Same or Different? A Qualitative Investigation of In-Service Science and Physical Education Teachers' Perceptions of Differentiated Instruction

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Abstract

In an increasingly inclusive educational environment in which Caribbean governments have signalled their commitment to *Education for All*, teachers are expected to respond to students' diversity through differentiated practice. There has been no empirical research about the response of practicing teachers involved in the UWI Diploma in Education programme to differentiated instruction. During the 2016/2017 academic year, forty science and physical education teachers were exposed to a session on differentiated instruction and were asked to plan and enact a lesson for differentiation and to reflect on the experience. This qualitative case study reports on the findings of teachers' perceptions of a differentiated approach to lesson planning and enactment. Qualitative data collection included lesson plans and written reflections on the lesson. Analysis of the data revealed that the majority of teachers differentiated by process and that none of the teachers differentiated by content. Analysis of teachers' reflections revealed themes related to the inputs, outcomes, and challenges of planning for and enacting differentiated lessons. The implications of the findings are discussed.

Keywords: differentiation, science education, physical education, teacher education, case study

Trinidad and Tobago – Achieving Education for All

With the declaration of Education For All (EFA) at Jomtien 1990, the international education community signalled its commitment to address inequity in educational opportunities by achieving universal primary education by 2000 (UNESCO 1994). The follow-up Dakar framework for action reaffirmed the vision of the World Declaration on Education for All adopted ten years earlier. Trinidad and Tobago, like many Caribbean territories is a signatory to EFA, the Dakar framework for action (2000), as well as the subsequent Millennium Development Goals (2000–2015), and the Sustainable Development Goals (2016–2030). Having achieved its goals of universal primary education in the 1950s and universal secondary education in 2000 (Manning, 2004), Trinidad and Tobago has therefore been able to progress in the attainment of Sustainable Development Goal #4 — to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (UNDP, 2017).

Unlike many international jurisdictions which are now becoming sensitive to student diversity, Trinidad and Tobago has, since the 15th century, been a country of diverse groups as a result of its history of colonialism, slavery, and indentureship. The population has been described as multicultural, multi-religious, and multi-ethnic and hence student diversity has always been an observable phenomenon (Campbell 1992; Subban 2006). In addition, between 1973 and 1981, a windfall in revenues as a result of the oil boom era allowed the extensive expansion of the secondary school system through the establishment of a junior and senior secondary school system. This system incorporated vocational education and sought to cater to a wide range of learners, opening secondary education to students across the range of academic abilities. Carl Campbell (1992) describes the Trinidad and Tobago education system in the 1980s as "the most impressive education structure in the Commonwealth Caribbean" (p.75).

Challenges of Inclusive Education

Despite the impressive increase in access to education at all levels, facilitating inclusivity in Trinidad and Tobago has not been without its challenges. Mainstreaming of students with special education needs takes place in limited numbers, programmes for gifted or special needs learners do not exist, and de-tracking is an option determined by individual schools, rather than a mandate to reduce student inequity. Indeed, it was only in 1980 that the state incorporated institutional schools such as the schools for the blind, deaf, and handicapped under the aegis of the Ministry of Education (Williams, 2007).

The country's standardised secondary entrance examination has also acted as a mechanism of segregation. In Trinidad and Tobago, students are required to sit a secondary entrance assessment (SEA) in their seventh year of primary school. The results of the examination assigns students to secondary schools based on the marks attained. The SEA examination is a historical legacy of the British colonial 11+ primary exit exams and was instituted in the early 1960s as the country began its movement into independence from Britain. At that time, secondary education spaces were limited and the common entrance examination acted as a mechanism to assign students to schools based on merit (Campbell, 1992, pp. 99–101). The SEA was meant to measure readiness of students for secondary school, as by 2000 Trinidad and Tobago was able to provide secondary school access to all students. However, assigning students to their school of choice based on merit has entrenched an elitist secondary education system in which schools become characterised not just by academic ability but by class, race, and religion (Campbell, 1997; De Lisle, 2012). The intersection of ability, race, and class is linked to the island's three-tiered system of secondary schooling. The first tier is populated by denominational schools which represent some of the oldest schools on the island and were therefore prized institutions of learning in an era of limited secondary education. Their reputation continues to attract the highest performing students; and they are able to provide access to approximately 10% of the student

population, which makes competition for entry to these schools fierce. Non-denominational government secondary schools which were built post-independence are in the second tier; and the third tier comprises the newest secondary schools which were built post 1970 to create access to secondary education for the majority of students. Working class students mostly tend to be average to low performers at the SEA and are filtered into this third tier. Working class students who enter a high performing school based on their SEA result and do not belong to the particular denominational grouping of the school, will find themselves in the minority position in these high performing schools. Not surprisingly, the segregation of students through the SEA leads to low expectations of students in the newest government schools and vice versa for those in the denominational sector (Campbell, 1997, pp. 203–208; De Lisle, 2012).

At the end of the five years of secondary education, high stakes standardized examinations equivalent to a high school leaving diploma further reinforce inequities as it pertains to class, race, and ability. Denominational schools predictably outperform their non-denominational counterparts in the academic subjects. These results reflect the strong correlation between class and academic success, as resources have been shown to be a prerequisite to good performance in all education systems (Campbell, 1997, p. 206; De Lisle, 2012).

Trinidad and Tobago can argue that it promotes equity by providing access to all students, varied curricula and examinations, and by supporting students' needs through the provision of generous resources such as free lunches, textbooks, and computers. However the structural segregation of the schooling system in which class, race, and ability intersect within schools and classrooms, continues to be a challenge for ensuring diversity, equity, and inclusiveness for all.

Differentiated classroom practice as a response to diversity.

