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TEACHER LEARNING IN ACTION RESEARCH: Insights From Information Technology/Computer Science Teachers in the Post-Graduate Diploma in Education Programme at the School of Education, The University of the West Indies, St Augustine

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The Action Research course, as part of the Post-Graduate Diploma in Education programme for in-service teachers, is conceptualised as research where in-service teachers investigate a problematic issue in their classroom/school. Action research expects a shift from practitioner to researcher, a journey that is often difficult for teachers, and presents opportunities for formal and informal learning through participation in the course. Using purposive sampling, 19 Information Technology/Computer Science teachers were selected to explore their learning in a blended Action Research course. Data were collected from online cross-sectional surveys, with closed- and open-ended questions, and qualitatively analysed for common themes. Findings revealed teacher learning occurred through participation in learning activities leading to desirable learning outcomes, such as change in knowledge, beliefs and practices. Teachers seemed committed to the action research process, appeared motivated during their learning and indicated a desire to continue to do action research. Four assertions about teacher learning are made, noting the importance of the learning environment in fostering teacher learning. Insights into teacher learning are useful for course lecturers, and recommendations are made to conduct further research into the teacher shift from practitioner to researcher.

Background

The in-service Post-graduate Diploma in Education (PGDipEd) at the School of Education(SoE) of the University of the West Indies (UWI), St. Augustine, offers a course in action research (AR), (formerly called the Curriculum study), one of four compulsory courses in the programme. The present study explored teacher learning among Information Technology/Computer Science (IT/CS) teachers in AR and followed a

large-scale evaluation of teachers' views of the larger PGDipEd programme (James et al., 2013). That 2013 study found that teachers held mostly positive perceptions of the programme and benefitted from pedagogical improvement. While teachers were expected to use research literature during the programme (p. 91), no specific findings in relation to teacher experiences with AR are stated.

AR emanates from a number of philosophical traditions and, in education, can take the form of teacher or classroom AR. According to Herr and Anderson (2014), AR is both a route to individual teacher professional development and a collaborative avenue to institutional change. Teaching AR methodology is considered to be relevant to the context of improving educational practice in Trinidad and Tobago for several reasons. Firstly, AR places the practitioner (the teacher) as the main actor in his/her research (McNiff, 2001). Secondly, it can be tailored to a specific historical-social context and allows researchers the freedom to choose which methods they wish to use (Kemmis & McTaggart, 2005). Further, AR is about empowerment and change, thus liberating practitioners from existing cultural practices (Kamalodeen, 2014). In an increasingly complex and challenging education environment, there is a need for teachers, administrators and school systems to improve practice and enhance the educational experience (Yamin-Ali, 2014). Thus, AR is critical in promoting social justice and in facilitating teacher reflexivity in practice, which can lead to desirable teacher change in the classroom.

Teachers face a multiplicity of challenges in their practice, from curriculum reform to school-wide policy change implementation. Teachers' daily work often does not allow for opportunities to engage in critical reflection on their educative practice. Teachers need to be decision-makers, which would be easier if data and evidence were available. Frequently, anecdotal data and observations are the sole data sources for decision-making. Yamin-Ali (2014) laments that:

> Whereas tacit knowledge, intuition, and hunches based upon experience may have their place, professionalism demands that schools be engaged in research if they are to use data to make decisions (p. 3).

James and Augustin (2017) looked at several programmes in which AR occurs, including higher education, preservice teacher education and teachers in graduate programmes. They, however, did not look specifically at the PGDipEd programme of which AR is a module. These distinctions are important as PGDipEd AR studies are practitioner-centred. The PGDipEd AR course is not necessarily aimed at publications. It requires

in-service student-teachers to plan, design and implement an AR project to solve a problem in their practice. Student-teachers face some tensions in shifting from practitioner to researcher (Yamin-Ali, 2014). Further, teachers may be reluctant to engage in reflective practice, a necessary component of AR, for many reasons, one being the fear of discovery and another a reluctance to sustain action within their practice that reflection may require (James & Augustin, 2017). But as adult learners, PGDipEd students are expected to be self-directed and to navigate new learning experiences efficaciously (Knowles, Holton,& Swanson, 2005).

