce good student outcomes. Their outcome expectancy was 3.68 (SD=1.06) at the pretest and 3.86 (SD = .093) at the posttest. The lowest score on this scale was on item 10, which ascribed blame to oneself for the poor performance of students. This shows that these PTs do not feel that they are to blame for poor

student performance. On the other hand, the highest scores were those that ascribed students' success to the efforts of the teacher (Item 4, 11 and 15). This implies that these PTs feel that they are responsible for the good performance or improvement in the performance of students.

Hypothesis Testing: Paired-sample t-test

According to Leech, Barrett, and Morgan (2007), a paired-sample t-test can be used to compare the means of two related samples on the same continuous variable. The mean of the scores should assume a normal distribution. I tested this condition first before doing the t-test. I used the Shapiro-Wilk Test to check if the data deviated from a normal distribution. The results showed *p* values of .087, .321, and .700 for the STOE, PSTE, and STEB scales, respectfully. Since the *p*-value of this test is greater than .05, we assume that the distribution of the data do not significantly deviate from the normal curve.

Since the conditions for a paired-sample t-test were fulfilled, I tested the following three null hypotheses and corresponding alternative hypotheses:

1 (a). There is no statistical difference between the mean scores from pretest to posttest on the PSTE scale for the PTs.

$$H_{0pste} = H_{0pste}$$

1(b). There is a statistical difference between the mean scores from pretest to posttest on the PSTE scale for the PTs.

$$H_{1pste} \neq H_{1pste}$$

2 (a). There is no statistical difference between the mean scores from pretest to posttest on the STOE scale for the PTs.

$$H_{0stoe} = H_{0stoe}$$

2 (b). There is a statistical difference between the mean scores from pretest to posttest on the STOE scale for the PTs.

$H_{1stoe} = H_{1stoe}$

3 (a). There is no statistical difference between the mean scores from pretest to posttest on the STEB scale of the PTs.

$H_{0steb} = H_{0steb}$

3 (b). There is a statistical difference between the mean scores from pretest to posttest on the STEB scale for the PTs.

$H_{1steb} \neq H_{1steb}$

I carried out paired-sample t-tests to determine if the changes from pretest to posttest were statistically significant. The results showed that the change in mean of PSTE from the pretest mean to posttest was not statistically significant at the 95% confidence interval (*M* =0.78, *SD* 3.3 *t (40)* =1.492 *p*=.144). The changes in mean of STOE from the pretest mean to posttest were statistically significant at the 95% confidence interval (*M* =1.78, *SD*=4.1 *t (40)* =2.788 *p*=.008). The overall change in mean of STEB from the pretest to posttest was statistically significant at the 95% confidence interval (*M* = -2.56, *SD*=5.8; *t (40)* = 2.802 *p*=.0.008) (see Table 4.17).

Table 4.17

Paired-sample t-test

Construct	Mean	t	SD	Sig (2 tailed)
PrePSTE - PostPSTE	-.78	1.49	3.35	.144
PreSTOE - PostSTOE	-1.78	-2.79	4.09	.008
PreSTOE - PostSTOE	-2.56,	2.80	5.8	.008

Hypothesis 1(a) was not rejected and therefore there was no significant change in the personal science teaching efficacy of PTs after using multimedia cases in the lesson. Though a net decrease in the mean score was noted, the decrease cannot be explained by the intervention

lesson. This finding means that multimedia cases did not affect the beliefs that teachers have about their ability to teach.

Hypothesis 2(a) was rejected, which means that the prospective teacher's teaching outcome expectancy increased when they were taught using multimedia cases. In other words, the PTs' believe more strongly that the way they teach will have a positive outcome on a student achievement in science.

Hypothesis 3(a) was also rejected. This means that the self-efficacy of PTs increased after having a multimedia case-based lesson. This finding means that the PTs' belief in their capacity to teach in a way that will improve students' academic achievements increased after the lesson with multimedia cases.

What Prospective Teachers Draw from Multimedia Cases

In this section, I answer the third research question: What do PTs (PTs) draw from multimedia cases (MMCs) in their teaching practices? I summarize the data from eight PTs who I interviewed during their teaching practice. For each of these PTs, I give a brief background of who they are, and then describe the school at which they doing their teaching practice. I then highlight the teaching experiences that informed their emerging teaching philosophy. Next, I highlight the ideas that these PTSs gleaned from the use of multimedia cases and how they were using these ideas in their teaching practice. Finally, I will summarize by highlighting noticeable patterns across all the participants.

I selected eight PTs using convenient sampling methods. I considered accessibility, convenience, cost, and type of schools. The participants were doing their teaching practice in Nairobi, Kiambu and Embu counties, and in schools that are near the main highway. These counties were easily accessible during the data collection period of May-July 2015. The

participants consented to the option of a phone call to schedule the follow up interview. I obtained a list of the schools each of the participants posted for their teaching practice from the university's office of teaching field placements. I then made an appointment and conducted a 45- to 60-minute interview with each of them.

I selected four participants from Nairobi County since it is a large city. I selected two participants from Kiambu County and another two from Embu County. A summary of each participant's location and their subject is shown in Table 4.18.

Table 4.18

Participants' details for clinical interviews.

Name of participant	Gender	County	Subject	Type of school
Eric	Male	Embu	Chemistry	National
Juma	Male	Embu	Physics	District
Bernie	Female	Kiambu	Physics	Private
John	Male	Kiambu	Chemistry	Private
Shauline	Female	Nairobi	Chemistry	private
Faith	Female	Nairobi	Chemistry	County
Ambrose	Male	Nairobi	Physics	District
Nick	Male	Nairobi	Physics	National

Ambrose's Profile

Ambrose is a fourth year mathematics and physics prospective teacher. He is one year behind his cohort since he deferred entering university for one year due to ill health. Other PTs (PTs) in his cohort had completed their teaching practice the previous year. He graduated from secondary school in a county school in central Kenya and scored a B+. Ambrose's hopes of getting a better grade and pursuing electrical engineering were spoiled by his performance in Kiswahili. Due to this passion for electrical engineering, Ambrose was disengaged during the

first two years of teacher education at the university. He told me that his third year at the university was the first time he woke to the reality of teacher preparation.

> I got placed for education by accident, so for the first and second year I still had the mentality that maybe my family will get cash then enroll me for a parallel course in electrical engineering, but it never happened.

Ambrose was doing his teaching practice in a single-streamed mixed-gender, day school in an informal settlement area of Nairobi (slum). The school had about 250 students, mostly from low social economic backgrounds. The school enrolls students from its neighborhood and has a relatively high truancy and dropout rate. It lacks the resources that Ambrose thinks would be needed to help students learn.

Teaching philosophy. Ambrose sees himself as a student-focused teacher, rather than a teaching or content-focused teacher. This means that he pays more attention to students' understanding of the content than both the extent to which he advances the syllabus and his evolving practice of teaching. He tends to diagnose and remedy student lack of understanding by offering to do more teaching, even when he knows that the students hardly come.

> I look at the students (to see) if they understand; if they understand, then I am okay. I am ready to move on to the next thing. If they don't, then I feel bad. Then I have to call those who have not understood or anyone else to come and see me during their free time so that I can explain to them personally. Unfortunately, (laughs) just a few come. Maybe two or three in a class of thirty, so that is discouraging to me.

Though Ambrose knows that the strategy of asking students who have not understood to go and see him is not effective, he still keeps relying on it. When students go to see him with difficulties in understanding, Ambrose explained to me how he modifies the instructional language to make his ideas accessible to students.

> I use the language now. Because in class I only use English, so now I use other language like Sheng (informal urban mix of Kiswahili and English) and I find that they have understood better.

In our discussion, with Ambrose, he kept going back and forth to the informal urban language. It could be that using the informal language makes the students understand faster, or that the language makes him explain better.

Ambrose combines such strategies with what he described as adequate content mastery. He told me that so far he had not "found anything challenging both in high school and the university." He told me that he is able to present physics content in ways that are different from those suggested in the course book. Ambrose believes that physics is a simple subject. He sees it as a set of facts that one needs to know, "unlike other subjects which have stories that can be twisted. It is a fact-based subject and once you know that a day has 24 hours that will never change." This means that he sees his subject a set of facts that need to be mastered as they are.

I sought to know how Ambrose acquired the set of teaching skills that he used. He told me that he does not think he learned how to teach from the teacher education program (TEP) courses. He explained to me that his experiences so far confirmed what his colleagues in his cohort had said about teaching practice:

> My friends had told me that you learn in the field. It's like what you were taught in the class is not reflected in the field. So you just learn for the sake of passing the exam. And I agree with them like 80%.

This means that even when Ambrose is doing the things that they were taught in the methods classes, he may not be aware that he is drawing from them. He feels that he learned the theories taught in the methods courses for the examinations.

However, he described to me the experiences he had with his Physics and Kiswahili teachers in secondary school. The Kiswahili teacher was very soft spoken and was usually "speaking to himself" in class. This experience helped him remember that he has to be audible to students all the time: "I make sure that my voice is audible. Also, I move around the class just to

see what the students are doing." The physics and mathematics teachers had the most positive impact on him because they "reminded us of what we had learnt yesterday." The mathematics teacher would "give some examples" and mark for "just few bright students who were able to finish, then give them additional questions as he is attending to others." These comments highlight the positive and negative ways that many years of schooling influenced Ambrose.

Ideas drawn from MMCs. Ambrose made summative evaluations of the teachers that were featured in the multimedia cases. He assigned a label "business-man" to one teacher and "real teacher" to the other. (A businessman in his context is a person interested in only profit without regard for customer satisfaction.

> The videos helped me a lot, like there was this video of a lady and the older man. The man was like a businessman, but the lady was like a real teacher. She involved students, the lesson was shared and students were a bit comfortable. The man had a lot of… *anafundisha na kifua* [This is Kiswahili, which directly translates to "teaching with the chest"-; which implies an extreme form of bravado]. The moment he gets profit… that's it…

I sought further the things that would guide Ambrose to make such conclusions. He further explained about the businessman teacher:-

> He was just there telling the students, giving them some of the information and I remember some of it was not correct. He was authoritative. The things he was using to teach, like pointing with a broom. And even when he points, he is so fast, it's like a computer (processes information very fast). He would point at a thing for just a fraction of a second, and then go to something else. You know what? Most of the students must take time to see the part he is talking about so that they can understand. This teacher did not care about that. To him it was like profit: It's acquired, move to another product and keep selling. So he was like a businessman.

This idea further extends the feelings expressed by many others and reported as noticing from physics video clip two, that the video teacher's manner of speaking did not come out as clear to the learners, as well as to the PTs. Ambrose's comments imply that the teacher's overall demeanor was not friendly.

Ambrose told me he believes that his perceptions of teaching changed in the time we were watching the videos. Ambrose told me that "If I am watching a video I can tell what the teacher is doing either to make the students understand or to control the class or just to deliver the content." This implies that MMCs illustrated to Ambrose class management strategies, as well as a teacher's instructional goals.

Another significant idea that Ambrose took from the cases was how the responsibility of student achievement is shared between the teacher and the students.

> From the video lessons you know I learnt a lot. In high school I used to believe that for me to pass it's upon me and it's not upon the teacher. But from the videos, I came to learn that the teacher has a great influence in persuading the student to work hard. So that was new to me; that a teacher can influence a student to study. Anyway that was new.

This means that the MMCs may have led Ambrose to become more conscious of his responsibility to enhance students' learning, above advancing the lesson's content.

Although Ambrose pinpointed the way ideas gleaned from the MMCs manifested in his emerging teaching career, he seemed to draw on generalizations of a teacher's character more than on the specific things that the cases were used to highlight. His general evaluation of the teachers is represented in his discussion through the use of metaphors, which can be seen as a broad brush that he uses to paint the teachers as either good or bad. He uses this lens to understand his role in stimulating students' academic achievement.

Bernie's Profile

Bernie is a third-year physics and mathematics prospective teacher. She went to a public girl's county school where she graduated at the top of her class with a B+. She was selected into her first choice course to train as a science teacher. She had teachers in her secondary school that she was very proud of. She told me that through teaching, she saw an opportunity to interact

with students, get to know their problems and help them as a way of paying forward the favor she was accorded by her own teachers.

Bernie's teaching practice was in a privately owned day and boarding school in Kiambu County. The one-streamed school (single class for each grade-level) has more students in the higher classes than the lower classes possibly due to declining enrolment. I estimated the entire school to be situated on a one-acre piece of land, with four classes, a semi-permanent staffroom and a population of about 100 students.

Teaching philosophy. Bernie's main focus is students' understanding; a feat she was willing to sacrifice her free time for. She told me that "an 80-minute lesson is so important that when a student misses one class, it is not alright to keep going on without ensuring that the student has caught up." Bernie uses her free time and weekends to tutor students who had been out of school. However, she acknowledges that it is not easy to achieve this since the students do not meet her halfway.

> The students are not the kind that is self-motivated or self-driven. You find that they just sit, they just relax while that lesson passes. If you don't follow up they will not write down notes, and they will not catch up with what they missed while they were away.

This strategy is similar to Ambrose's ideas of inviting the students who have not understood to go and see him later. Bernie does the same and still knows that the learners will hardly go to see her.

Bernie's suggestion for improving student outcomes was centered on both teacher's preparedness and the student motivation. She told me that students do not perform well because "most teachers do not write schemes of work and lesson plans, so the teacher is going to class just blindly". She also thinks that the other challenge, especially in science, is that "the teachers don't encourage the students or they don't show them the positive side of being interested in

sciences." She therefore thinks that it's a collective effort from all teachers as well as the self-drive of inspired students that would make her achieve her instructional goals.

Bernie's strengths are in her content mastery, which she proudly told me, had been verified as sufficient. "I have been assessed like thrice so far and my assessor says that I have a good mastery of the content. The assessor cannot talk of something which is not true." The wide range of pedagogical techniques that Bernie uses to make this content available to students have been learned in the teacher education program (TEP) courses, especially the methods courses including the multimedia cases-based lesson.

> I have learned this from [Central] University, mostly those ECT (Education, Communication and Technology commonly referred to as methods courses) classes, and also the tutorials, and also there was the video lesson. From the clips you were showing us, we could compare which teacher is better than the other, the techniques they are using.

The requirements placed on the PTs to prepare and write schemes of work and lesson plans seemed to form a significant source of pedagogical techniques that Bernie relies on in ensuring her effectiveness.

Ideas drawn from MMCs. Bernie explained to me how she was skeptical at first, but eventually came to appreciate that the MMCS not only presented a practical way to understand teaching, but also highlighted important variations in apprenticeship of observation by highlighting unique and exemplar practices that the PTs may have lacked in their schooling experience.

> Okay, at first I did not think it was an important thing. But the second time, I came to learn that it is very important because you know at first we were just learning theory. We were told this is what happens in class. For example, I had never been to a class to teach before, when I see a teacher explaining I take it for granted. That's the same for most of us who went to schools that the teacher never showed any concern for student's understanding, so we take it for granted. We think that since we did not see our teacher doing this, we should not do it. But now with the videos we see real life situations. I think the videos for the people who are serious like myself, they would help us a lot, they are very nice and I think if that could be done to every TP students it would be really helpful.

This statement explains not just why there may have been requests for an additional lesson after the first intervention lesson, but also the ways in which the MMCs provided an alternative apprenticeship of observation, different from the one the PTs had experienced as students. The difference in this case being that they are not participating as students but as engaged prospective teaching practitioners.