Despite these problematic structural barriers to inclusion, the

Ministry of Education of Trinidad and Tobago (MOETT), signalled its commitment to full inclusion in its strategic plan 2000–2006 (Williams, 2007). In 2007, the director of the Student Support Services division noted that the government at the time supported the UNESCO (1994) definition of inclusion, which identified the role of differentiated practice as an integral tool for inclusion. Accordingly, inclusion was defined (author's emphasis) as a:

> "Process of **addressing and responding to the diversity of needs of all learners** through increasing participation in learning, cultures and communities and reducing exclusion within and from education. … **It involves changes and modifications in content, approaches, structures and strategies,** with a common vision which covers all children of the appropriate age range and a conviction that is the responsibility of the regular system to educate all children (Williams, 2007, citing UNESCO, 1994).

The idea of responding to diversity by modification of content, approaches, structures, and strategies speaks directly to the need for differentiated teaching. Indeed, the MOETT website describes one of the foci of primary education as the "explicit attention to differentiated instruction to meet the needs of a range of students" (MOETT, 2018). Inclusiveness then goes beyond the special needs population and equity of access, and incorporates the full range of student diversity. Student diversity is a constant across all school levels and differences in race, culture, gender, class, ability, and learning style can be found in all schools, regardless of the segregated nature of the secondary system.

Teachers' perspectives of inclusion and differentiated instruction

In anticipation of providing support for greater inclusion for students with learning disabilities (LD) in the classroom, the MOETT hired Miske Witt and Associates to conduct a survey of teachers' broad-based perspectives on knowledge and attitudes of inclusive education and differentiated practice (Johnstone, 2010). The survey, which was conducted between 2007–2008, targeted the entire population of primary, secondary, and special needs

teachers, a total of 8,000 teachers, with a 25% response rate fairly evenly distributed across educational districts (Johnstone, 2010).

The Miske Witt survey revealed that 37% of teachers believed there was at least one student in their class with a diagnosed LD, while 71% of the teachers believed that there was also at least one student with an undiagnosed LD. Teachers generally believed that all children could learn (73% strongly agree), but only 45% strongly agreed that all students could become productive citizens. A similar disjunction was also seen in teachers' belief in differentiation of curricula and practice. Nearly 100% of teachers recognized that collaboration was important in addressing inclusion, and most admitted that they used a variety of assessment types for monitoring progress. However, only 6% stated they had a lot of knowledge of curriculum differentiation, while 42% had just some knowledge of curriculum differentiation and the pedagogy for inclusion.

The Miske Witt survey results mirror global observations of teachers' response to inclusion and classroom diversity. Internationally, it is reported that most teachers still do little to adjust their instruction in ways that effectively reach out to academically diverse populations. Studies vary in reports of the importance that teachers place on attending to academic diversity in classrooms; and even when teachers express support for inclusive classrooms, they are likely to plan for whole-class instruction (Frey, n.d.; Llewellyn, 2011; Tomlinson et al., 2003). Further, research on teachers' beliefs generally shows that both pre-service and in-service teachers view student differences as problematic, rather than as inevitable phenomena that offer positive possibilities for teachers and students alike. When teachers see differences as deficits in students, rather than as classroom characteristics, this may lead them to relinquish responsibility for their academic success (Tomlinson et al., 2003). Research has also revealed that while many teachers acknowledge academic diversity in their classrooms and often affirm the need to address student variance, their practice tends to be misaligned with those beliefs.

According to Guskey (1985), shifting practice does not begin with changes in beliefs and attitudes, but because teachers are able

to observe the intersection of pedagogy and students' learning. As Figure 1 illustrates, it is improvement in student learning that drives the attitudinal and belief changes of teachers, and not the converse.

Figure 1. Guskey's theory of teacher change (Guskey, 1985 & 2002).

The Guskey model suggests that teacher training institutes would be more powerful agents of change through the close juxtaposition of clinical work with theory based knowledge. In Trinidad and Tobago, the School of Education at UWI St .Augustine has attempted to implement the Guskey model in its in-service Diploma in Education programme for secondary school teachers. Established in 1973, the Dip Ed programme is an intensive one year programme that attempts to provide teachers with not just the knowledge and skills of education and pedagogy, but with opportunities to investigate their classroom based problems through action research and to practice their pedagogical skills with scaffolding from their supervisor. These objectives are fulfilled through four courses: (1) Educational Foundations: foundational work in the history and sociology of education, as well as the psychology of learning, language, and health and family life education; (2) The Reflective Practitioner – action research (3) Pedagogy as Process and (4) the Practicum. The juxtaposition of theory with classroom practice attempts to mirror Guskey's model of teacher change and therefore has the potential to facilitate and support teachers' development of differentiated practice.

The Problem Statement

Within the context of a universal secondary education, but

within a structurally elitist system supported by standardized curricula and examinations, there is in tandem an era of EFA which is underpinned by a postmodern philosophy that recognizes and celebrates difference. While standardised tests may segregate by academic scores, they do not ensure homogenous classrooms by learning styles and cultures. According to the wide ranging Miske Witt survey (2008), teachers in Trinidad and Tobago understand and support a philosophy of inclusiveness. Teachers also recognize the diversity within their classrooms and the limitations of their pedagogy in addressing these needs. Throughout the literature of the current school reform movement, there is a call for teachers to adjust curriculum, materials, and pedagogy to ensure that each student has equity of access to high-quality learning (Tomlinson et al., 2003); a call mirrored in the UNESCO objectives for inclusive education which have been adopted by Trinidad and Tobago. However, it is also clear from the Miske Witt survey (2008) that there is a gap between implementation and understanding, and this gap is mirrored in research globally (Tomlinson et al., 2003; Frey (n.d.); & Llewellyn, 2011). Since teachers at the interface of teaching and learning are expected to operationalize concepts of inclusiveness through differentiated practice, teacher education programmes such as the UWI postgraduate Diploma in Education which provides initial training for secondary teachers, are also required to respond.

Following the Guskey model, it may seem reasonable to suggest that exposure to knowledge of differentiation with opportunities for classroom practice could influence teachers' beliefs and classroom response to student diversity. However, there has been little empirical research about the response of practicing teachers involved in the Dip Ed programme to either student academic diversity or their perspectives about differentiation under such conditions.

This research seeks to address this gap, and in so doing, to gain knowledge and understanding about secondary teachers' responses to and perceptions about differentiation after direct exposure to concepts of differentiation and opportunities for classroom practice. It is expected that this research will add to

the literature on differentiation, as well as inform the planning and structure of future interventions in educating teachers for differentiated practice within the UWI Dip Ed programme.

Research purpose and questions

The purpose of this research is to explore teachers' responses and perceptions of differentiated practice. The participants are teachers from the science and physical education group of the 2016–2017 cohort of the UWI Dip Ed programme. The research questions are:

- How do science and PE teachers enrolled in the UWI Dip Ed programme plan lessons using a differentiated approach?
- What are the teachers' perceptions of a differentiated approach to lesson planning and enactment in their classrooms?

Literature Review

Concepts of differentiation

Differentiation has been defined as an approach to teaching in which teachers proactively modify curriculum, teaching methods, resources, learning activities, and student products to address the needs of individual students and small groups of students to maximize the learning opportunity for each student in the classroom. (Tomlinson et al., 2003, p. 121). Tomlinson (2001) has noted that concepts of differentiation have evolved from individualized approaches to addressing differences to a more holistic and organic pedagogy. Differentiation is an integral component of the Universal Design for Learning (UDL) framework which was introduced by Myer and Rose and colleagues at the Centre for Applied Special Technology (CAST) in the 1990s (Myer, Rose, & Gordon, 2014).

Differentiation In Theory

Theory and research support movement towards classrooms attentive to student variation that is manifest in several areas, but mostly including readiness, interest, and student learning profile (Tomlinson et al., 2003; Frey (n.d.); Whipple, 2012; Llewellyn, 2011). It appears important for teachers to consistently, defensibly, and vigorously adjust curriculum and instruction in response to students' readiness, interest, and learning profile. Differentiation must be conceived and practiced as a reflection and extension of educational best practice. Therefore, as outlined in the literature, effective differentiation:

- Is proactive rather than reactive.
- Employs flexible use of small teaching-learning groups in the classroom.
- Varies the materials used by individuals and small groups in the classroom.
- Uses variable pacing as a means of addressing learning needs.
- Is knowledge centered; and
- Is learner centered.

(Tomlinson et al., 2003, Tomlinson, 2001).

Elaborating on Tomlinson et al. (2003), and situating differentiation within a framework of effectiveness, Doubet and Hackett, (2015) contend that differentiation is underpinned by a philosophy rooted in effective teaching and learning and is critical to improving instruction for all students.

Student variance and the psychology of learning

Effective instruction is premised on an understanding of how students learn.

Tomlinson (2003) advocates that differentiated instruction addresses student readiness, interests, and learning styles, but addressing such differences can only occur effectively in the

context of sociological and psychological theories of learning. In her review and synthesis of the literature on differentiated instruction spanning 25 years (1980–2005), Subban (2006) identified four theories that supported the conceptual underpinnings of differentiated instruction – Vygotsky's Sociocultural Theory of Learning, Brain research, Learning styles, and the theory of Multiple Intelligences.

Vygotsky's sociocultural theory supports the constructivist view that learning is an active process in which associations between prior knowledge and new knowledge through the processes of accommodation and assimilation are the basis for new learning. However, Vygotsky argued that such learning was mediated by the social interaction of the learner with a more knowledgeable mentor. This socio-cultural interaction facilitated the movement of the learner through their zone of proximal development (ZPD) — that is, the discrepancy between the child's actual mental age and the level that the child reaches when she is able to solve a problem with support. Language and speech were tools which mediated this process (Subban, 2006; Vygotsky, 1997/1934). Vygotsky's theory has implications for not just understanding and responding to individual readiness, but also to cultural differences. The same implications are true for research on learning and brain function. A wide range of laboratory and clinical studies support the view that the brain has not evolved to assimilate meaningless information. As such, aligning instruction to students' interest and culture is integral to learning. Brain based learning research also provide evidence that punitive, threatening environments prevent deep learning while challenging and stimulating tasks promote optimum learning (Subban, 2006; Jensen, 1998). Pat Burke Guild (1997) further notes that despite the differences between learning styles (our preferred orientation to learning), multiple intelligences (our preferred problem solving approaches) and brain based learning, each theory promotes sensitivity to diversity. She posits that the core principle underpinning each theory is that the unique nature of individuals influences their orientation to learning, and teachers and students should "foster and celebrate diversity" (Burke Guild 1997, p. 31).

Responding to readiness, learning styles and interests

The literature purports that as a response to student readiness, teachers engaged in differentiated practice set tasks at the appropriate level of difficulty or challenge in order to keep students motivated. Teachers act on the premise that students are bored by tasks that are too easy and become frustrated by tasks that are too difficult (see Tomlinson et al., 2003).

In the differentiated classroom, teachers can also respond to students' varied interests. As with readiness, addressing learning interest can be important to students' academic development and therefore determining and designing tasks that tap the motivation of particular students is at the heart of interest-based differentiation (Tomlinson et al., 2003).