Though the use of demonstrations as a teaching strategy was discussed in most methods classes, the ability of PTs to engage students in such demonstrations was highlighted in one of the video lessons. The focus of the video lesson was to move students' participation from passive observation to active involvement. Bernie explained to me the extent to which she has applied this strategy using an example of magnet. She told me how she demonstrates attraction between two magnets, and between a magnet and a nail, and then demonstrates repulsion, which she said was the sure test for magnetism.

> There is a lot of involvement in my demonstrations. They [students] say whatever they have observed. For example, for the repulsion in magnetism. I asked them "What can you see?", "What have you observed?" They communicate and explain the observations and why this one is happening.

This level of participation by answering question is different to the kind of participation demonstrated in the intervention lesson. The intervention lesson focused on encouraging the active manipulation of experimental setup as well as data collection.

I probed if students are allowed to manipulate the equipment and she told me "not much; first of all they are limited and you find that for example we have 28 students and I only found 3 magnets so there you just demonstrate as the teacher and the students observe". The circumstances in a school therefore, may not support the intentions or instructional strategies that PTs bring from their methods courses.

Bernie overcame her initial skepticism about using MMC to transfer the ideas illustrated in the MMCs, especially the concern for students' understanding and instructional strategies for a teacher demonstration to her own teaching. She therefore sees the potential for MMCs to bridge the gap between theory and practice.

Faith's Profile

Faith is a third-year chemistry and physics prospective teacher. She is the first-born in a family of two, went to a private primary school and county high school, and obtained an A-. She was admitted to her first choice course, a teaching degree. Her interest in teaching had been cultivated from her university-lecturer mother, and her numerous stints at part-time teaching jobs in primary schools and high school. She already has an early childhood certification and continues to pursue her interests in early childhood education alongside her degree in teaching. "I have passion in teaching. I like teaching." Her dream career is to become a principal of a school.

Faith was formal in her dress and talk. She presented herself as a go-getter with considerable control of her choices. She is in the school she was doing her practice because it is located where she can pursue all her other interests while at the same time succeed in her teaching practice. She chose the school in advance to ensure she was placed there so that she could gain the experience of teaching in a school larger and more established than her previous teaching stints. The school is a four-streamed girl's school in the heart of the city. It is well funded and the students, as well as the PTs, have resources that they easily access. The school also provides a robust induction and support for the PTs. This support is constantly available when needed. She explained: "The cooperating teacher introduced me to the class and told

students that from now on for this term they will have me as their teacher". She went on to inform me that the teacher offered to help her teach some of the concepts she may struggle with.

Teaching philosophy. Faith describes her ability to be firm on her discipline expectations of students, alongside her passionate approach to teaching as the rationale for the love that students have for her lessons. "I am seeing it as interesting. I don't have any issue with the students like the other teachers… Yet I punish them too". This means that she has been gaining confidence in her firm and fair stance on students' management.

She has taken a proactive approach to student learning and credits herself for advising the school management to increase rest time for students so that they can stay attentive in class.

> The most important part is the concern for the students. First, you should ensure that students are okay because even if I deliver the content very well, and the students are not comfortable, nothing actually is going to happen.

Students used to sleep at 11:00 P.M. and wake up at 4:00 A.M. She engaged the school management to increase the sleeping time of students. Her primary concern in teaching is the welfare and comfort of the students.

Faith told me she is more confident teaching chemistry than physics. She said she has had prior experience teaching chemistry in other schools. She believes in engraining in the students' minds experiences that they will associate with the phenomena she is teaching. She explained to me an unusual approach she used to illustrate the relationship between pressure and area:

> "For example, I went to class. I asked everybody to kneel down, as in, go on your two knees then I asked them to kneel down on one knee. So I asked them, when you are kneeling with both knees and one knee when were you feeling much pain? They told me when we were kneeling with one knee".

The idea of having learners kneel down to feel the pain as a strategy for teaching is quite unorthodox. Faith used this experience to explain a concept about pressure. Her goal was to make sure that the learners never forget. She explained to me that all her students in that class

know that “When the area is small, the pressure is higher because the surface area is small. They have never forgotten that”. I asked her where she learned how to teach this way. She said,

> From my physics teacher, because I am just applying the same principle that she was applying when she was teaching us. Even now I can remember … like that one of kneeling down I remember when I was in high school we were told to do so, so I am just applying what that physics teacher used to do to us. That’s what I am doing.

This shows how the PTs cling to the ways that they learned how to teach from their own schooling.

Faith described to me some feedback from assessment that shed some light on the nature of her lessons. She explained to me her experience one time where she had not made some lessons plans for the unit. The assessor noted this and was not pleasant to her. I probed to know exactly what the assessor saw. Faith brought out her emotional side of teaching. She seemed to articulate her anger of negative feedback, as well as the confidence she gets from positive evaluation by other people.

Faith: He assessed me and told me that my teaching was fast and a lot of dictation of notes, but in terms of confidence, he said I was just okay. But the main problem was in the schemes and the lesson plans. That was where the problem was, I had not prepared all the lesson plans, so because of the problem of the lesson plan, he quarreled me the whole time.

Researcher: Do you feel like the lesson that you were assessed went well?

Faith: According to me, I see the lesson was just nice because students’ participation was there. There were no chorus answers. After the lesson, I was asking questions, and even the weak learners. I could see the weak learners were understanding according to me. I think I was… I don’t know why the assessor told me that. (Long pause) He told me that my teaching was pathetic. Not only me, but also the other physics and biology (prospective) teachers, we were all told that we are pathetic.

Even though Faith knew why the assessor may have been dissatisfied with her lesson preparation, she seemed distraught by the comments from the assessor. Her explanation,

however, shed some light on the ideas that she thinks are important for an effective lesson: participation of the learners, class order, and learning assessment.

Faith gets encouraged to stay focused by all the stakeholders in the school, which shows further the importance of a supportive school environment. She explained how this feedback motivated her.

> The chemistry teachers said I am doing fine…they told me that assessor was not good. The physics teachers, they have confidence in me and that's why they have given me the form four classes because they saw I am capable of teaching them. From my peers here on teaching practice, and colleagues, they said I am okay. Even parents have given positive feedback. The principal told me that the form-fours (grade 12) are impressed. The principal went to take feedback and asked form-fours if they are benefiting from TP teachers. The students said they don't benefit from English, Mathematics, Biology and History. So the principal asked about chemistry they said they love the chemistry teacher (Faith). I just hear them say, but I don't talk. I just keep quiet. Then, there was parents' academic day for form-one two weeks ago. So parents could come and say, "I have heard my daughter tell me about a new physics teacher who is so good she understands the subject well". So the parents, they congratulated me and I was feeling good.

Faith recounted the incidences that validated her ways of teaching even when the assessment from the university was negative. It appeared that there were many contradictions in her statements through the interview. In one instance, she explains how she has a lot of concern for students' welfare and then in another instance she has them kneeling down to relate pressure and pain. She also explained to me how effective she is and how highly she is rated by her peers and the school administration, but also explained that her assessor said she was pathetic when she was assessed without lesson plans.

Ideas drawn from MMCs. Faith described to me a very well thought-out lesson introduction routine. Since these strategies matched what we had discussed using MMCs in the methods class, I asked her where she learnt the strategies. Faith could not connect the experiences of the MMC lesson with her strategy. "Nobody told me. I just sat and thought of

that. Nobody told me that I am supposed to do this and that." I specifically asked what Faith has learned from the videos. She explained to me the importance of videos in bridging the gap between theory and practice generally without linking her own lessons with what was discussed in the methods classes.

> "Use of videos is effective when training the teachers because from the video, you can actually see when the lecturer is saying. Introduction: this is how the introduction is supposed to be. When the lecturer is talking about students' participation this is what student's participation is. So the video lessons had a better impact compared to when the lecturer just comes to class and says: when you are teaching ensure that all the students are participating, group them in groups, all that. So the video lesson you can now get what the lecturer was saying; they assist in better understanding."

From our discussion, I noted specific things that she took from the video lesson into her class, especially when she described to me an example of how she used the illustrations on the video lesson to justify the way she adapted her instructions even when she had to deviate from what was taught in the methods courses.

> Sometimes if there are easy answers, I can encourage "chorus answers" but I don't know whether it's wrong or right. There are times I tell them raise their hands and answer for me. But if it's a question where you are taking the readings like the way the lady [in the video lesson] was teaching, when it came to collecting the readings, all the students were answering "20" after 20 seconds. All of them participating in that manner, chorus answers. That way they fill the chart and you can see their understanding and involvement. So, I don't see any problem with chorus answers.

I asked her if she would be able to defend her decision if she was asked why she allowed chorus answers in class. She explained that she was actually asked about it, and she provided insights into the way PTs may use MMCs as justification for their decisions.

> Yeah, actually I was told so. Because there is a point I asked the students, this is color what? And it was blue. So I had to ask them this is what? I was showing them litmus paper changes color. Then I was told that my class had chorus answers. So I just disagreed with the lecture, but I never told him. I just kept quiet.

Faith presents an example of teachers who hold teaching knowledge and skills subconsciously and do not attribute their knowledge to the theories that are taught in their

methods classes. Though the concerns raised in her evaluation are legitimate, including the dictation of notes and making lesson plans, she feels confident in her work and seems to extend her charisma into teaching. This charisma is what she equates to good teaching.

Juma's Profile

Juma is a third-year physics and mathematics prospective teacher. He was raised by his widowed mother who endeavored to provide basic support, but did little follow up of his academic performance. Juma, therefore, got serious about his schoolwork late in high school when he realized he was obligated to change the social economic status of his family, and that education is one way he could do that. Due to financial constraints, Juma forfeited his chance in a leading national school. He instead joined a small private school where he graduated at the top of his class. He then chose teaching as a career because he views teaching as a stress-free career and affords him time to do other things. Juma has succeeded purely as a self-made student. He lacked the support mechanisms that usually push students through school even when they are struggling. He attributed his success through both primary and secondary schools to challenging himself to perform well. He therefore tends to associate the success of students with their personal effort.

The school where Juma was doing his teaching practice is a double-streamed, mixed-gender school in Embu County. The boys and girls are taught in separate classes. The school's main problem, according to Juma, is the lack of discipline of the students. He said that the main focus of the school's administration is to sustain a sizable student population irrespective of the conduct or academic ability of the students. The catchment of the school is the lower performing students from low-income families in the subsistence farming area.

Teaching philosophy. Juma believes that passing physics and mathematics is easy and involves understanding, and not cramming concepts. He says that he is very dedicated to teaching, but he is frustrated by the discipline problems that he blames for the problems at the school. He believes his endeavors to motivate these students are in vain, and however much effort he would put in his teaching, the students in that school never play their part.

> You can do all that, but it will rarely work, because you can't handle indiscipline as a teacher; the principal is against it. So you just let them do what they want to, I go to class, teach, do my best, the few who concentrate, the few who ask questions, I help them. For those who are not well disciplined, I just ignore them.

Juma's frustration about the conduct of students leads him to think that his strategies will not improve students' outcomes.

At his best, Juma focuses on preparing students for their national exams. He believes that the notes he prepares for students are comprehensive enough to help students pass the national examination. He offers help if students seek it and is happy about the two or three who come to ask him questions. However, he feels that the students he is teaching do not have the right attitude towards education and the school administration does not care.

> The principal is the problem, because these guys [students] they are not focused on education. Look at admission marks, they admit 100 and something, [out of a total of 500 marks] so it also becomes a problem. Like you go to class you ask them, why did you fail, and then students tell you "if education is not meant for you, then it is simply not for you".

This shows how personal Juma takes the poor performance of students, sometimes to the extent of interrogating students why they are not achieving good grades. I found this interesting since there were clear efforts in the country to increase the transition to secondary schools and the school he was teaching was born of such national initiatives. Besides, it is quite uncommon to inquire from students why they did not pass their primary school exams. However, having been a self-driven student himself, it's not unusual for Juma to expect the same of the students.

This situation has affected the way Juma teaches. He told me sometimes he works hard because he knows that students will entirely depend on what he gives them in class, and at the same time he is demotivated by the fact that the outcome of his work is not going to be appreciated. He explained to me his paradox:

> …the more you work, the more you will get frustrated and the lesser you work the more you realize that the failure of the students is your responsibility. They only depend on what you teach them. They think that's enough for them. So you just go to your class, do your best ensure that everybody gets your answers.

This statement depicts a transition from idealist to realistic beliefs about classroom practices. Teachers are emotionally connected to students' outcomes. They would like to do well but may not be in control of all the factors that affect the students' performance.

Ideas drawn from MMCs. When we started talking about MMCs, Juma told me that the use of videos was akin to the demonstrations that are done in class. He said that using videos in the methods courses helps him understand and increases retention of what is discussed. He specifically told me that he is now good with lesson introduction and demonstrations. These are the two areas that we covered in the methods course using videos. I asked if there are specific things that Juma recalls and uses from the videos that we used in class and he said that he is still working on his major take home from these videos, which is student involvement.

> … involving the students, that's something I learned from the videos, I was not doing it, so now I try as much as possible to have students do something as part of the lesson, I am still working on that idea.

This shows that Juma is still working on his emerging teaching philosophy and knows that it will get better.

Juma was frustrated by the academic behavior of the students in the school he was teaching. He presented himself as a person who prepares very good learning resources for his students, but is not motivated to make those resources accessible through creating an enabling

environment in class. He feels that the problems he is having in his classes are caused by things outside his control.

Nick's profile

Nick graduated from primary school at the top of his district. He was admitted to a national school in the capital city. The national school had high fees and was far from home, which was strenuous to Nick's father, a primary school teacher. Through a lot of strain, Nick scored an A- on his high school exams. He desired to do industrial chemistry at the university, but did not make the cut-off mark. He desired to complete a degree in nutrition, food, and dietetics, but was discouraged by his friends from taking this course and advised to pursue an education degree.

> Although I qualified I was faced by different forces: Some people told me that the course you are going to do, who is going to connect you to some job somewhere? Some said, for education it is an open field, so I went for education.

This statement means that Nick's choice of teaching as a career was influenced by other people. Later, Nick mentioned that teaching is a noble profession that he feels he has a calling for.

Nick considers himself a social person and attributes his choice of the teaching career and his competence in teaching to his social skills. He told me that education matched well with his perceived interpersonal skills.

> By nature, I am someone who likes to socialize with people. I didn't feel like being a doctor would be good, you know those guys [doctors] are normally quiet and then the environment they work in to me I think it was not going to be conducive.

My personal assessment of Nick was inconsistent with these alleged social skills, and so I thought his words were his rationalization for taking the education degree.

Nick was doing his teaching practice in one of the best schools in the country. The school is located in a prime area of the city, has many resources, and a very supportive staff. The

national boys' school has over 1,300 students. The school has a one-day induction process for its PTs. He was an alumnus of the school and knew his way around.

Teaching philosophy. Nick explained to me that he struggled to fill gaps in the content when he was in high school, and he would not wish that for his students. So he tries to focus on student comprehension above content coverage while he is teaching. He also acknowledged that the school has high student expectation, and that affects the way he teaches. The other members of staff in the school make Nick to think critically and extensively about the planning requirements for PTs. Prospective teachers are required to write duplicate copies of their lesson plans and schemes of work, alongside other professional documents, for the purpose of assessment. Nick has been observing the regular teachers. "They have been in the system for some time. They have developed some shortcuts in teaching." Nick told me that he envies them and does not see the reason for planning so extensively for a lesson he can execute without all the planning: "After all, the content is all same; the [veteran] teacher is going to deliver, I am also going to deliver the same thing and the students will just understand even if you don't lesson plan." The requirements by the teacher preparation program to write lesson plans and schemes of work, in Nicks' case, are unnecessary.