Differentiation in response to student learning profiles refers to practices which address a student's preferred mode of learning. Learning can be affected by such factors as learning style, intelligence preference (thinking style), gender, and culture (Tomlinson et al., 2003). Therefore, the goal of effective instruction seems to be adequate flexibility in a teacher's mode of presentation and in a student's options for learning and expressing learning, so that an individual can generally find a match for his or her learning preferences. (Tomlinson et al., 2003).

In summary, based on student readiness, interest levels, and learning profile, teachers can differentiate through content, process, or product (Tomlinson, 2001; Tomlinson et al, 2003) and affect/environment (Tomlinson, 2014) with the aim of increased academic growth, motivation, and efficiency in student learning.

Differentiation In Practice

Even though the concept of differentiation is accepted intuitively, studies vary in reports of the importance that teachers place on attending to academic diversity in classrooms. For example, even when teachers express support for inclusive classrooms, they are likely to plan for whole-class instruction (Tomlinson et al., 2003; Frey (n.d.); & Llewellyn, 2011). After an

extensive review of the literature, Tomlinson et al. (2003) reported that when teachers have attempted differentiated instruction, it has often been used in ways that are limited and ineffective. They further state that in most cases the adjustments teachers make to student classroom variation seem to amount to little more than providing reinforcement and establishing rapport with students or reducing expectations (citing Fuchs & Fuchs, 1998). For example, in the Trinidad and Tobago context, Joseph (2013) found that teachers in training reported that they engaged mostly in process differentiation. In sum, several studies reviewed by Tomlinson et al. (2003) have concluded that students generally do not receive what could be called meaningful differentiated instruction (citing McIntosh et al., 1994; Schumm & Vaughn, 1995), as high-stakes testing likely exacerbates this problem (citing Callahan et al., 2003). Evidently, there are challenges associated with differentiating in practice.

With respect to teachers in training, another challenge surfaces — Tomlinson et al. (2003, p. 124) caution: "it appears that both pre-service and in-service teachers view student differences as problematic, rather than as an inevitable phenomena that offers positive possibilities for teachers and students alike". It seems that these beliefs evident during training often carry over to teachers' practice. For example, a letter from a practicing Trinidadian teacher which was published in a local newspaper highlights this problematic perspective of addressing student diversity in mainstream classrooms.

The teacher lamented:

> "As a teacher in the regular classroom, I have had troubling experiences with the teaching of the differently abled, which have caused me to question seriously the concept of inclusive education. I think that with even the correct training, this venture would be too much for the ordinary teacher to handle, as our teaching schedule is already so full. …So who is being included and in what? Since the needs of either group are being compromised seriously" (Prentice, 2012).

Tomlinson et al. (2003) suggest that when teachers see differences as deficits in students rather than as classroom

characteristics, they may relinquish responsibility for the academic success of each student. Therefore, if contemporary classrooms are to serve contemporary student populations effectively, there is a need for investigating and addressing pervasive teacher beliefs, as well as providing scaffolds which can support teachers in effectively addressing student diversity.

The Intervention

In an attempt to provide teachers with the support systems to use differentiation as a response to student diversity, the following intervention was implemented by the Science and Physical education lecturers of the UWI Diploma in Education programme at St. Augustine, Trinidad.

The intervention involved forty teachers of the 2016–2017 cohort. The teachers were initially exposed to differentiation as an issue within the plenary session that occurred in August. As a follow-up to the plenary session on differentiation, students in the science/PE curriculum group were exposed to a 3-hour session on differentiation during the first Semester. The objectives of the session were to:

- Articulate and discuss key elements in a teacher's planning for differentiation over time.
- Analyze and pose solutions to problems and issues inherent in differentiated classrooms.
- Reflect on their own growth in addressing academic diversity in the classroom.

During the session, students viewed the video entitled, "At work in the differentiated classroom" produced by ASCD. The interactive session provided opportunities for teachers to discuss the concept of differentiation, approaches to differentiation, and how their current practice aligns with a differentiated approach. As an exit strategy, teachers were asked to describe three things they learnt and one action that they would take to differentiate their practice. Students were also assigned the task of planning and enacting a differentiated lesson and were asked to reflect on the experience.

Methodology

Research questions:

The study attempted to answer the following questions:

- How do science and PE teachers enrolled in the UWI Dip Ed programme plan lessons using a differentiated approach?
- What are the teachers' perceptions of a differentiated approach to lesson planning and enactment in their classrooms?

A qualitative approach to case study research was chosen for this inquiry into Dip Ed science and PE teachers' responses to differentiated teaching. In this case study research, the unit of analysis is teachers' responses to differentiation and the case (the bounded system) is the Dip Ed science and PE teachers who comprised the 2016–2017 cohort. Van Wynsberghe and Khan (2007) suggest that "the interplay between the unit of analysis and the case is a constitutive element of case study research." (p.8). Hence, the phenomenon — teachers' perception of differentiated planning and instruction cannot be unravelled from the case — that is, the cohort of teachers which constitute a unique demographic. The phenomenon and the case are uniquely intertwined and constitute inextricable elements of a whole.

Yin (1994) states that case study is "an empirical enquiry that investigates a contemporary phenomenon within its real life context" (p.13), and Stake (2000) categorizes case study as intrinsic or instrumental. In this research, the case is conceptualized as instrumental, as it provides insights and understanding from the empirical data gathered from teachers themselves within their classroom contexts. Case study can provide in-depth understanding of a phenomenon within its context, and qualitative case study is underpinned by an acknowledgement and acceptance of the subjective constructions and multiple perspectives of participants within their unique contexts. Moreover, the intention of the study is not to generalize to a wider population of secondary teachers,

but to gain insight into the perceptions and understandings of differentiation from a selected group of teachers (secondary science and PE teachers enrolled in an in-service Dip Ed programme). This case study is interpretative, as it emphasises the meanings that participants assign to differentiation as an approach to learner difference, as well as the researchers' interpretations of the findings and the interactions among the various interpretations (Starman, 2013; Best & Khan, 1998, p. 248–250).

Participants

The group exposed to the intervention comprised 40 teachers, including 32 who were science specialists in the areas of biology, chemistry, physics, integrated science, and agricultural science. Six were physical education teachers and two were food and nutrition educators. The teachers were employed as science and PE teachers in a range of secondary schools, including 7-year government assisted (denominational schools), 7-year government schools and 5-year government schools and, as a group combined, taught at all levels of the secondary system — forms 1-6 (students between the ages of 11-19 years). The teachers ranged in age from 26 to 55 years and the range of years teaching experience spanned from 4-10 years to 21-25 years teaching experience. All teachers possessed a first degree in their subject specialization, and some also possessed postgraduate degrees. The group consisted of 11 males and 29 females.

Participants were informed of the purpose of the study, and conditions of anonymity and confidentiality were emphasized. All teachers who agreed to participate were asked to indicate their willingness in writing by signing a consent form. Respecting the need for confidentiality, the names of teachers were not used. Teachers were also free to withdraw from the study at any time, as participation was voluntary. Teachers were assured that despite the fact that they were students in the programme, their responses or desire not to participate would not be used to assess their participation or assign grades.

Data Collection

Data collection instruments consisted of teachers' lesson plans and their reflective journals.

Teachers' lesson plans provided responses to research question 1, as it allowed the researchers to determine how teachers planned for differentiation, and hence their perceptions of how differentiation could be operationalised. Teachers' journals were analysed to answer research question 2. The journals were reflections on their belief systems, and provided insights into their perceptions of differentiated practice in their classrooms.

Data Analysis

Lesson plans were analysed with respect to the lesson objectives and their alignment with strategies for differentiation as described in the cited literature. The lesson plans were therefore analysed to determine whether teachers planned for differentiation by content, product, and/or process. Commonalities and differences between plans were described.

Teacher journals were subject to thematic analysis during a process of analytic induction. After reading for familiarity, emergent themes were coded using in vivo, and constructed labels were identified. The coded categories were further categorized into more abstract thematic areas. Thematic analysis is an iterative, inductive process, in which data is subject to constant comparison, leading to data crunching as data evolves from information to conceptual categories. Creswell (2016) notes that themes provide "evidence for the central phenomenon of the study" (p.175). Thematic analysis occurred in several cycles of coding. First level codes were descriptive and emerged from the actual writings of the teachers. Second and third level cycles of coding provided more abstract categories and broad themes. The broad themes emerging from this study were the inputs, outcomes and challenges. (See Figures 2 & 3).

As an illustration of the development of the theme through inductive analysis and multiple levels of coding, the theme of

"inputs" was developed through the following process. At the first cycle of coding participants' journals were searched for emergent codes. These included comments on their concerns about their "effectiveness" in "meeting the needs of all students". "Effectives" and "Meeting students' needs" were in-vivo level 1 codes. In addition to others, these codes illustrated the category, "a reflective stance", which, along with other categories such as "commitment" spoke to the more abstract and nuanced theme of "Teacher disposition" (see Figures 2 & 3).

Findings

Research Question 1: How do science and PE teachers enrolled in the UWI Dip. Ed. Program plan lessons using a differentiated approach in their classroom?

Lesson plans provided data on research question 1.

Lesson and Unit plan structures: Thirty of the forty students (75%) prepared a differentiated lesson plan. Of these thirty students, differentiation was planned across all levels (Form 1- Form 6), but the majority were planned for upper secondary level (Forms 4-6). Learning outcomes were developed for the class as whole group rather than differentiated for a sub-group, and were classified at all three domains (cognitive, affective, and psychomotor) — but the majority focused on cognitive outcomes. Forty percent of lessons (12/30 lessons) engaged in formal pre-assessment prior to or as part of the lesson. Of those, forty two percent planned for a test of pre-knowledge to address students' readiness for learning, and the other fifty eight percent assessed learning preferences using the VARK (visual, auditory, read/write and kinaesthetic) instrument to address preferred modes of learning or learning profiles.

Most students except one planned for the single lesson as assigned. This student planned for differentiation across several lessons independently. Two students developed their Action Research unit as a differentiated unit which comprised 8-10 lessons. Seventy percent differentiated by process; 27% differentiated by process and product, and 3% differentiated by product only.

Differentiation processes: Group work was the most common

example of process differentiation in which there was flexible grouping — that is, students moved between groups based on multiple criteria such as preference, ability, and subject matter. Other types of group assignment included, grouping based on students' learning preferences; grouping based on pre-test scores of knowledge (labelled by teachers as struggling/low scorers and non-struggling/high scorers), or as mastery and non-mastery groups. Indicated on the plan and journals, teachers specified that they provided varying amounts of attention and allotted time based on the academic needs of students.

Another method of process differentiation involved providing students with tasks of varying complexity. These included: three methods for calculations involving the mole concept; providing students with three different samples of specimens and having one group observe for similarities, one for differences, and the third group for similarities and differences.

With respect to product differentiation in a Food and Nutrition class, students were given the choice of designing a poster or creating a storyboard. In one PE class, students could choose to demonstrate a skill, explain a skill, or evaluate a peer in the performance of a skill. Other examples of product differentiation included choice of role play, poster, or lecture. However, the most elaborated planning for product differentiation occurred in delivery of the AR project in which the teacher designed an interactive notebook and students were provided with product options in relation to the dimension of learning as active (for example, create a play, debate, interviews, joke book, or tap it out), reflective (journaling and letter writing, personal response, make a test/quiz), sensing, intuitive, visual, verbal, sequential or global. None of the students differentiated by content.