Ideas drawn from MMCs. Nick told me that he took the idea of lesson introduction from the MMC lesson we had done. Nick told me that when we discussed the video cases in the methods classes, PTs did not reach an agreement on which introduction is better. Nick, however, felt that it was important that they explored different types of introduction and then each PT would be able to pick what works best for them. For example, Nick told me that he has his own way of doing his introduction. He values the connections that a lesson introduction is supposed to make to other ideas in the unit and subject: "Once the learners get to connect the lessons, there

is proper transition and their understanding is enhanced." This idea is the same as what the physics intervention lesson using MMCs focused on.

Nick also expressed his value for the relationship that a teacher makes with his students. He recalled and took exception with the "teacher who was not only encouraging chorus answers, but to some extent he was arrogant. He doesn't allow the students to express themselves freely and it is like he is the boss." This indicates that Nick learned how to relate with students from watching the teacher in MMC that highlighted how not to relate with students: "Those videos were helpful because you come to learn of some things that teachers do that really discourage students."

Shauline's Profile

Shauline attended a local primary and a county level secondary school. She did not make the university grade at first attempt, so she repeated two years of high school and eventually got a grade B. She did not make the cut for regular university admission, and so joined the parallel program as a self-sponsored student.

When I caught up with her, Shauline was doing her teaching practice in a privately owned school right in the middle of an informal settlement in the city. The entrance to the school looked like a hangout for young people taking drugs. I saw about 10 young men, some smoking cigarettes and chewing khat (leaves of a plant native to eastern Africa that are chewed as a drug) outside a kiosk right at the gate of the school. The school has very squeezed buildings and one could hear the discussions going on in the adjacent room. All the members of staff in the school are relatively young, including the school principal, who I estimated to be under the age of 30. The students come from the surrounding informal settlement. The turnover of teachers is very high.

Shauline had not been given any induction into the classes that she was teaching in the school. She did not work under any teacher. When she reported to the school in May 2015, she was the first biology teacher in the school for that year. “They had stayed for a whole term without a biology teacher, so I was the first one to come. I started from introduction in form one.” This means that the lessons she took up had gone untaught the entire previous term. The school lacks basic laboratory requirements and so Shauline is at loss as far as planning a practical lesson is concerned. She explained to me that:

> I am not in a position to use all my skills in teaching. If you go to the lab you find that you don’t have chemicals, we don’t have heat source, you don’t have any metal. How do you show them how aluminum reacts with water, how potassium reacts with water?

Shauline seems to have ideas of teaching that cannot be supported by the schools’ resources.

Teaching philosophy. Shauline’s approach to teaching prioritizes getting student’s attention and then having them develop a conceptual understating of whatever she is teaching. She believes that students have psychological and physiological barriers that interfere with their ability to participate in schooling effectively. Some of these barriers may affect students’ ability to grasp what she is teaching.

> Sometimes you find that the students are distracted psychologically when they enter to class. Maybe they are thinking about how they left home, how their parents are, or maybe they didn’t take a meal or maybe it could because of me. Maybe I am not bringing out something clearly according to their level of understanding. I might think they are sharp but maybe their level could be lower, their understanding level.

This shows that Shauline believes that teaching is more than just the classroom transactional interactions between a teacher and the learners, and that it is espouses an element of interpersonal relationship. This also shows Shauline as a reflective teacher who is curious to understand the underlying challenges that inhibit students’ learning.

I asked Shauline to tell me about her questioning skills. She explained how she has had past success in class with carefully thought out questions that spark meaningful class discussion in a number of her lessons. Shauline thinks of an appropriate question, poses it at a time she deems appropriate in her lesson, gives students time to think through it, and then reacts to students' correct and incorrect responses. Shauline was aware that appropriate questioning may take more class time. "I taught this topic, the metallic bond, and after giving the physical properties, I had to ask them why aluminum is preferred to make the cooking pans. They were able to relate the properties to uses, but then it took time." This shows that the outcome of the lengthy process was more important to her than the extra time it took to ask students questions.

Ideas drawn from MMCs. Shauline thought that the MMCs used during the methods course were a practical demonstration of exemplars and non-examples of questioning.

> I have been taught before about the questioning method, but then using a video it was much more practical than theoretical. I could see the good questioning method and the poor questioning method from the video.

Shauline says that the methods course prepared her for teaching, but mentions that using the MMCs reinforced what she knew: "I learned many things from how I was taught by my lecturers at the University and by what you showed us the video." She told me that applying those ideas made her feel like she knows how to teach.

Shauline expressed confidence in her questioning strategies and even told me about how other teachers are borrowing from her: "There is one teacher who borrowed my questioning method and he is using it. He was like, "I want to confirm" then he came to class. He sat down then he was like, "I love your questioning,"" Shauline said that she explained to the teacher a method of posing a hard question, asking students to think alone, then talk as a pair and then debate about it in class.

Though the schools seemed to present challenges to Shauline's instructional strategies, she came out as resilient and adaptive. She gave me many examples of how she has had to do improvisation in her lessons, counsel traumatized students, and made changes on her teaching schedule to reflect the pace of students' learning.

Eric's Profile

Eric joined a top school in Embu County, his home district, where he went on to score an A- in his secondary school examinations. He did not qualify for his first choice degree program in economics and finance. He was, however, advised that a science education degree is a marketable course and he would get a job immediately after school. His peers seemed to both encourage him and doubt his ability to become a teacher, but he believes that he has proved skeptics wrong.

Eric was doing his teaching practice in a school adjacent to where he went for his secondary school. The four-streamed, girls-only school has sufficient resources and a tradition of performing well. Although Eric has a sister at the same age level with the students he was teaching, he still had challenges adjusting to the requirements of dealing with a different gender. His shyness eventually changed to confidence. He told me that his students now show him a lot of cooperation.

Teaching philosophy. Eric teaches his favorite high school subjects, biology and chemistry. He prides himself with a high level of content mastery. He says that the fact that he does not need to refer to a textbook is an indication of his mastery of the content.

> When I go to class I just feel comfortable and that's happens when I know that I have all the content in my mind. I don't need to look at my books to refer to anything. I just use my brain. I just close my book and just start teaching them as I interact with them. They ask questions, I answer all of them.

Eric says that this content mastery is important to him because it helps him to demonstrate to his students a high level of understanding of the subject, which will motivate students to also understand the subject. He told me that looking at a book while one is teaching implies that one does not know the content. “The teacher doesn’t know what he is teaching he is just reading from the book.” Content mastery therefore is an important thing for Eric to not only have but to demonstrate.

Eric assesses his effectiveness by engaging students with questions at the end of his lesson and measures students’ learning using quizzes and assessment test scores at the end of a topic. Good outcomes reflect on his ability to deliver content. When I asked him to tell me if he thinks of his teaching in terms of student understanding or content delivery, he said that all of them are important.

Eric did not appropriately attribute the acquisitions of skills to the teacher training he had. He believes that he just knows the things that he does and that they are not necessarily learnt from teacher training: “I didn’t learn that from anyone, they just come from my mind.” Later I rephrased this same question and Eric repeated more emphatically that he does not think the teaching strategies he uses are taught in teacher education:

> No one taught me that, but I just try to use the strategies I get from my brain. I just use my brain to think about something, (then) I say that this one can work. Let me try it, if it works then I see it succeeding and I am like at least it worked. I just come up with most of them.”

This means that Eric does not connect teaching theory to his actions in class, and thinks of his instructional abilities as an art that he has perfected on his own. He told me that the only thing he learned from the university is how to prepare schemes of work, lesson plans, class demonstrations, and ways to enhance students’ engagement. When we explored further the teaching strategy that uses class demonstrations, he explained using an example his

understanding of teacher demonstration. He does some activities when all the students are watching, and later asks a student to repeat the same kind of activities. The ability of students to replicate these activities is his assessment of successful class demonstration.

Ideas drawn from MMCs. When we talked about MMCs, Eric said that it was the first time he has seen another teacher in class, other than when he is being taught. Eric confirmed that the MMCs were very important and said: “What I liked about the videos is that we got the chance to see how it is to teach. It is an important thing to do, watch lesson before you come to teach so that you can understand the teacher’s movements in class.” This statement does not indicate any specific idea gleaned from the video cases, but implies that a general perception of teaching can be developed from watching others teach on a MMC.

When I probed the teacher movements and sought specific things that Eric saw as relevant from the cases in his teaching, he insinuated that there are many variables that make it difficult to implement lessons as you were taught in the methods classes or even as seen on the MMCs. He explained that when he is posing questions to a class he moves around the class so that he can “interact with the students” and to vary the monotonous teaching position from the front.

Eric gave me an example of his questioning strategy. He described to me how after teaching that the products of an acid and base reaction are salt and water, he started his lesson that day with the question: “What is the product of reacting an acid and a base?” Then about 30 out of 50 hands were raised as a bid to respond. Eric selected the student to respond in such a way that maximized participation. He sees his class in terms of three rows, so he makes sure to ask questions from all rows: “I then call out a student by name since I know their names.” He then gives positive reinforcement remarks for all answers, whether correct or wrong.

Eric seems to follow a classic way of posing a question to aid recall or evaluate his effectiveness based on students' retention. He poses a question, then selects the students to respond in a predetermined way, and then evaluates the response and finally gives feedback. His most important lesson from MMCs was the importance of the teacher's movement in class.

John's Profile

John is a third year chemistry and mathematics prospective teacher. He started school in a public primary school in his rural village and was admitted to district public secondary school. Mid way through, he dropped out of school for three years due to harsh economic conditions in his family. He later went back to school after working casual jobs at a farm and saving enough to pay his fees. He continued to work during the school holiday as a casual farm worker, and at the same time soliciting support from the well-wishers, governmental, and non-governmental bodies. He finally finished and obtained a grade B-.

John did not qualify to join the regular bachelor's degree program but was determined to become a lecturer or professor in the future. Through student loans and private individuals' support, his university education has continued uninterrupted. He said that his good performance at the university has ensured sustained sponsorship. I caught up with him in a private, mixed-gender, day and boarding school where he was doing his teaching practice and teaching 14 lessons.

John presented himself as a focused, mature and responsible teacher. One can see his dedication to education from the way he personally surmounted odds and the way he reflects this victory in his passion about teaching. The private school in which John was teaching at has a population of less than 100 students and has dilapidated facilities. The entrance has a loosely

suspended gate, bearing a free hand and an unevenly painted name of the school -- a sign that the school may have inadequate resources.

Teaching philosophy. John showed a lot of respect for the input of Education and Communication Technology (ECT) courses from his teacher training. He believes that he should combine the tenets espoused in these courses with experiences of teaching from his schooling. He told me that his teaching style is complicated by a lack of resources. He is strongly inclined to focus on student understanding. He constantly reflects on his lessons, and designs subsequent lessons to incorporate ideas from his reflection, as well as to maximize student understanding.

In class, John is so committed to student's participation that when he has to do all the talking, he feels like he is taking away something from the students.

> I think students will learn well by doing by themselves and observing. So you find that when I am explaining, I am taking over the whole lesson. So, I may not be allowing learners to participate. A learner will do very better when he does something, than when he or she observes, looks at illustrations or just listens. But I think in this school, not having materials will compromise students understanding."

Like in a few other cases discussed before, the school environment seemed to have an effect on John's successful implementation of the teaching strategies that he considers important for student for understanding.

John's questioning strategies provided a typical opportunity for students to participate, but this opportunity was carefully controlled. He gave me an example of one question that he had posed to his class that morning: "What happens to anhydrous copper sulfate when it is heated?"

Researcher:	Then what happens (when you pose the question)?
John:	Depending on the class, some students will want to shout out the answer, which I don't expect. I just tell them I want only one person.
Researcher:	ehe.
John:	I just tell them to raise up their hands. Then I call the name.
Researcher:	How do you know who to call if there are many hands?
John:	I call anybody not because of any reason. I might use anybody. I will point a learner who is maybe raising up his hand. I cannot ask a learner who is

not raising his hand because he has not understood the question. Sometimes I may decide to repeat the question if few students are raising their hands. Maybe they have not understood the question. Then I wait again. I just give them some time to think then I ask one of them. I do this so that I can vibrate their brains to think.

Researcher: Then when now you ask a student and they say an answer what happens next?

John: I will motivate him or her. I may say "very good" depending on the way he has answered. If it was so good, I may say "excellent". If he has got wrong, I will just say a good trial then try another student.

He explained the ideas emphasized in the intervention lesson about posing questions. First, questions need to "vibrate students mind", that is cause students to think, teachers need to allow enough wait time, and finally, a teacher needs to be mindful about allowing fair participation in class discussions.

John described to me a typical strategy where the teacher poses a question and calls for bids to respond to the question through either a short silence or prompt to raise up hands. John seemed to value this adherence to his way of students showing their bids to respond to the question. In this case, they were required to raise their hands and after a student's answer is given, John evaluates the response and gives a motivating remark.

Ideas drawn from MMCs. John picked from the MMC lesson the exact things that were discussed. This can be described as direct transfer. This was a match between either what was covered in the MMCs lesson, or what was taught in other methods courses, or even what was transferred as apprenticeship of observation from years of schooling. However, there were incidences that John admitted to have done a direct replication of the MMCs lesson.

> What we did with the videos was a good method because it happened that the lesson that we were watching I came to teach it. I came to teach about matter so I first I had to explain the characteristics of matter. I explained things like balloon inflating and using stones as examples of matter. And so on, I was able to ask what the characteristics of matter from these examples. So I think that the videos will help a teacher to teach effectively. They really helped me.

The MMC lesson that John was describing featured the question, “what is matter?” During the intervention lesson, the PTs evaluated the question as valid and good initially. Upon further discussion, the PTs suggested that it would be better to pose the question in terms of specific examples of matter. They suggested several ideas including asking if a stone can exist in gaseous form, or if an inflated balloon can be solidified, and whether in both cases you would still call that matter. The use of abstract and extreme examples was seen as a way to advance the thinking of a concept, and to extend students’ thinking beyond memorization of definitions. Though John could recall the discussion, the example he gave me about copper sulfate was a simple recall question. This implies that direct replication may be only be applicable in identical situations, where the featured lesson matches the lesson that the PT was doing.

John represents the PTs who use a classic way of asking questions, nominating learners to respond, and offering an evaluation. He was able to recall the content of the MMC intervention lesson, though the specific lessons gleaned from the MMCs were not applied to new situations, that is, the lesson was replicated as it was given.

General Observations from Interviews

In general, the PTs self-reported that they have a higher concern for students’ understanding above the concern for content coverage. This means that they care more about how well their instructional strategies make the content of the lesson accessible to the learners, and in some cases extend their concern to students’ welfare. The effectiveness of the teachers was greatly influenced by the kind of school in which they were teaching. The schools that had challenging environments made some of the PTs frustrated, while in some instances, their resilience and compassion made them go beyond classroom teaching, to offer supplementary

instructions over the weekend, and even using a language that was accessible to students, like Kiswahili.