Research Question 2: What are science and PE teachers' perceptions of a differentiated approach to lesson planning and enactment in their classrooms?

Teacher journals provided data on research question 2.

Teachers' perceptions were categorized into three themes: Inputs, Outcomes, and Challenges. The themes referred to:

1. Teachers perceptions on the inputs that facilitated the use of a differentiated approach
2. Teachers' perceptions of the outcomes of a differentiated approach. The outcome was described in terms of the impact on (i) teachers themselves and (ii) on students
3. Teachers' perceptions of the challenges associated with a differentiated approach.

Figures 2 & 3 illustrate the relationship between themes and categories.

INPUTS: Factors Facilitating the Use of a Differentiated Approach

Two major categories emerged from perceptions of inputs that facilitated differentiation: (i) Teacher characteristics/disposition, (2) Planning and preparation.

As teachers reflected on their role, several sub-themes emerged which described their perceptions of the dispositions of a teacher who catered to the learning needs of diverse students. These dispositions included a reflective stance, flexibility, and open-mindedness, commitment, and student-centredness. The second emergent category was "Planning and preparation", which involved reflections on the importance of the planning process in differentiating lessons, and the role of time, assessment, collaboration, and students learning needs in the process of planning. Figure 2 shows the relationship between the categories and sub-categories of the theme "Inputs".

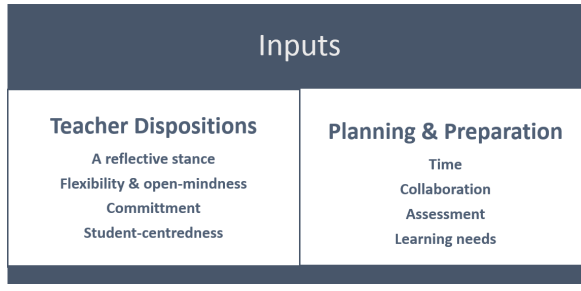

Figure 2: Categories and sub-categories of the theme Inputs

Teacher Characteristics/Dispositions

Teachers suggested that a differentiated approach focused a reflective stance, flexibility and open-mindedness, commitment and student centeredness. Teachers' reflected on and had concerns about their effectiveness in the classroom in catering for each child, and connecting their effectiveness with professionalism. One teacher reflected: *"On a daily basis, one of the dilemmas I face as a teacher is delivering and adapting the learning outcomes as outlined in the science syllabus to each child in my classroom such that effective learning can take place." Another teacher indicated "As part of my professional role, I am to meet the needs of these diverse learners present in my classroom."*

Another important area was flexibility and open-mindedness. One teacher stated, *"Flexibility and open-mindedness are also needed in developing my confidence and competence towards meeting my students' needs, and my disposition to cater to and meet student needs."*

Commitment was another major factor in engaging a differentiated approach in the classroom. Teachers felt that this approach required a large investment of time, effort and creativity, which at times could be frustrating. One teacher commented, *"Much thought and effort would therefore be needed in the planning and preparation of my lessons for effective delivery and optimization of students' learning as well as teaching."*

Teachers perceived the differentiated approach as student-centered and therefore indicated that a significant contribution to planning differentiated lessons was knowledge and understanding of students' learning styles and abilities.

Planning and Preparation

Teachers recognized that differentiation could not occur without thorough planning and preparation. Included in this would be the elements of time, collaboration, assessment, and learning needs. This planning and preparation led to perspectives on the processes involved. One teacher commented, *"In planning this*

lesson, it felt like I was planning four small lessons to be taught in one session. The process was exhausting and called for creativity."

The most predominant perspective on the process of planning differentiated lessons was the time needed to plan for different groups and readiness levels. Availability of time was described as a constraint. In general, teachers stated that planning is critical to maximizing learning in the classroom. Two teachers commented, *"One limitation of planning for differentiation is the time constraints of teachers' schedules"* and *"Planning is important to cater to the individual needs, however, planning can be time."*

Collaboration was another important element in planning and preparation. For some teachers, planning in a highly centralized school environment meant first convincing peers that a different approach to teaching was legitimate and beneficial. One teacher commented, *"I collaborated with my peers by first outlining the details of differentiated learning and then we determined how we would differentiate."* Another participant stated, *"Due to the unique nature of the activities, we will get to collaborate with other staff members such as the music teacher and VAPA."* Many others mentioned that the nature of differentiated activities required to cater to different learning preferences necessitates collaboration with colleagues from other subject areas.

Participants suggested that differentiation required attention to assessment issues, for example, pre-assessment of students' learning preferences and design of varying assessment tasks in relation to learning preference and student choice. With respect to learning preferences, teachers sourced the VARK instrument, which allowed for developing assessment choices and enabled students to express their knowledge through different learning styles. The interactive notebook is one example which provided students with a wide choice of products (to compose a skit or song, develop jokes or a riddle, write an essay or use charts, graphs and drawings).

An understanding of the learning needs of the students was a major challenge in planning and preparation. In order to achieve effective planning, there must be an alignment with the activities and levels of learning. This was evident by one teacher's comment:

> The greatest challenge to the lesson was preparation for the lesson. I realized for the method used to be effective it needs to have appropriate activities prepared for all the students which match their levels. This however can be challenging and requires a lot of consideration and planning.

OUTCOMES: The Impact of Planning and Enactment of Differentiated Lessons

Most teachers reflected on the positive outcomes derived from engaging in planning and enacting a differentiated approach to lesson delivery in terms of the impact on themselves and their students. Emergent codes referred to changes in teacher thinking and beliefs, enhanced knowledge and understanding of students and self, improved teacher effectiveness, and a commitment to continued implementation. Effects on students included the establishment of a welcoming and positive classroom environment, as well as enhanced student engagement and academic performance.

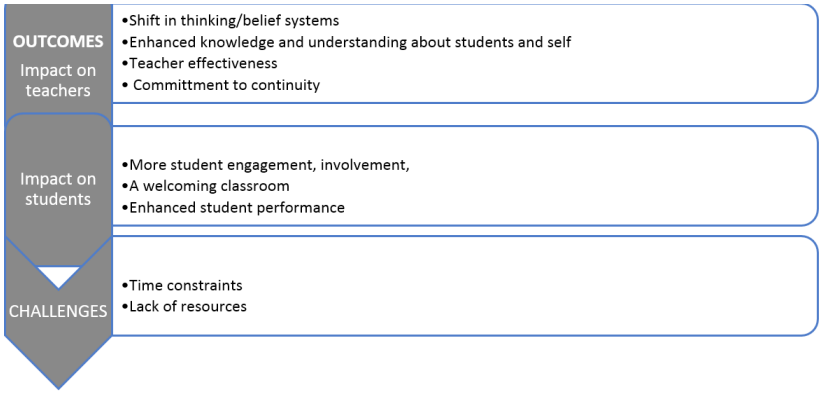

Figure 3: Categories and subcategories of the hemes *Outcomes* and *Challenges*

Impact on Teachers

Teachers reflected on their thinking and beliefs prior to exposure to differentiation, as well as on part of their experience of planning and enacting a differentiated lesson. For example, one said: "I did not even consider about the students having different learning styles and that I was responsible for understanding how they learn and find strategies that would allow me to reach them." After the lesson she indicated: "I realize now that we cannot treat with students the same way. They are not the same, they don't think the same and they all don't learn the same." Others also expressed new ways of thinking: "When we as teachers, as educators, do not recognize this reality we find ourselves teaching in a way to exclude or leave behind many students", and another teacher said, "One teaching method does not fulfil the learning requirements of all students, and teachers need to vary teaching strategies."

Teacher knowledge and understanding increased with respect to the concept of differentiation as well as knowledge and understanding of their students, which relates to a shift in their beliefs and thinking. One participant commented,

> "Students come to the classroom with their own unique knowledge and skills set. They have their own preferences in the way they learn content and concepts. They have their own special ability to express their learning. It showed that the students have the ability to learn once the methods used are appropriate to them."

In addition to learning about the concept of differentiation and gaining knowledge and understanding of the students, teachers' self-knowledge can contribute to the enhancement of their skills, abilities, and dispositions. One teacher found, "I learnt that I am capable of meeting these challenges as I was able to quickly adapt the lesson when I needed to do so." While another stated, "On reflection, I was able to identify lessons about myself and not just my students. I was able to see that I also have the ability to adapt to the needs of the students.

Teachers referred to the transformative potential of a differentiated approach as well as teacher empowerment, resulting in enhanced teacher effectiveness. Teachers expressed the

transformative potential in these sample comments:

> "I believe this approach to teaching has the potential to accomplish student learning with respect to any topic in any subject area and transform me into a better educator. I am myself a student and I can see how implementing this technique will increase my knowledge and raise interest and understanding of any subject matter."

> "The exercise also makes it easier to observe whether the students were having any issues with the completion of the task. One group was observed to be having some difficulty and additional assistance was given to that group."

> "In the past I taught a topic the same way every time as long as the syllabus stayed the same and even though the students change every year. I now understand and appreciate the need for a differentiated approach to teaching if I am to increase the probability of achieving the learning outcomes of a lesson."

Empowerment was evident in the following teacher descriptions. One teacher noted that ,"Learning about differentiation in this programme empowered me to try this approach in my classroom"; while another stated ,"differentiation afforded an opportunity to ensure that no child was left behind and I was able to assess where each student was in terms of the concepts that were being taught."

Based on their experiences and the outcomes achieved, teachers indicated commitment and continuity in their intention to plan and enact differentiation in their own classrooms as well as to engage their peers in the school.

> "The strategy proved to be quite effective in the delivery of the lesson, so that I can see myself incorporating it more often into my teaching."

> "I plan to share this insight with my fellow instructors with the hope that it will be implemented and this may lead to a general improvement in motivation and the school."

> "I therefore need to tailor my future lessons to be suitable to each of them as it is possible for all of them to learn once teaching is done in an appropriate way."

> "I am able to see a range of possibilities for teaching of future lessons through the use of various strategies appropriate to the students that utilizes the strengths of each student that was identified."

Impact on Students

Student engagement and involvement, a welcoming classroom, and enhanced student performance were three important impacts pertaining to the students. In addition to the impact on motivation as implied previously, using appropriate methods to target different learning preferences resulted in more efficient learning and enhanced student self-esteem. There was more student involvement and engagement —all students were meaningfully engaged in learning for the entire time alloted to complete the exercise, and meaningful learning. One teacher described the "excitement my students expressed" during a session that was differentiated. With respect to a lesson on the mole concept in which three different approaches to problem solving were presented, the teacher stated "Catering for students preferences and student self-esteem was enhanced. Students were more attentive and asked more questions. The students grasped the proportion logic method rather easily."

Another teacher referred to the welcoming classroom environment and the authentic nature of a differentiated approach, "They would perceive the classroom as welcoming, their grades will rise because they are adequately challenged in the classroom and differentiation makes their learning more authentic…" .