The multimedia cases created the perception that teachers who show no concern for students are not effective. This concern for students was interpreted from an overall assessment of the teacher's demeanor in a video and his interaction with students in the class. The cases were also used as a means to justify decisions that the teacher made, be they in line with the tenets espoused in their methods courses about teaching, or alternative ways of viewing classroom discourse. For example, the PTs seemed to be concerned about systematic ways that the students have to answer questions and disdained chorus responses.

In most cases, the PTs said that the MMCs were a practical demonstration of the theory that is taught in their methods classes. Viewing these videos enhanced their retention as well as served as an approximation of practice, especially to those who had not experienced teaching before in any other way other than as a student. Those who said that they drew ideas from the discussions featured in the intervention lesson with MMCs gave examples that ranged from direct replication of the lesson featured in the cases to applications based on their interpretation of the intervention lesson objectives.

Some of these PTs held the notion of teacher cognition subconsciously or lack the words to express it. They report that their teaching actions are almost automated. Some PTs do not know if or how the ideas taught in the methods classes influence their instructional strategies. They reported to have thought of the ideas on their own. Those who draw on the methods courses thought of the assessment requirements embedded in the lesson preparation documentation, especially the lesson plan and schemes of work.

In this section, I highlighted the ideas that the PTs gleaned from the use of MMCs during teaching practice. The ideas include direct replication of the MMC-based intervention lesson, application of the questioning strategies and lesson introduction strategies highlighted in the video, and the involvement of students in a teacher demonstration.

Summary

In this chapter, I highlighted the ideas that PTs notice and /or attend to from watching multimedia cases. I explained that; PTs see teaching and learning as predominant teacher driven, they easily notice and attend to errors they see on an episode of teaching, and they are not able to accurately determine if a question or task is at an appropriate cognitive level for the learners. MMCs are suitable for deductive learning, especially when exemplars cases are combined with non-exemplar cases.

I also reported that MMCs have no significant effect on the personal science teaching efficacy but have a significant effect on the student outcome efficacy as well as the overall science teaching self-efficacy beliefs of the PTs. The personal science teaching efficacy is very high compared to other studies and tends to decrease after watching the video cases.

Prospective teachers reported that MMCs were an effective demonstration of the theory they learn in their methods classes. They made overall evaluation of the character of the video teachers and drew from the way they related to students to develop a student-centered approach to teaching and learning. Though, the PTs did not know if they were taught the skills they used in the methods classes, they used ideas in their teaching that were similar to the ideas demonstrated in the videos.

Chapter 5: Discussion

The purpose of this study was to examine the effects of using multimedia cases (MMCs) on the self-efficacy of prospective teachers (PTs). To do this, I collected and analyzed data from questionnaires developed during a multimedia case-based lesson to help understand what PTs notice and/or attend to while watching a multimedia case. I also evaluated their science teaching self-efficacy beliefs before and after the intervention lesson to determine if there were significant changes. Lastly, I interviewed some of the participants during their teaching practice (student teaching) to understand if and what they drew on from the multimedia cases.

In this chapter, I discuss the findings from the data and tie it with what is known about teaching and learning with multimedia cases, and also what is known about self-efficacy beliefs. I start by discussing what PTs notice and/or attend to while watching a multimedia case, then I discuss how this affected their self-efficacy beliefs. I then explain what the PTs drew on from the multimedia cases during their teaching practice. I summarize the discussion of findings by suggesting implications for the study and then make some recommendations.

Prospective Teachers' Noticing During Intervention Lesson

In this section, I highlight what the PTs noticed and/or attended to from watching episodes of multimedia cases. First, I make suggestions for modifying the analytical framework, then explain how the prospective teacher's understanding of the process teaching changed in the process of watching the multimedia cases and then link these findings to literature about learning with multimedia cases.

The prospective chemistry teachers viewed four clips focusing on questioning skills while the prospective physics teachers watched two clips focusing on lesson introduction. I analyzed worksheets that were completed by the PTs during the intervention lesson. I used the

Learning to Notice framework (van Es & Sherin, 2008) to achieve a deep engagement with the multimedia episodes during the lesson. I used Roth McDuffie et al.'s (2014) framing to analyze the worksheets. Roth McDuffie's framing categorizes teacher noticing using four lenses: teaching, learning, task, and power and participation. I use this framing to structure the discussion in this section.

Merging the Teaching Lens and Power and Participation Lens on the Analytical Framework

Roth McDuffie et al.'s (2014) framing described the teaching lens as noticing how the teacher elicits student thinking and how the teacher responds to it. More specifically, they noted that the lens points to the opportunities that the teacher creates for learners to communicate and thereby show what they know. The lens also encompasses the actions that the teacher uses to maintain or change the cognitive demand of the task. During data analysis, I interpreted the teaching lens to encompass all PTs' comments that described the procedural actions of the teacher as a build up to the question, including the actual posing of the question. I also included the PTs' comments that reflect the perceived intentions of the teacher (e.g., the teacher motivated the students, the teacher kept the students attentive, etc.). A number of comments however, were based on what the PTs expected to observe but did not see, often worded with statements like "the teacher should have…" or, "the teacher did not…"

The power and participation lens refers to noticing who participates in a class and how the classroom culture values and encourages participation. This lens encompasses ideas that reveal who holds the authority for content knowledge (Roth McDuffie et al., 2014). During data analysis, I interpreted the power and participation lens to include all the actions that determine who will respond to a question, as well as the evaluative comments that the teacher gave

whenever a student responded, especially when these had a bearing on encouraging learners to continue to participate.

These two lenses in most instances overlapped. For example, when the multimedia case study teacher asked the question, “What is a pure substance?” in the chemistry clip three, I analyzed the following two comments: (1) the teacher motivated the learners, and (2) the teacher is encouraging; the students who fail to give good answer he tells then “good trial”. The first statement I categorized as a teacher’s action during the inter-rating process because we both understood the statement to refer to the nudging actions that the teacher used in class to urge students to give more responses. The video shows the teacher subtly rejecting some answers and seems to do that so as to afford opportunities for more learners to participate. Without more specific and clearer excerpts, it is not be possible to know what specific actions the PTs saw as “motivating”. In the second sentence, the prospective teacher was clear about what was encouraging: the instructional decision to tell the learners who responded to the question “good trial” creates a culture in the class for participation. I therefore categorized this statement as taking the power and participation lens.

Sometimes, I found it problematic to delineate the comments taking the teaching lens from those taking the power and participation lens. The common thing about the comments taking the power and participation lens was that they highlighted teacher actions and how the teacher used such actions to manage classroom discourse. I therefore decided to combine these comments together and discuss these under a teaching and controlling lens. In the following section, I will discuss the results using three lenses, the noticing of teaching and controlling actions of the teacher, noticing of the students’ actions, and noticing based on the task.

Noticing Teaching and Controlling Actions

I found that PTs pay more attention to the actions of the teacher, including how the teacher uses his/her power to control participation in class, than they do about student learning or the task. Quantitatively, my analysis of the 240 comments made revealed that more than 62% of the comments focused on a teacher's action that advanced instructional objectives as well as maintained control of class.

Teachers' control of knowledge: Starting from known to unknown. PTs know from theory that teaching should progress from known to unknown, but the PTs do not know what the learners know. In the first clip, the PTs focused on the control that they perceived the teacher had or was supposed to have on knowledge. The PTs were expecting to see a progression of knowledge from what is known to the learners to what is not known. A number of comments were worded using the same words that the teacher educator used to describe this expected progression of content coverage: "From known to unknown". Some PTs stated that "the teacher ought to have described what matter is first" before he could ask the question to the learners. One PT clearly stated that, "the teacher makes an assumption that the students know what matter is". These comments were made with disregard of two clearly observable facts on the teaching episode: (1) When the teacher posed this question, many hands were raised immediately, and (2) the selected learner not only gave a correct answer, but also all the other learners stopped raising their hands after this response, even before the teacher gave an evaluation of the learner's response. This implies that the other learners concurred with the first answer.

The response of one learner, and the reaction of the other learners show that the answer to the question "What is matter?" is part of what is known to them. The comments from the PTs show that they were not expecting that learners know what matter is. Therefore, I inferred that the PTs may not know what is "known" to the students and that they tend to underestimate

learners' entry knowledge. Prospective teacher in this study initially assumed that learners do not know anything about matter, even when it was clear that the learners had no challenge recalling the definition. The reason they felt that this knowledge of matter was not known to students was mainly because the teacher had not told them. They held the belief that knowledge is a preserve of the teacher and learners' role in learning is recalling the knowledge once it has been transferred to them.

In the subsequent clips, the remarks that depict the fact that PTs think the teacher should be in full control of the knowledge of students decreased. In chemistry clip 2 there were various comments pointing to the need for a teacher to evaluate and give feedback to the learners' responses. This is a slight shift from the initial perception that learners know nothing, towards an acknowledgement that learners may have some ideas, but the teacher needs to validate this initial learner "knowledge". In clip 3, the PTs notice that the students actually give responses that are agreeable to them, but the teacher's answer is not agreeable. The teacher asked learners to define a pure substance. The learners gave various definitions, such as, "A pure substance is a substance that contains only one kind of particle. It has no contamination; it is not mixed with anything. It is just one *(emphasis with one finger)* element." The PTs perceived the teacher to have rejected this answer by his actions of going on to allow other responses from other learners who had raised their hands. The teacher, in defining what a pure substance is, eventually said, "A pure substance is a substance that has only one substance." This shows a further shift not just towards the accuracy of "knowledge", but also towards an acknowledgement that the learners are able to give answers that are more agreeable than a teacher's answer.

In clip 4, the teacher posed a question ("What is the formula of bromine?") that required a specific answer ("Br"), but elicited some wrong responses ("B"). The PTs' comments reflected

their understanding that when the response is not correct, the teacher needs to give a justification for rejecting students' responses. There were subtle insinuations that the teacher's release of the authority to "know" is not acceptable to the PTs. For example, one PT wrote that, "Other learners were given a chance to evaluate others' responses, which is not correct." This means that though the PTs are noticing the peer discussion in class, they still hold the notion that the teacher has the authority to poses, dispense and evaluate knowledge.

The comments I categorized in this lens highlight a progression from belief that you have to teach first before you pose a question, to realization that students have multiple ways of inferring knowledge from their own cognitive processes, and finally that a teacher may not always be the sole source of knowledge. Towards the end, the PTs had started thinking about knowledge co-creation, but occasionally reverted back to beliefs that the control of knowledge is a teacher's responsibility.

The clips assisted the PTs to advance their perception of learners from blank slates where the teacher inscribes knowledge, to noticing and attending to the fact that knowledge can be co-created in a discussion forum created in class. This kind of epistemological evolution of prospective teacher cognition is prerequisite for belief and attitude modification.

From this discussion, I draw two conclusions: (1) the MMCs helped the PTs to apply theory learned in their methods classes to episodes of classroom situation in ways that they would not be able to do using lecture-method, and (2) the beliefs about students' initial knowledge that the prospective teacher had at the beginning of the lesson began to change after viewing four clips.

Noticing Students' Actions

The learning lens refers to the instances where the PTs pay attention to the understanding and confusion implied in the learner's actions or behavior (Roth McDuffie et al., 2014). The data

show a dismal noticing using this learning lens: only 7% (17) comments of all the 7 clips used this lens.

Though the PTs did not notice anything meaningful in the first chemistry clip, the PTs noticed and attended to the observable behavior of students in the second video clip. Some PTS noted that, "Many of the students raised up their hands." Others observed that the learners are actively involved. In the subsequent clip, the ability to notice how learners were engaged in the episode advanced to more elaborate interpretation of the body language. For example, some PTs commented that the way the learners were raising up their hands seems as if they are not sure. Another PT interpreted the behavior as "One student tried to think so hard, but the idea is not clear." This progression shows that the PTs advanced their noticing and interpretation of learners' behavior and how it impacts learning.

The comments that focuses on the student lens from the physics clips showed that PTs expected to see participation of students and so when they did not see it in the first clip they noted that the episode lacked active learner participation. In the next clip, they noted and interpreted the struggle that was inferred from seeing learners looking at each other's work. One PT, on observing two learners looking at each other's books, commented that, "The learners were not following the lesson." The teacher had paused to allow the learners to make an entry in their notebook about a concept he had mentioned. The camera focused on a learner trying to jot down something and then looking at what the learner next to him was writing. The PTs saw this as an indication of a struggling student. Noticing student engagement is an important first step in achieving learner-centered lessons.

The discussion from the students' lens leads me to two conclusions: (1) PTs know that students' participation is important, and (2) they do not immediately get concerned with how

students are participating, but when they do their ability to notice increases in sophistication as they watch more clips.

Noticing about the Task

The task lens was described by Roth McDuffie et al. (2014) as the characteristics of the content that makes its good or problematic, including the ideas that would improve the task design. The task lens also includes the characteristics of the task that makes learners' thinking visible. The excerpts that I categorized under this lens included the description of the content that the teacher was exploring in class, and the perceived cognitive demand as well as the errors that were observed by the PTs. Quantitatively, about 33.3% (81 excerpts) of all the comments focused on the task. Of these comments, 28 were reactions to an error seen in the question, and 40 excerpts commented on the cognitive demand observed in the task. My analysis of the comments that I categorized under the task lens revealed three ideas.

First, the PTs almost always noticed and attended to content errors in the video clips. The errors in this case include the teacher moves that are inconsistent with the teaching and learning approaches that are taught in methods classes, as well as perceived content discrepancies. The errors discussed in this study are not deliberate design omissions or commissions in the design of the multimedia case. In chemistry, the PTs noted that (a) the teacher displayed the slide bearing a response to the same question he was posing in clip 1, (b) he did not give a clear way to identify each of three diagrams displayed on a slide in clip 2, (c) he used the word "substance" while defining a "pure substance", and (d) he wrote a note about the question on a blackboard that had notes from another subject.[2]

[2] Comments about not erasing the blackboard were coded under the teaching lens. These comments, however, support the idea of noticing
and attending to errors.

Second, there were consistent suggestions that the task was either above or below the learners' cognitive ability. The participants drew from their theoretical understanding of Bloom's taxonomy to assign the questions a label as high-order or low-order. Even then, there was no agreement as to whether a question was high or low order. The question "What is matter?" was described by PTs as both high-order and low-order. The next question, which I selected to progressively reflect more cognitive engagement, was characterized by PTs as not enhancing students' cognitive skills. The open-ended question, "What is a pure substance?" was seen by PTs as requiring abilities that are above the level of the learners. When the teacher revealed patterns of assigning chemical symbols and asked students to use a Think-Pair-Share strategy to come up with the formula of bromine, all the comments made under the task lens, without exception, said that the question was beyond what the learners can answer, despite the fact that they did come up with the formula.

Thirdly, the PTs inferred theory from practice when they were shown a good clip first, and then used what they saw to critique another clip. In the first physics clip, the PTs' description mentioned the links that the teacher made with ubiquitous cathode tube-base appliances. The teacher also projected a slide with outcome-based objectives in which he highlighted what will be covered in the lesson. The PTs also noticed that the teacher made the expectations very clear. There were no affective comments on this clip.