One teacher referred to improved student performance, suggesting that students were more interested in the subject area after exposure to a differentiated unit. They specifically stated, "On reflection having taught this unit, I believe the method used was very effective for my students as they were able to show improvements in their performance and expressed greater interest in the subject area."

Challenges

In addition to the time constraints mentioned above, teachers spoke about the lack of resources. For example, "I had to use my personal laptop and tablets to facilitate the students in order to carry out all the planned activities." "This strategy is challenging to teachers as it requires additional equipment, facilities, tools, and support staff (PE). Differentiated lessons are challenges, as teachers have to multi-task."

Interpretation and Discussion

Results of the study resonated with many studies of differentiated practice highlighted in the literature and reflected the constraints of the education system.

1. The finding that none of the teachers differentiated with respect to content is likely as a result of the standardized curricula and standardized examinations at the end of Form 5 or standardized school examinations. This is similar to reports in the literature, for example, Joseph (2013) who found that the majority of pre-service and in-service trained teachers did not differentiate content (or product) in the classroom.

2. The finding that teachers tend to differentiate by process is consistent with the findings of Tomlinson (2005) and Joseph (2013), among others.

3. That teachers mentioned changes in belief, which may provide support for the operationalization of Guskey's theory of teacher change. Such operationalization can only be fully realised through a longitudinal study when the support of the programme is absent and teachers must utilize the support systems of their schools and educational districts.

4. The findings indicate the iterative nature of the experience of planning for and enacting differentiated lessons.

For example, knowledge of students in terms of their readiness levels, learning profiles, and interest is an input into planning, however, based on the enactment there is increased teacher knowledge and understanding about students in terms of their responses to the strategies selected (the process of differentiation) which can then in turn be used for future planning. Similarly, the impact of the experience of differentiation on teachers' beliefs about students and the process of differentiation itself are critical inputs in designing and enacting differentiated instruction. The iterative nature of the process is illustrated in Figure 4.

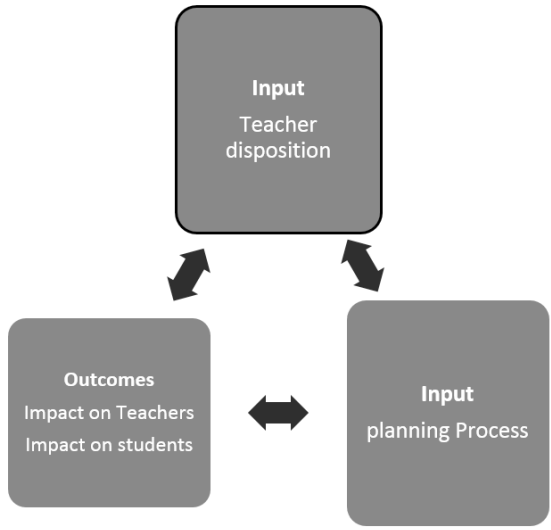

Figure 4. Relationship between inputs of disposition and planning process and Outcomes on students and seachers.

Discussion

The findings indicate that the science and PE Dip Ed teachers in training did respond to student diversity through differentiation. That 75% responded to the task requiring them to plan and enact a differentiated lesson seems to suggest that

the concept of differentiated instruction resonated with them and they were motivated to try this strategy to address student diversity, and teachers did so across all school types. Most of the teachers planned and enacted lessons at the upper secondary level which is guided by standardized curricula and high stakes examinations. Therefore perhaps it is not surprising that teachers did not differentiate by content, a response that is supported by the literature (Joseph, 2013; Tomlinson, 2005). However, given that students display a range of levels of readiness for the curriculum, there is need for School of Education curriculum tutors firstly to engage teachers in training in discussions about differentiation by content, and also to scaffold them to differentiate science content and goals particularly at the lower levels of the system. The literature suggests that with this strategy students are likely to achieve success, which can in turn enhance student motivation and interest in science and PE and lead to more of them selecting these disciplines for advanced study.

Unlike the report from Tomlinson et al. (2003), teachers in this study affirmed the meaningful strategies of differentiation and that such strategies were beneficial to students and teachers. Strategies adopted were not merely for reinforcement and establishing rapport as reported by Fuchs and Fuchs (1998 cited by Tomlinson et al., 2003). It is plausible within the context of an assigned task that teachers exerted greater effort in planning and delivery; but having engaged in meaningful planning and enactment, teachers now have evidence upon which beliefs were changed and intentions to sustain practice highlighted.

Teachers in this study did not express a view of difference as problematic and instead recognized it as part of their professional responsibility to cater to each student in the classroom. This is in contrast to research cited in the finding of Tomlinson et al. (2003) which cited greater hesitation toward the innovation. Teachers however noted the challenges of time, resources, and increased planning, and how these challenges influence commitment in the long term is worthy of further investigation.

Implications

Given the variation in Dip Ed teachers' responses to differentiation, it is clear that there is need for exposure to additional sessions throughout the year to provide support and feedback on their attempts at differentiation. The research by Guskey (1985) and Holloway (2000) also notes that innovations require long term support, teachers require continual feedback and the opportunity to experiment and implement their work incrementally. Such approaches suggest the need for continuity between in-service treatments and continuing professional development. Attention to differentiated practice as part of an initial training programme does not mean that such practices will persist.

There is also room for systematic data collection in relation to other methods of andragogy. Research by Defruyt, Aelterman, and Ruys (2010) for example refer to "congruent" teaching in which the teacher educator not only teaches the subject but models the practice with metacognitive support.

The research has been beneficial to the Dip Ed programme, providing empirical evidence of the impact of the intervention on teachers' practice and beliefs. Furthermore, the findings are a rich resource for innovation and further research in the development of differentiated practice in teacher education.

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