In the second clip, the students used superlative adjectives to describe their overall assessment of the lesson introduction as well as the teacher's effectiveness. The comments about this clip confirm that the PTs perceived that the first clip was better than the second. The absence of a basis for comparison may have made PTs critical of the first (better) clip, but when they saw the second clip they were harshly critical of it. They described the second clip as "the worst

introduction" and said the teacher was not effective. These comments not only show a summative evaluation of the teacher's effectiveness in the introduction, as well as for the whole lesson, but also highlight the way the PTs used the learning from the first clip to make descriptions and evaluation of the second.

My analysis based on the task lens leads me to three conclusions: (1) errors in MMCs are an important episode for learning, (2) PTs do not know, and often underestimate, the cognitive abilities of learners, and (3) MMCs are an effective means to teach theory deductively, that is, from practice to theory.

Findings from Analysis of Noticing Data

The patterns in the data on prospective teacher noticing and/or attending to classroom practices revealed three ways that the MMCs impacted the PTs. First, the case provided a dual-directional relationship between theory and practice. The PTs applied theory in practice as well as deductively inferred theory from practice. Secondly, the comments showed a progression in the changes in PTs' beliefs about students' participation and their initial cognitive abilities, as well as changes in beliefs about teachers' control of class discussion. Thirdly, the problematic cases provide opportunities that have as much value as exemplar cases. I discuss these three findings in the following section.

Multimedia cases as a dual-directional bridge between theory and practice. This study established that multimedia cases not only provide an opportunity for the PTs to apply the theory taught in their methods classes to practice, but also provide a unique opportunity for PTs to deductively infer theory from practice. Bencze (2009) posited that cases are a boundary agent between theory and practice based on the higher possibility of PTs to apply what they learn from cases in their initial teaching experiences than PTs taught using traditional methods. His study,

however, did not concern itself with the dual directionality of this relationship, but focused on the increased adoption of teaching strategies demonstrated in the videos. In another study, van Es and Sherin (2002) reported PTs' acquisition of pedagogical knowledge in ways that are practical and visible. The studies discussed above viewed MMCs only as representations of exemplar teaching strategies that are available to PTs as an alternative to theoretical discussions.

Brantley et al. (2008) reported on the ability of PTs to link the ideas gleaned from watching cases to teaching standards. This means that given a set of ideas to watch out for, PTs can identify such ideas from a teaching episode but the study does not explicitly imply that PTs can infer theory from the viewing of cases as is the case for the present study.

In this study, the Professor Polaris and I identified a clip that would highlight three ideas that he wanted to emphasize as important when introducing a lesson. The ideas were based on the 5E lesson plan approach (Goldstone et al., 2013) and highlighted the "Engage" introductory part of such a lesson. The first clip we showed to the prospective physics teachers incorporated three tenets of "Engage" in the 5E lesson. The video teacher (1) made connections between the present and past learning experiences, (2) highlighted the anticipated activities and expected outputs from the students, and (3) presented in a way that was organized and pleasant. The second clip lacked these ideas. The video teacher in the second clip told students what they ought to have known before the lesson, and went on to start the lesson before the students were sufficiently "engaged".

The PTs in the physics lesson, when asked to describe what they observed in the first clip, identified the elements of "Engage" that the teacher planned to cover as ideas for a lesson introduction. Furthermore, when they viewed the second clip that noticed the absence of these

same ideas. This demonstrates that the MMCs were able to provide an opportunity for PTs to infer theory from watching a teaching episode.

MMCS scaffold PTs' changes in beliefs. The discussion about changing PTs' perception of students' prior knowledge, students' participation, as well as a teacher's controlling role in class, highlighted the progressions that were observed through the various video clips. The beliefs that PTs held when viewing the first clip, especially in chemistry, changed over the course of viewing the subsequent clips. As stated earlier, PTs beliefs can be described as tacit, often unconsciously held assumptions about students, classrooms, and the academic material to be taught. (Kagan, 1992). For example, in this study, the apparent verisimilitudes about the sage-role of a teacher in class changed as the PTs viewed more clips from the MMCs. At the conclusion of the fourth clip in chemistry, the PTs exhibited beliefs that the authority of knowledge can be shared in class discourse, implying that the PTs acknowledged, though subtly, that learners have the capacity to co-construct knowledge. Similar changes occurred for PTs across the clips with respect to their beliefs about the importance of noticing and attending to learning activities explicitly communicated by learners' behavior, as well as beliefs about the cognitive level of learners.

Various studies have highlighted the potential for cases to alter the beliefs of both prospective and continuing teachers. For example, Fitzgerald et al. (2011) found that cases cause changes in behavior that are sustained through the initial years of teaching. Koury et.al. (2009) reported that PTs' beliefs were deconstructed when cases are used over a long time. Lundeberg (1999) suggested that PTs become metacognitive about practice when they view multimedia cases of teaching, while Thomas and Reid (2011) noted that PTs superimpose new beliefs on their existing ones when using cases.

When teaching large classes of PTs, teacher educators regularly use lecture methods and examinations to teach and evaluate the learning of PTs (Hardman et.al., 2012). In such class sizes, the curriculum is usually very theoretical and field practice is not adequately supervised (Akyempong, Pryor & Westbrook, 2013). Without an opportunity to model exemplary teaching practices, teacher educators are deprofessionalized (Foley & Masingila, 2014), and lack opportunities to modify epistemological beliefs of PTs through enactment of exemplar pedagogical practices. Dolphin and Tillotson (2015) explained that the manifestation of beliefs in practice reflects some form of direct transfer from the teachers that PTs interacted with in their schooling and teacher preparation. The use of MMCs presents an opportunity, albeit one that is heavily dependent on the type of case chosen and mode of facilitation, for teacher educators to influence and scaffold PTs' emerging epistemological beliefs through challenging their held beliefs.

Problematic multimedia cases increase prospective teacher noticing. About 27% of all the comments made in the four chemistry clips identified errors made by the teacher. The unexpectedly high number of comments that focused on the notable errors in the MMCs may provide a window of opportunity for noticing classroom practices for PTs. The errors identified in the clips showed no discernible teaching patterns and were not deliberate. However, since they formed a large percentage of the comments, I analyzed and coded them as a separate category to understand how such errors influenced the notable moments from a MMC.

There is very little research on the effect of errors in video episodes with PTs. However, studies about flawed videos in medical journals show that observing both flawed and flawless video clips produces significant difference in medical students' performance of medical procedures. For example, Nieminen, and Stenfors-Hayes (2015) noted that although medical

students were able to perform central-line insertion accurately after watching a flawless video, those who learned from watching both flawed and flawless videos reported better results in an assessment of their global procedures (handling equipment and amount of force used against the tissue).

In another study about using errors to teach computer applications, Lorenzet, Salas, and Tannenbaum (2005) noted that guided errors led to better and faster performance as well as a higher self-efficacy. The authors, however, noted that the culture of the participants may affect the outcomes of a learning process. They gave an example of cultures where the instructor is held in particularly high esteem such as the case for Africa and Asia. The high esteem shown for instructors is derived from the high power-distance cultural orientation of communities in Africa and Asia. High power distance is a cultural orientation that is summarized from broad observation of how people view those in power. In Africa, positions of power, such as the one taken by a teacher in class, set them a large distance from those without the power in class, as is the case for learners (Hofstede, Hofstede & Minkov, 1991). The noticing of errors by PTs in this study represents a significant amount of noticing as indicated by their comments. According to Lorentz et al. (2005), such errors in a high power-distance culture may be seen as a sign of incompetence.

Changes in Self-efficacy

In this section, I discuss the analysis of the quantitative data to answer my second research question: is there a change in the self-efficacy of PTs after watching an episode of MMC? First, I explain the results of analyzing the demographic details, then I discuss the findings from my analysis of the personal efficacy scale, and finally I discuss the findings from the outcome expectancy scale.

Generalizability

The results gleaned from my analysis of the demographic data show that the sample represents the population of prospective science teachers at Central University. The sample had a modal age of 20-25 years, 73.2% male, and most of them came from lower cadre schools (48.8% district schools). Although demographic details of the university are hard to obtain, I make the claim that this sample matches with the University's demographics from the estimates that I obtained from the interview data with cooperating teacher educators. Central University admits approximately 50% of the PTs enrolled in the universities in the whole country (KBS, 2013). Many Sub-Saharan universities have an identical situation of rapidly increased enrollments that are not accompanied by commensurate increase in the number of teacher educators and sufficient opportunities for field experiences (Mohamedbhai, 2008). This means that the findings in this study are generalizable to the entire prospective science teacher population of Central University, as well as SSA universities that have similar enrollment challenges. The findings may not be generalized to teacher preparation programs that have meaningful field experiences embedded in the program.

Rationale for using Self-efficacy

Considering the multiplicity of factors that make a teacher effective, it is understandable that disagreements exist about the specific skills or dispositions that make one teacher more effective than another (Goldhaber & Antony, 2004). Different ways have been used to measure teacher cognition, including the evaluation of their pedagogical content knowledge (Davis, 2004), use of metaphors (Kilic & Yelken-Yanpar, 2013), and concept mapping (Chichekian & Shore, 2013) among others. Kagan (1990) pointed out that the "prospective teacher's cognition; self-reflections; beliefs and knowledge about teaching, students, and content; and awareness of problem-solving strategies endemic to classroom teaching" (p. 419) are held subconsciously and

occasionally, PTs lack the skills and language to express them. The absence of appropriate field practice opportunities further problematizes the assessment of PTs' manifestation of their understanding of pedagogy.

Bandura's concept of self-efficacy has been extensively used to study certain dispositions about a teacher that determine if a prospective teacher will be successful in teaching. Self-efficacy, according to Bandura (1997), is a reflection of a person's ability to produce certain attainments. Two constructs are brought out in Bandura's explication of the concept of self-efficacy: outcome expectancy and personal efficacy, each independent of the other. "Outcome and efficacy expectations are differentiated because individuals can come to believe that a particular course of action will produce certain outcomes, but question whether they can perform those actions" (Bandura, 1977, p. 79). In the specific case of prospective science teachers, personal science teaching efficacy (PSTE) is the belief that PTs have that they can be able to teach science well. Science teaching outcome expectancy (STOE) is the belief that the chosen teaching strategies will produce desired results. The reference to these being independent implies that knowing that a certain strategy would produce desired results does not mean that one knows how to execute the strategy. Since there was no opportunity to see the manifestation of instructional strategies, self-reported self-efficacy scores provide an accurate estimation of how effective a prospective teacher may be.

Prospective Teachers' Personal Science Teaching Efficacy

This study found that these prospective science teachers' PSTE was very high. At pretest, the score's average was 4.46 (SD 0.77) out of a possible score of five. At posttest, the score was 4.40 (SD 0.88). This decrease was not statistically significant. A number of studies done in Turkey have extensively reported PSTE scores using a similar instrument, albeit

modified for the country. For example, Ilhan and Yilmaz (2015) surveyed 517 PTs from five Turkish universities and reported a PSTE mean of 3.44, while Akkuzu and Akcay, (2012) reported a score of 4.12 from a sample similar to the one in this study.

Moseley, Reinke, and Bookout (2002) reported PSTE scores of U.S. PTs in an environmental science teacher preparation course as 3.40 at pretest and 3.31 at posttest after a seven-week collaborative activity between a US-based university and a public elementary school. They attributed the decline to the PTs' re-evaluation of their teaching abilities as they learn more about teaching methodologies. Surprisingly, the control group in this study reported an increase over the same period: from 3.51 at pretest and 3.74 at posttest, which shows that practical experiences may result in a decrease in the confidence expressed by PTs about teaching science.

In another longitudinal study in Netherlands, Velthuis, Fisser and Pieters (2014) reported PSTE scores of the PTs across the program's four years. The scores increased significantly from the first to the second year from 3.16 to 3.57. In the third year, the PTs had some field experience and their PSTEs score was reported as 3.43. The author attributed this decrease to an "implementation dip" (p. 458), which is typical when PTs start implementing what they had learned in their methods courses.

In my study, the PTs experienced, for their first time, an approximation of classroom experience. The requirement that they identify the tenets espoused in their methods courses from a video clip of a teaching episode presented a challenge of transferring the theory to practice. The decline could imply that the PTs realized that classroom instruction may not be the way they thought about it. Analysis of a teaching case was a reality check for the PTs. The decrease in PSTE scores in this study was not significant. Perhaps because the intervention period was brief

or because the PTs scores were already quite high, the MMCs did not experience an incident that was strong enough to cause a further change on the "retained ways" (Nespor, 1985, p. 137) of perceiving teaching and learning.

Prospective Teacher Science Outcome Expectancy

The STOE scores were slightly lower than the PSTE scores, and comparable to others studies: 3.86 (SD 1.06) at pretest and 3.86 (SD .093) at posttest. Ilhan, Yilmaz and Dede (2015) and Karaduman and Emrahoolu (2011) reported identical STOE scores of 3.45 from Turkish PTs. Akkuzu and Akcay (2012) reported chemistry teaching outcome expectancy scores of 3.49. Both these studies were done in Turkey. In the U.S., Plourde (2002) reported STOE scores of 3.61 at pretest and 3.39 at posttest after a semester-long field experience. The range of STOE scores in my study, therefore, is comparable with other studies.

In my study, the STOE scores increased from pretest to posttest by 0.18, which is a 3.6% change on a scale of 1-5. This change was significant (p=0.008), which means that there was a positive change in students' outcome expectancy after viewing the MMCs episodes. Outcome expectations involve the causal relationship between teaching and its outcome (i.e., students' achievement) (Bandura, 1997).

The significant change in outcome expectancy occurred even when the PTs did not experience a live classroom environment. This increase may be therefore attributed to the fact that MMCs allowed PTs to see the students' cognitive capacity and thereby estimate the extent to which their perceived instructional capabilities can impact students' achievement. All this was achieved in an environment that does not burden PTs with the need to focus on how their instructional decisions affect the students' outcomes in real time since they were watching another teacher's instructional approach.

These findings demonstrate that MMCs have the potential to alter the self-efficacy of PTs. The direction of this change may be dependent on a number of factors that have to do with the case itself. Some of the factors that may affect the outcomes of using cases include: duration of an episode (Cannings & Talley, 2002), the cognitive load of a case (Mayer, 2001), and the facilitation process adopted during the case study session (Mersyth, 1996).

Since this was a brief intervention, changes that were observed can point to a very promising opportunity. Though not significant, a decrease in personal efficacy is an indication of the beginning of a re-evaluation process. Kluger and DeNisi (1996) deduced from a meta-analysis of studies with feedback interventions that the effectiveness of interventions that cause one to self-evaluate decrease as attention gets closer to the self and away from the task. This decrease in effectiveness is moderated by task characteristics. The measurement of personal science teaching efficacy beliefs was through questions that accessed the personal ways that PTs feel about their abilities to execute a task. The posttest, therefore, was a means to self-evaluate after a multimedia case intervention lesson. The changes in PSTE and STOE in the present study imply that when a deeper way of seeing teaching are introduced, initial personal teaching efficacy may decrease, but even with such a lowered personal teaching efficacy, the PTs still feel that are more able to improve student learning outcomes.

Applying Ideas from MMCs in Field Experiences

The teaching practice (student teaching) experience provided a chance for the PTs to apply some of the ideas that had been discussed in the intervention lesson. Laurier's (2010) perception of sports commentators provides a relevant analogy for multimedia case-based teacher preparation. Laurier sees commentators as persons who are seldom the ones playing the game. They sit on the side observing the action and explaining what they see. He argues that

insightful commentary is not the same as knowing how to play a game. The use of multimedia cases in the teacher preparation program presented the PTs with a commentator's view of the interactions in a classroom. The PTs' commentator view is vantage enough to notice many of the teaching and learning activities and safe enough for the PTs to critique the teacher's moves based on what they know about teaching and learning. Safety in this case implies that the process if free from intimidation of the teacher executing the lesson.

Kenyan PTs have only one student teaching experience. The number of PTs going for the field experience at the same time is very large for the teacher educators to support. The PTs receive no formal induction into the classrooms from the cooperating teachers. It is not uncommon for some of the PTs to be the sole teacher in charge of the subject in the classes he or she is teaching. In this study, only two of the eight PTs who I interviewed received some form of induction in the school in which they were doing their practice teaching. The other six PTs were the sole instructors for the classes they were assigned. As stated earlier, the induction to schools by injecting PTs straight into classrooms where they experience teaching and learning contexts is comparable to teaching people how to swim by throwing them into the deep end of a swimming pool (Fulei, 2010). The use of MMCs, therefore is identical to asking PTs first to serve as commentators for a game, before going to play. This way, they experience the game, learn what works and what does not, without first going to the pitch to play. Grossman et al. (2009) referred to experiences that are given to PTs in methods classes to practice teaching as approximations of practice. My argument is that by showing PTs cases of veteran teachers, they are better prepared to make more effective teaching moves. Without the multimedia cases, there is no opportunity to experience teaching, other than when they are actually teaching, like is the case of Kenyan teaching practice experiences.

Professional Vision of Prospective Teachers

Prospective teachers manifested both a gestalt view of the video teacher's behavior and specific-issue view of the ideas learned from the clips they saw. Goldwin (1994) described professional vision as a socially organized way of seeing and understanding activities. For PTs, professional vision involves noticing important interactions in class and a knowledge-based reasoning about such interactions.

Drawing from gestalt view of the multimedia case teacher. In the instances that PTs drew their instructional strategy from the gestalt interpretation of the MMC episodes, they compared the three video teachers featured in the physics intervention lessons and assigned descriptors that reflected a wholesome evaluation of the teachers. Ambrose used a metaphor "businessman" to describe the teacher who showed little concern for students. Nick described the same teacher as "arrogant" and as a "boss". These descriptors imply self-centeredness or lacking regard for others. They compared this with the "very good lady" in another video who managed to engage students deeply in her lesson. Both Ambrose and Nick told me that after watching that video they intend to be student focused in their teaching and show a high concern for students. For example, Ambrose, as a show of concern for students, provides extra coaching and uses an alternative informal language to make content accessible to students.

I asked the PTs what they prioritized in their instructional planning between teaching (content coverage) and learning (student understanding of the content). Except Nick, who said that both are equally important, all the others stated that that they place student understanding ahead of content coverage. Faith described to me how her relationship with students has endeared her to them and made her an effective teacher, to the point that she gets extra classes to coach for a small stipend. In some of these cases, the concern for students understanding more

than teaching was attributed to the generalizations that the PTs made about effective teaching from observing the multimedia cases teachers.

The vision held by PTs, and the words used to describe it, were constructed from the PTs' social understanding of relationships. Tannehill and MacPhail (2014) posited that PTs' use of metaphors, and the evolution of such metaphors over time, represents a realization that the teachers are only part of the teaching and learning process and are not solely responsible for all learning that occurs in schools. In this study, PTs used metaphors of an unconcerned teacher and of a caring teacher to rationalize their instructional decisions and to adopt a concern for students' teaching philosophy. Moreover, the use of metaphors represents a way of explaining tacit knowledge inferred from the video teachers. McFadden et al. (2014) saw this transfer of tacit knowledge as a unique feature in videos developed by veteran teachers and used by PTs.

Drawing from specific issues highlighted in the multimedia cases. Although Mitchell and Marin (2015) observed that PTs tend to notice more superficial aspects of classroom practice, such as class management, there were instances the PTs said that they picked the specific ideas that were discussed in the videos and integrated them into their repertoire of strategies. Shauline explained how she has adopted a questioning strategy that other teachers at her school admired. Juma said that he is always conscious about how to set up a demonstration lesson, while John demonstrated a carefully planned questioning strategy. These PTs said they feel confident implementing the specific instructional strategies that were discussed in the intervention lesson.

The issues addressed in the video cases could have been addressed even without the cases since they were part of the course outline developed by the teacher educators. However, using videos to cover these concepts not only provided an opportunity to address them in practical and

tangible ways, but also addressed them in ways that align with Talanquer, Tomanek and Novodvorsky's (2013) idea that using videos of other teachers provides PTs with an informal rubric to identify critical teaching strategies with more specificity.

An example of ways that PTs became more critical of the instructional strategies used in class was with regard to the means through which they thought students should participate in class, specifically their concern for chorus answers. The extra lesson given to the physics group had some moments where the students used chorus responses. Faith explained to me how she rebutted an assertion by the supervising faculty member from Central University that she ought not to allow chorus answers in her class by referencing the cases. Nick, on the other side, based his negative assessment of one of the video clips on the fact that the video teacher allowed chorus answers in his class.

How PTs Manifest the Pedagogical Knowledge Learned from MMCs

My analysis of the interview data shed light on the ways that PTs understand teaching and learning and how MMCs may have helped then in their teaching practice. The PTs thought that their knowledge of teaching and learning was either automatically inferred from their own intuition, advanced from their experiences that teaching is making content available to learners or in other instances, their knowledge was direct replication of the illustrated strategies from the MMCs. Often, the inability to execute good lesson was seen as the problem that is related to the school. The resilience shown by the PTs varied according to their own schooling experiences that they had while they themselves were students.

There was one moment during the interview that Faith thought her ideas about teaching were intuitive and that she could not tell how she learned then. She attributed her instructional strategies to her own artistry and not to anything in the teacher education programs. Kagan's

(1995) assertion that PTs hold their cognition subconsciously was exemplified in Faith's description of her teaching knowledge. Faith told me that nobody taught her the things that she knows despite the fact that she previously spoke eloquently about the ideas carried on from the MMCS intervention lesson. This is evidence that PTs learn and recall theoretical perspectives of pedagogy, yet do not know if they are being influenced by these perspectives while teaching. According to van Putten, Stols and Howie (2014), teachers may be able to articulate theory eloquently since this is the basis for their teacher preparation assessment and fail to exhibit theory-in-practice if they hold beliefs that teaching involves drilling learners to know certain concepts.

The drilling viewpoint is prevalent when PTs believe that teaching involves explaining and re-explaining, availing and enforcing good records of content through carefully planned note-making, and infusing fun as a means to grab learners' attention. Eric explained to me that since the learners in his school are disengaged, he prepares notes for them that are comprehensive enough to allow them to pass the national examination. Bernie and Ambrose believe that re-teaching the "slow learners" is the best way to show concern for students. They continually encouraged students to come see them anytime, even though they admitted that the learners rarely came. The teachers hold on to beliefs about best practices even when such strategies are not effective. They feel that it is the learners who fail to take advantage of the opportunities that they (the PTs) provide.

Most of the other PTs gave me examples of how they learned by direct replication of the ideas discussed in the videos. John explained to me how he taught the same topic that was in the video clip and tried as much as possible to make it identical. Shauline copied the general patterns in questioning strategies and applied them in both chemistry and biology successfully. Ambrose

thought that one of the videos taught him that the responsibility of a student's achievement is shared between the teacher and the student and feels responsible for students' success. Nick complained that the class of PTs never reached a decision regarding which of the two video introductions was better. These comments imply the expectation that the cases would provide an exemplar illustration that would be replicated directly.

Though in most cases the PTs felt that they are successful in their teaching approaches, there were a number of times that they explained a situation that is akin to a big fish in a small pond. They felt confident that they are able to teach well, but were restricted by inadequate amenities in the school, and the low morale of students. Eric blamed the school administration for admitting students with low scores on the primary school exam and not enforcing the tight disciplinary suggestions he made. Another prospective teacher, Shauline, struggled to improvise whatever the school did not provide. She seemed to have more resilience and was willing to try hard, while Bernie and John tried to make do with the meager resources available by extensively relying on teacher demonstrations where student experiments were required. These efforts show that the PTs see themselves as able to do very well in terms of lesson planning and find themselves in schools with low uptake of the pedagogies that they bring in from their teacher preparation programs. They therefore feel constrained by circumstances in the school, even though they have within themselves the ability and skills to plan and execute very superior lesson designs.

The differences in resilience may be explained by the nature of schooling and type of schools that the PTs graduated from. Eric is a self-made student. He struggled through schools without amenities and made it to a university degree program. He holds the belief that students require a consistent self-drive to succeed. Shauline attributed her personal success to the efforts

the teachers in her school put forth to make content accessible and understandable to students. Bernie graduated from the top of her class and knew that the things that are very clear to her may not be that way to other students. John's story is one of his attempt to pass on the goodwill he enjoyed in his seven-year struggle through high school.

Akkuzu and Akcay (2012) reported from their study of PTs in Turkey that the nature of schools that the PTs in their study attended affected their lived mastery experiences, and thereby affected their self-efficacy. Bandura (1997) explained that self-efficacy is related to the amount of effort a person is willing to expend in the face of challenges. Positive mastery experiences are lived experiences where a student has been able to succeed even when faced with challenges. The efforts that went into the success for these PTs in their high schools may have been from themselves, like the case of Eric, and therefore his belief that students' success is influenced by their self-drive, or from teachers and the goodwill of others, like in the cases of Shauline, Bernie and John. These PTs seem willing to expend more energy to assist students in succeeding.

Summary

In this section, I discussed the findings to answer my three research questions. The first question was: what do PTs notice and/or attend to while watching an episode of a multimedia case. The findings indicated that (1) noticing and attending to both teacher actions in class and power and participation is not distinguishable as described in Roth McDuffie et al.'s (2014) framing of noticing, (2) multimedia cases act as a dual directional bridge between theory and practice, (3) multimedia cases scaffold the changing beliefs of PTs, especially about students' initial knowledge and teachers' control of knowledge, and (4) problematic cases increase PTs' noticing from an MMC focused on teaching and learning.

The second research question was: is there a significant change in the self-efficacy beliefs of teachers after watching a multimedia case. The findings revealed that: (1) the PTs have a very

high personal science teaching efficacy, which, though it decreases as expected, does not have a significant change after watching an episode of multimedia cases, and (2) the PTs' outcome expectancy increases after watching and discussing MMCs episodes.

The third research question sought to find out what PTs drew on from the MMCs in their teaching practice. The findings revealed that (1) the PTs' professional vision was informed by both a gestalt view of the video teacher, which was represented by use of metaphors, and a specific-issues view of the MMCs, (2) the MMCs taught the PTs about concern for students, the specific issues featured in the cases (questioning, lesson introduction and teacher-led demonstration), and (3) the use (or misuse) of chorus answers type of participation.

From these findings we can conclude that science prospective teacher's self-efficacy beliefs are altered in the process of watching multimedia cases. Their beliefs about knowledge start to change from absolute ownership to shared and co-constructed knowledge in class. This is supported by the decrease in the personal teaching outcome expectancy (PSTE) that was noted in the quantitative data analysis. The PTs who initially subscribed to a teacher-centered, content delivery teaching model, may have assumed that teaching involves only knowing what to teach and going to class to tell it. This model subsumes the role of students in learning and hence the low attention to learners in the multimedia cases. Essentially, the prospective teachers portrayed the belief that if one knows all the topics in high school physics, he/she can very effectively teach it, and hence the high scores on the PSTE scale. In the process of watching the multimedia cases, the notion of absolute ownership started to change as they noted that students are able to co-construct knowledge. This was also supported by both the increase in noticing of students' role in learning in subsequent clips, and a decrease in the PSTE scores noted after the intervention. The affirmation of the new ways of teaching was made by the prospective teachers

who replicated the lessons in the field experiences and taught the lesson on *Matter* the way it was discussed in the intervention lesson.

In the next session, I discuss some recommendations, and the limitations for the study. This discuss includes my suggestions for future research. Finally, I give a summary of the whole research study.

Implications

Teaching and Learning with Cases

In this section, I discuss the implication of the findings on the design of multimedia cases, facilitation of case-based lessons, measurement of prospective teacher cognition, and teaching large classes.

Teaching large classes. Prospective teachers in this study enjoyed the intervention lesson. The most exciting moments were when they got a chance to talk with their peers about what they noticed in the video lessons. The discussions in these classes initially were directed to me as the facilitator, but eventually my role changed to that of keeping order and ensuring that many people do not talk at the same time. I did not evaluate any of the comments during the discussion. I noted that when PTs make comments that do not agree with another PT, they sought to use words that displayed a high level of professional knowledge. They did this to support their viewpoints.

I would therefore suggest that, as much as possible, PTs' emerging professional outlook should be supported in forums that cause them to draw on relevant ideas from their courses to make arguments. Such a forum can be achieved through small group discussions. Giving PTs an opportunity to speak in a large class may not achieve the quality of discussions that can emerge from smaller groups. Well-designed multimedia cases and facilitation questions can be used with

a delegated role of a confident facilitator who is not necessarily the teacher educator. In my opinion, the benefits of small group discussion outweigh the disadvantage of not having the teacher educator present in such discussions.

The tendency to draw on theories to support a viewpoint is important for developing PTs' emerging teaching philosophy. Instead of learning the materials for the sake of examination, they will start to see a need to understand and apply these concepts in their careers. Furthermore, apprenticeship of observation (i.e., teaching the way one was taught) is not an effective strategy for most SSA countries. First, the population is youthful, the interests and attitudes that the learners bring to class vary rapidly. Secondly, the resources available to a teacher can vary from one time of the year to another and from one school to another. Teachers therefore need to be adaptable. MMCs highlight the complexities inherent in class instructions in a way that PTs see the importance of being adaptable.

Design of multimedia cases. In this study, the video lessons were filmed in authentic classes; that is, the ordinary class that one would typically find on a given day in the schools. The National ICT Innovation and Integration Center (NI3C) identified the teachers in the video lessons as "champion teachers". It was, therefore, reasonable to expect that these teachers could display exemplary teaching skills since they have demonstrated certain teaching and technology skills and have had the opportunity for further professional development as a champion teacher. Such teachers may provide suitable illustrations of instructional strategies endemic to Kenyan classroom teaching. The filming was done using two cameras and both sets of video footage were edited and combined into one lesson. A transcript for the videos was prepared, and subtitles added to make the multimedia case.

When using these cases in this study, I selected only a short clip from a number of videos. The selected clip fit a specific objective from the methods course syllabus. The clips selected had other instructional incidences that represent the multiple and rapidly changing instructional decisions that a teacher makes in class. For example, while focusing on questioning strategies, the PTs noted the teacher's blackboard practices, importance of task coherence, and learners' behavior in class, among other things. These incidences, when noted, increase the teaching and learning value of the clips. For example, in this study, the errors that initially were seen as mistakes to be avoided become important noticing points for the PTs. The problematic videos also brought out the ideas highlighted in the exemplary videos more clearly. This implies that cases need to be prepared from authentic teaching environments and it may not matter if the case is an exemplary or problematic case. The only caution needs to be about the way the students and the teachers in those videos are portrayed.

Filming with more than one camera enables one to create a case that focuses on the teacher at the time he or she is providing instructions and another camera that provides a teacher's view of students when the students are engaged in learning activities. Editing should be done to track the important focus moments in a classroom depending on who the actor is in the specific teaching and learning episode.

Facilitating case-based lessons. The cases used in this study had a facilitator guide prepared to guide teacher educators through using the case for case-based teaching. The facilitator guide envisions a situation where the teacher educator plays a section or a whole video to a methods class. The facilitator guide, therefore, was based on systematic analysis of one lesson, and tried to match with the expectations of teacher preparation, specifically the methods courses. In this study, I found that short vignettes of video clips elicited a detailed and

comprehensive engagement from PTs. It may be more engaging to combine vignettes that illustrate the same instructional objective and compare across many clips than to watch one entire video. Based on the discussions with Professor Polaris and Prof. Orion, attempts to ask the PTs to view a whole lesson had not yielded meaningful engagement. However I noted in my field notes that watching a two-minute clip in the chemistry lesson elicited a discussion that was more detailed in connections that students draw between an episode and theory, than watching a 7-minute segment about teacher class demonstration in the physics teacher demonstration lesson.

Further, when facilitating case-based lessons, teacher educators can divide the PTs in groups that have a chance to react on each other's suggestions. The need that the PTs have to support their views makes them draw more from theory, and thereby connect their understanding of the teaching decisions that the teacher makes to the pedagogical strategies that they learn in teacher preparation programs. The chemistry smaller group was engaged more deeply than the physics whole group. The reason being that it was not possible to give each of the PTs in the large group a chance to make a comment, and when there were contradictory viewpoints, the chance for a PT to defend her or his viewpoint conflicted with the need to give everyone a chance to at least say something.

Measurement of Teacher Cognition

In this study, I wanted to measure the effect of multimedia cases only and try as much as possible not to measure the effect of other factors endemic to teaching episodes. As much as the ability of a PT to teach is dependent on numerous factors, researchers have viewed self-reported self-efficacy beliefs as the best indicator of how well the PTs can teach. There is a body of psychology literature that suggests that the confidence PTs have about the accuracy of their judgments about student outcome is not an accurate measure of student outcome expectancy, or in general, the confidence we have in our assessment of other people's situation is not a

reflection of the accuracy of these judgments (Apley, 2014). PTs may feel confident about their assessment, but that may not necessarily mean that they are accurate in their assessment. Self-reported efficacy beliefs are not in themselves free from the errors caused by reluctance of PTs to air unpopular beliefs. I talked to one participant who presented himself as quite introverted as he explained to me that he chose teaching because he is a social person who loves interacting with others. Since many PTs may also lack the language to express their teaching beliefs, using multiple data collection strategies and using a broader sample may help researchers accurately understand the self-efficacy beliefs of PTs.

Furthermore, the tools used to measure self-efficacy need to be adapted and validated for each subject in more robust Kenyan studies. In this study, the reliability of the PSTE scale was below the 0.7 that is recommended in social sciences. Therefore, while using case studies, researchers need to make decisions about what attribute about PTs to measure and how to measure it, and what the measurements implies.

Science Teaching

The Kenyan government places high priority to science as an enabler for the attainment of the Kenya Vision 2030. The Kenya Vision 2030 aims at making the country a newly industrializing, middle income country providing high quality life for all its citizens by the year 2030 (Republic of Kenya, 2007). Through the education sector, Kenya hopes to achieve the goals of a globally competitive quality education, training, and research by the year 2030. A lot of emphasis has been placed on science as the field that will drive technology, engineering and innovation.

Consistent with this goal, pedagogical shifts in science are currently being focused towards innovation, critical thinking, problem solving and application of theory to solve social

problems. Such focus has been the core of professional development initiative in the SMASE program that I discussed earlier. Beginning teachers have extensive knowledge of their content areas, but may not necessarily know how to engage learners in cognitive activities that promote critical thinking, problem solving and applications of theory to new problems.

Multimedia cases enable PTs to observe and discuss with their peers, and with the teacher educators, enactment of strategies that effectively promote attainment of desirable outcomes from learners. In this study, the noticing of students thinking increased, albeit decimally, from watching four short video clips. This means that using such cases promotes prospective teachers' attention to the student learning outcomes.

More specifically, science teaching and learning involves making science content more meaningful and interesting to the learners. This process requires that learners be cognitively engaged with the content. Teachers therefore need to pay attention to learners' ways of thinking and design instructional strategies that place science content at a challenging, but not frustrating cognitive level. Teachers therefore need to attend to students thinking more that they attend to content delivery. Multimedia cases initiate teachers to this complex teaching strategy and are, therefore, one platform where science teaching and science learning can be re-evaluated.

Limitations and Suggestions for Further Research

The survey instrument that I used in this study was prepared for U.S. elementary school PTs. It has been used in other countries and adapted in to many languages and to various subjects. In this study, the tool was adapted for Kenyan classrooms by changing the wording of some of the statements to make them suitable for the local Kenyan context, but the meaning of the sentences and the structure of the tool were not altered. The piloting of the Kenya version was done using Kenyan graduate students in the U.S. This is a limitation in the instrument used. I did not find any study in Kenya that had used the self-efficacy belief instrument.

Future research needs to develop an appropriate tool for measuring PTs' competencies for pedagogical attributes, and if possible to exclude the content mastery. Though both content and pedagogical knowledge is important for teaching, there are few or no tools that can be used to exclusively measure pedagogical beliefs, knowledge, or attitudes, without requiring that they are enacted and observed.

The other limitation for this study is the time that was allocated for the intervention lesson. The intervention lesson was carried out for only two hours. This time was was not long enough to make strong claims about the effectiveness of the multimedia cases. Further research needs to be conducted to see what would be the effect of continuous use of multimedia cases in the methods courses.

Another limitation for this study is that the progressive results reported from this study, and the enthusiasm shown for case-based teaching at Central University, could have been the effect of a new approach and new teacher educator/facilitator. The lesson departed from what the PTs were used to and it was more engaging. For the chemistry group, despite the huge numbers and small space, the boardroom is by far a better place to have a class than a large lecture room. These new changes could have had an effect on the results. In future research it would be important to study the effect of using multimedia cases, controlling for such factors as the facilitator, space constraints, and the effect due to introduction of a new instructional strategy.

Conclusion

In Chapter 1 of this study, I explained the context of the study by reviewing the education in SSA for the period before colonization to date. I emphasized the reform efforts that have been in place especially towards provision of learner-centered education, and how this has been affected by the prevailing dispositions of both external consultants and the local officials. I explained the way that the recent massification of education in most SSA has problematized the

teaching experiences of PTs and suggested that MMCs can bridge the resulting gap between practice and theory. To investigate the effect of multimedia cases, I posed three research questions: What do PTs notice and or/attend to when viewing MMCs? What is the effect of such MMCs on their self-efficacy beliefs? And, what do they draw on from such cases, when they go for their field placement?

In Chapter 2, I reviewed the literature about teacher beliefs and behavior. I suggested that Bandura's concept of self-efficacy beliefs gives a suitable projection of the abilities of a prospective teacher to be effective when they start teaching. I also reviewed the literature of multimedia cases focusing on how they are made, facilitated and the effect of using multimedia cases in teacher education. Finally, I explained more about large classes since it is a very pervasive problem in most SSA universities.

In Chapter 3, I provided a rationale for using a mixed methods approach, and described the methodology used in the study. I also described the intervention lessons that were conducted and the type of data collected. To answer the first question I collected data through a worksheet. I also collected pretest and posttest quantitative measurements of self-efficacy beliefs to answer question two. Finally, I conducted interviews with a small group of the PTs to understand what they draw on form multimedia cases in their field practice.

In Chapter 4, I presented the results from the three data sets. I used Roth McDuffie et al.'s (2014) framing to create categories of prospective teacher noticing. I then used paired-sample t-tests to evaluate the changes in self-efficacy beliefs for the PTs. Finally, I created teacher profiles for the PTs that I interviewed. The profiles reported some background information of the PTs, described their teaching philosophy, and then described the ideas they drew from MMCs in their teaching practice.

In Chapter 5, I presented a discussion of the findings. First, I reduced the analytical framework to combine a teacher lens of noticing and the power and participation lens. Using the modified framing, I reported the dispositions that the PTs hold about teaching, learning and the task, and how these progressed and increased in sophistication as they watched subsequent clips. I also reported that the intervention had a negative, but statistically insignificant change in teaching expectancy, and a significant positive change in outcome expectancy. Finally, I explained that the professional vision that PTs developed was drawn from both gestalt view of the clips, as well as replication of specific issues explained in the MMCs.

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Appendix A: Chemistry Teaching Self-efficacy Beliefs

Thank you for considering to complete this survey questionnaire. The survey instrument will take not more than 20 minutes of your time. I would request that you kindly take some time and complete this survey as accurately and honestly as possible. The results will go a long way towards improving the quality of teacher training in Kenya.

Part One: Efficacy Questions

Please indicate the degree to which you agree or disagree with each statement below by ticking the appropriate column to the right of each statement.

SA= STRONGLY AGREE
A =AGREE
UN= UNCERTAIN
D= DISAGREE
SD= STRONGLY DISAGREE

		SA	A	UN	D	SD
1.	When a student does better than usual in chemistry, it is often because the teacher exerted little extra effort.					
2.	I will continually find better ways to teach chemistry.					
3.	Even if I try very hard, I will not teach chemistry as well as I would most other subjects.					
4.	When the chemistry grades of students improve, it is often due to their teacher having found a more effective teaching approach.					
5.	I know the steps necessary to teach chemistry concepts effectively.					
6.	I will not be very effective in monitoring chemistry experiments.					
7.	If students are underachieving in chemistry, it is most likely due to ineffective chemistry teaching.					
8.	I will generally teach chemistry ineffectively.					
9.	The inadequacy of a student's chemistry background can be overcome by good teaching.					
10.	The low chemistry achievements of some students cannot generally be blamed on their teachers.					
11.	When a low-achieving child progresses in chemistry, it is usually due to extra attention given by teacher.					
12.	I understand chemistry concepts well enough to be effective in teaching chemistry.					
13.	Increased effort in chemistry teaching produces little change in some students' chemistry achievement.					
14.	The teacher is generally responsible for the achievement of students in chemistry.					

15.	Students' achievement in chemistry is directly related to their teacher's effectiveness in chemistry teaching.					

		SA	A	UN	D	SD
16.	If parents comment that their child is showing more interest in chemistry at school, it is probably due to the performance of the child's teacher.					
17.	I will find it difficult to explain to students why chemistry experiments work					
18.	I will typically be able to answer students' chemistry questions.					
19.	I wonder if I will have the necessary skills to teach chemistry.					
20.	Given a choice, I will not invite the principal to evaluate my chemistry teaching.					
21.	When a student has difficulty understanding chemistry concept, I will usually be at a loss as to how to help the student understand it better.					
22.	When teaching chemistry, I will usually welcome students' questions.					
23.	I do not know what to do to increase students' interests in chemistry.					

Part Two: Background Questions
Please complete the following items.

1. Gender:
a. Female_____
b. Male _____

2. Please select the category that best indicates your age group?

Category	Tick
Below 20 years	
20-25	
25-30	
30-35	
Above 35 years	

3. What subjects are you preparing to teach?

Major_____ Minor_____

4. What was your favorite high school subject? _____

5. Which of these reasons would you say was the top reason why you liked the subject you mentioned above in high school? If more than one apply, rank them by numbers 1-5 (1-most important) – 5-least important)

The teacher was kind and personable	
I got high grades in the subject	
The subject was important for my career aspiration	
The teacher was very competent in teaching the subject	
There are other reasons other the ones mentioned above	

6. Is this subject one of the subjects you are preparing to teach?

Yes	
NO	

7. Have you done any other course before coming for teacher education at Kenyatta University?

Yes	
NO	

8. What category of school did you go for your high school?

School category	Tick whichever applies
National	
County	
District	
Private	

Part Three: Personal information

Please provide your mobile phone number: _____
(This number will be used to match your pre- and post-test scores)

In this study, we will use multimedia cases to teach some of the topics that are taught in the methods classes. Would you like to be contacted for further information about participating in that part of the study?

Yes	
NO	

If Yes, how would you like to be contacted?

Contact Method	**Contact Information**
By text message (provide number if different from above)	
By email (provide email address)	
Other (provide details)	

Appendix B: Lesson plan for Physics- lesson introduction

Lesson 1. Physics lesson introductions

Background

This lesson will be based on the need to have a lesson introduction that engages students. According to Goldston et al. (2013) a lesson introduction needs to begin with learning activities that have the following outcomes:

- Elicits relevant students' prior knowledge
- Raises student interest and motivation to learn
- Provides opportunities for student discussion or invites student questions
- Leads into the exploration

Lesson Plan 1
Lesson Introduction Strategies

Objectives

By the end of the lesson, learners should be able to;

a) Describe the teacher activities and learner's activities that are used in the video clips to introduce the various lessons.
b) Evaluate the activities for their contribution to teaching and learning in the various lessons.
c) Interpret the activities' pedagogical relevance by linking them to learning theories covered in their methods classes and to Goldston's (2013) criteria.

Lesson duration: 50 minutes

Teaching activities

The lesson will entail the following activities: -

- Show a slide of the criteria of a good lesson introduction
- Show selected video clips and prompt learners to describe what they saw. (What did you notice?)
- Show the selected clip a second time and ask learners to evaluate the activities for their contribution to teaching and learning in the proposed lesson.
- Prompt student to think about what they know about teaching and interpret the lesson introduction, trying as much as they could to link it with what they know about teaching and learning (How can you support your evaluation of these activities from what you have learnt about teaching and learning)

In the first question, the process will be supported by plenary discussions after each activity. This will ensure that each person knows the expectations for each of the segments requiring them to describe, evaluate and interpret.

In the second round of video clips the learners will be asked to work as a pair, and then they will be asked do it on their own in the third video clip.

Finally they will be asked to make a contribution the first video in a way that they think would improve on what the clip shows.

Learners' activities

The prospective teachers will be issued with a work sheet. Learning activities will include: -

- Describing, evaluating and interpreting the lesson introduction on the clips

- Discussing with their peers
- Writing down their ideas on a work sheet.

Time allocated	Activities
5 minutes	Introduction to case based pedagogy: • Personal introductions • Introduction of the study • Introduction of the framework (describe, then evaluate, then interpret) • Expectations • Clarifications Availability of videos?
	Kakamega Chemistry video: Constituents of Matter
6 minutes	**Watching Video clip 0:00-4:07** (Plenary discussing) In this segment, the video teacher does a follow up of his promise to look at the CRT. He them demystifies the CRT by naming a few things that use the CTR, Then gives a structure of the whole lesson, (Looking at the equipment around the lab, going through a text presentation that summarizes cathode rays, he them reminds the students of the E-M spectrum, and then displays the study objectives, before starting the lesson with questions to re cap on what a cathode and anode are.)
3 minutes	What you notice in that segment? Questions to PT *What did the teacher say?* *What information was the teacher in this segment conveying?*
6 minutes	**Watch: 0:00-4:07 Again** **How would you evaluate this lesson introduction?** *Do you think this is good or bad introduction? Why is it good/bad? Satisfactory or needs some improvement? Use any other evaluative descriptors.* *If you are not good at describing, think of giving the teachers a grade on a scale of 1-10.* *Are there parts you would give more than others?* *Think about the reasons you give for this grade.*
4 minutes	How can you support your evaluation of this introduction from what you have learnt in the methods classes? *In this section you need now to give a reason for the kind of evaluation you gave in the part above? You need to use what you know about teaching and learning to justifying why you evaluated the clip that way.*
3 minutes	**Watching video clip 2** **Shitochi Physics Circuits 0:00- 3:03**
3 minutes	What you notice in that segment?

7 minutes	**Watch the video clips again and pose next question** Do you think this is good or bad Introduction? Why is it good/bad?
4 minutes	How can you support your evaluation of this lesson introduction from what you have learnt in the methods classes?
5 minutes	**Modification: Look at video clip 2 again and suggest how best you would either (a) modify this lesson. OR** **(b) design a different way to introduce the lesson that shows students how to set up simple circuits.**
4 minutes	**Wrap up and collection of worksheets**

Appendix C: Work sheet

Topic: **Lesson Introduction**
Subject methods physics.

Description of video clip Clip 1: Chavakali physics Clip 2 Shitochi Physics
Evaluation of video clip Clip 1: Chavakali physics Clip 2 Shitochi Physics

Interpretation of video clip Clip 1: Chavakali physics Clip 2 Shitochi Physics
Modification or re-designing of the introduction to simple circuits

Prospective teacher's identity _____ (Write your phone number here).

(Throughout this research, I will treat the personal information with extreme privacy and confidentiality. The number helps to match the data collected over the period of the study. It will not be shared with a third party)

Appendix D: Lesson plan for chemistry- Questioning strategies

Lesson 1. Physics lesson introductions

Background
This lesson will be based on the need to have a lesson introduction that engages students. According to Goldston et al. (2013) a lesson introduction needs to begin with learning activities that have the following outcomes:

- Elicits relevant students' prior knowledge
- Raises student interest and motivation to learn
- Provides opportunities for student discussion or invites student questions
- Leads into the exploration

Lesson Plan 1
Lesson Introduction Strategies

Objectives
By the end of the lesson, learners should be able to;

d) Describe the teacher activities and learner's activities that are used in the video clips to introduce the various lessons.
e) Evaluate the activities for their contribution to teaching and learning in the various lessons.
f) Interpret the activities' pedagogical relevance by linking them to learning theories covered in their methods classes and to Goldston's (2013) criteria.

Lesson duration: 50 minutes

Teaching activities
The lesson will entail the following activities: -

- Show a slide of the criteria of a good lesson introduction
- Show selected video clips and prompt learners to describe what they saw. (What did you notice?)
- Show the selected clip a second time and ask learners to evaluate the activities for their contribution to teaching and learning in the proposed lesson.
- Prompt student to think about what they know about teaching and interpret the lesson introduction, trying as much as they could to link it with what they know about teaching and learning (How can you support your evaluation of these activities from what you have learnt about teaching and learning)

In the first question, the process will be supported by plenary discussions after each activity. This will ensure that each person knows the expectations for each of the segments requiring them to describe, evaluate and interpret.
In the second round of video clips the learners will be asked to work as a pair, and then they will be asked do it on their own in the third video clip.
Finally they will be asked to make a contribution the first video in a way that they think would improve on what the clip shows.

Learners' activities
The prospective teachers will be issued with a work sheet. Learning activities will include: -

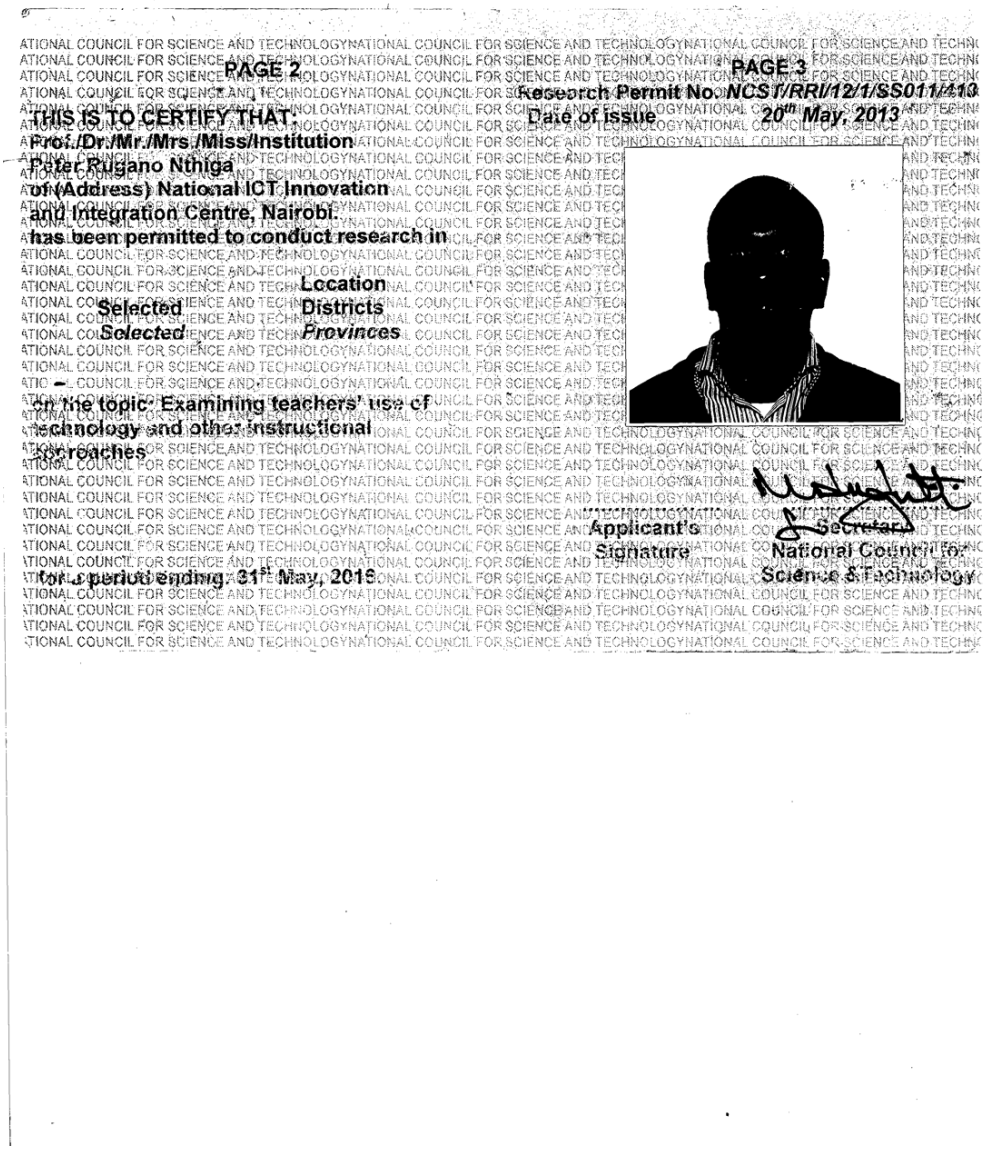
- Describing, evaluating and interpreting the lesson introduction on the clips

- Discussing with their peers
- Writing down their ideas on a work sheet.

Time allocated	Activities
5 minutes	Introduction to case based pedagogy: • Personal introductions • Introduction of the study • Introduction of the framework (describe, then evaluate, then interpret) • Expectations • Clarifications Availability of videos?
	Kakamega Chemistry video: Constituents of Matter
6 minutes	**Watching Video clip 0:00-4:07** (Plenary discussing) In this segment, the video teacher does a follow up of his promise to look at the CRT. He them demystifies the CRT by naming a few things that use the CTR, Then gives a structure of the whole lesson, (Looking at the equipment around the lab, going through a text presentation that summarizes cathode rays, he them reminds the students of the E-M spectrum, and then displays the study objectives, before starting the lesson with questions to re cap on what a cathode and anode are.)
3 minutes	What you notice in that segment? Questions to PT *What did the teacher say?* *What information was the teacher in this segment conveying?*
6 minutes	**Watch: 0:00-4:07 Again** **How would you evaluate this lesson introduction?** *Do you think this is good or bad introduction? Why is it good/bad? Satisfactory or needs some improvement? Use any other evaluative descriptors.* *If you are not good at describing, think of giving the teachers a grade on a scale of 1-10.* *Are there parts you would give more than others?* *Think about the reasons you give for this grade.*
4 minutes	How can you support your evaluation of this introduction from what you have learnt in the methods classes? *In this section you need now to give a reason for the kind of evaluation you gave in the part above? You need to use what you know about teaching and learning to justifying why you evaluated the clip that way.*

3 minutes	**Watching video clip 2** **Shitochi Physics Circuits 0:00- 3:03**
3 minutes	What you notice in that segment?
7 minutes	**Watch the video clips again and pose next question** Do you think this is good or bad Introduction? Why is it good/bad?
4 minutes	How can you support your evaluation of this lesson introduction from what you have learnt in the methods classes?
5 minutes	**Modification: Look at video clip 2 again and suggest how best you would either (a) modify this lesson. OR** **(b) design a different way to introduce the lesson that shows students how to set up simple circuits.**
4 minutes	**Wrap up and collection of worksheets**

Appendix E: Research Permit from Kenya



PAGE 2

THIS IS TO CERTIFY THAT:
Prof./Dr./Mr./Mrs./Miss/Institution
Peter Rugano Nthiga
of(Address) National ICT Innovation and Integration Centre, Nairobi.
has been permitted to conduct research in
Location
Selected Districts
Selected Provinces
On the topic: Examining teachers' use of technology and other instructional approaches
for a period ending: 31st May, 2015

Applicant's Signature

PAGE 3

Research Permit No: NCST/RRI/12/1/SS011/413
Date of issue: 20th May, 2013

Secretary
National Council for Science & Technology

Appendix F: Vitae

Peter Rugano Nthiga

Syracuse University, Department of Science Teaching,
2111 East Genesee St, Apt 5. Syracuse, NY. 13210.
Cell phone (+1) 315 403 4130. email prnthiga@syr.edu

EDUCATION

Doctor of Philosophy (expected May 2016), Science Education, Syracuse University, Syracuse, New York, USA. *August 2012 – present*

Masters of Science (expected May 2106), Teaching and Curriculum, Syracuse University, New York, USA. *August 2012-present*

Master of Science, Organizational Development, United States International University, Nairobi, Kenya. Thesis: *Making Effective Student Councils in Schools, December 2011*

Bachelor of Education, Science, Kenyatta University, Nairobi, Kenya. *December 1995*

HONORS

Outstanding Teaching Assistant 2016, Science Education, Syracuse University

Certificate of University Teaching Award (upcoming)

PROFESSIONAL POSITIONS HELD

(In reverse chronological order)

Teaching assistant, Syracuse University (August 2013-present)

- Planning and teaching two course on Quest and Questions in physical phenomena

Graduate Assistant, Syracuse University (August 2012 –May 2013)

- Preparation of research materials for professional development of teachers
- Organizing workshop for language teachers of New York

Dean of Academic Affairs, Nairobi School, Nairobi, Kenya (2011-2012)

- Coordinating academic activities in the schools

Head of Science, Nairobi School, Nairobi, Kenya (2004-2012)

Physics and Chemistry Teacher, Nairobi School, Nairobi, Kenya (2004-2012)

Deputy Country Coordinator, Global Learning and Observation to Benefit the Environment- Kenya (GLOBE-K) (2011 – 2013)

- A school-based program that uses observations and data interpretation to sensitize students about climate changes while seeking authentic ways to apply science and mathematics in real situations

Lead Trainer in Adolescent Reproductive Health, Health Users Alliance, Kenya (2009 – present)

Physics and Chemistry Teacher, County High School, Garissa, Kenya (1995-2004)

PROFESSIONAL ACHIEVEMENTS AND AWARDS

Spector/Warren Fellow for Holocaust Studies, Houston, Texas, USA. *2013*

Teacher of the Year, Nairobi School, Nairobi, Kenya, *2012*

Sexuality and Leadership Development Fellow, Lagos Nigeria. *2008.*

First Runner-up, Teacher of the Year, Westlands District, Nairobi, Kenya, *2012*

Collaborates with faculty as resident physicist to design lessons, activities and implement exemplar instructional strategies to inclusive and elementary education majors at Syracuse University NY.

Contribute to graduate research by participating in weekly seminars at Syracuse University NY.

Led science department teachers at Nairobi school in employing Information Communication Technologies (ICT) in teaching. This was accomplished by seeking and developing partnerships with other organizations, such as Cyber Schools Solutions and other top schools in the country. I have also taken a leading role in implementing the integration of technology in teaching through the *HP Catalyst Initiative* project with Kenyatta University and Syracuse University.

Led the physics department in Nairobi School in achieving excellence on the Kenya Certificate of Secondary Education (KCSE) results since 2007 by steering the department teachers to embrace effective techniques for preparing students for national examinations.

Led schoolwide policy changes. For example, decentralized funding of departments in Nairobi School, No-opting-out of physics during subject selection among others

Collaborated with local Non-governmental Organizations (Center for Study of Adolescents, Health Users Alliance) to develop curricula, pilot the curricula, and roll out a comprehensive ICT adolescent reproductive health program in 130 schools in Kenya. The program has helped delay the start of sexual activity in Kenyan adolescents.

Facilitated a visit to Nairobi School by the administrator from the U.S. National Aeronautics and Space Administration (NASA) as the patron of GLOBE club.

GRANTS

USD 25000 (declined). National Academy of Education support for dissertation research in teacher preparation.

USD 700 (awarded 2015). Writing and Creative Research Grant award from Syracuse University for data collection and analysis in the field of teacher preparation.

PUBLICATIONS AND PRESENTATIONS

Rugano, P. Twoli, N. & Waititu M. (2015). The Effect of Using Multimedia Cases on Prospective Teachers Self-Efficacy Beliefs. In A. M Bwire, M. S Nyagisere, J. O Masingila, & H. O. Ayot, (Eds) (2015). *Proceedings of the International Conference on Education*. Nairobi, Kenya: Kenyatta University (436-447) available at http://cuseinkenya.syr.edu/wp-content/uploads/2015/10/ICE-2015.pdf

Rugano, P. & Masingila J.O. (Sept 2014). Teacher Educators' Ideas for Using Multimedia Cases in a Sub -Saharan Africa University. *Presented at the National Center for Case Study Teaching in Science, Buffalo NY.*

Masingila, J. O., & Rugano, P. (July 2013). Using case studies to promote teacher learning. *Presented at the 3rd International Conference on Education*, Kenyatta University, Nairobi, Kenya.

CONSULTANCIES

Center for the Study of Adolescents, (Kenya) (2013). Development of peer training manual "Be the best you can" Developed a teachers manual for training life skills to school based youth.

PROFESSIONAL TALKS

Rugano, P., (2014). Selection of subjects: A Forecast of Skills for 2020 in Kenya and Match with Subjects. A talk given to Form 2 (K-10) Students at St Martin's girl's school in Nairobi, Kenya.

Rugano, P., (2014). Can girls be nerds? Female Students and Physics. A talk given to Brookshine Academy to encourage female students doing physics at Form 4 (K12).

Rugano, P., & Boron, A., (2013). Kenya and U.S.A: A photo story. Presented to East Syracuse Elementary School, Syracuse N.Y. Grade 2 students.

CURRENT REMUNERATION DETAILS

I have a teaching assistant's job that combines with a scholarship for PhD.

Teaching assistantship stipend: USD 22,717 per year

PhD scholarship USD 28,994 per year (Awarded as credits for PhD degree).

REFERENCES

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