Rationale for the Study

As relatively new entrants to the existing PGDipEd programme, IT/CS teachers are under-researched, and their engagement with AR can lead to better comprehension of their learning in the course. IT/CS has been taught at all levels of the secondary school system in Trinidad and Tobago since 1989. However, IT/CS education was initiated in 2012 at the UWI School of Education by the lead author of this paper. Action researchers tend to retain the basic academic model of small-scale experimental research (minus the 'control group'), and the 'problem-solving' attitude of hoping to change things for the better by finding more efficient classroom techniques (Allwright, 2015). In order to identify a research focus for the AR classroom study, some IT/CS student-teachers used the strategy of selecting a 'failed' educational target, such as low-test scores or poor student engagement in a particular content area. This has been called a 'failure-driven' learning approach by Schank & Abelson, 1977 (as cited in Bereiter & Scarmalia, 2014), and perhaps test scores are all the data that the teacher or schools have. This AR course was designed for teachers to consider their own practice, as well as that of others, to become more systematic in their research on practice.

The AR course demands strong academic writing and research skills, but IT/CS student-teachers are often bereft of these skills upon entering the PGDipEd programme, as their undergraduate degrees in Information Technology/ Computer Science often focused on technological and content knowledge. Additionally, student-teachers are full-time workers without reduced academic demands at their schools, while trying to conduct research there. Sometimes student-teachers face conflict with school administrators, colleagues and students in achieving multiple targets in the same timeframe (James et al., 2013). Lecturers, too, felt a level of frustration in student-teachers' slow grasp of methods and apparent inability to diagnose problem areas in their practice. In the year 2014/2015, the PGDipEd utilised a blended learning format to reduce time

away from work and modernise the course. Lectures and tutorials, both face-to-face and online, dominated the course facilitation but students were expected to do a significant portion of the work as independent study.

The main purpose of this paper is to explore how learning took place among IT/CS teachers in the AR course. It focuses on teacher experiences and learning activities, learning outcomes, and challenges that they may have faced during the course. This understanding may be useful to course lecturers and designers, as classroom AR is highly contextual.

The main research question that guides this study is, what is teacher learning in an AR course in the PGDipEd at the SoE, UWI? The sub-research questions are:

1. What learning activities do IT/CS teachers engage in during the action research course in the PGDipEd at the SoE, UWI?
2. What are IT/CS teachers learning outcomes while conducting action research in schools?
3. What are the barriers/challenges to IT/CS teachers learning while conducting action research in schools?

Conceptual Framework and Review of the Literature

This study is grounded in the framework of adult learning (Knowles, Holton, & Swanson, 2005), and understanding how teachers become learners in adult education settings. The latter is the subject of ongoing research (Cochran-Smith & Lytle, 1999; Knowles, Holton, & Swanson, 2005; Feinman-Nemser, 2008; Patton, Parker, & Tannehill, 2015). Initial work on understanding adult learning is credited to Knowles (1990) who developed the concept of andragogy, which is built on principles of pedagogy applicable to any adult learning situation. He created a set of assumptions about how adults learn, which he used to develop educational programmes for adults. The six assumptions of andragogy are that adults are autonomous, self-directed learners; they need to know why they are learning; they bring a wealth of experience to the educational setting; they enter educational settings ready to learn; they are problem-centered in their learning; and they are best motivated by internal factors.

While there is ongoing criticism of Knowles' theory of andragogy, his work has elements of constructivism, such as self-direction and problem-centred learning; as well as that of motivation. Several other theories are important to adult learning, such as Mezirow's (1991) transformative learning and Kolb's (1984) experiential learning. While these theories have different emphases, they are founded on a common

principle that adults are independent learners who are capable of taking control of their lives and learning. Self-direction became a core component of adult learning and Deci (1980) argues that teachers participate in a learning environment to satisfy needs of competence, self-determination and connectedness. Motivational factors to participate in adult learning may be external (such as job mobility and performance appraisal) or internal factors (such as job satisfaction and self-esteem), but the latter has a stronger pull (Knowles, Holton, & Swanson, 2005, p.57).

Related to self-directed learning is the newer idea of self-regulated learning which originated from educational psychology and cognitive psychology. In examining key constructs within the context of achievement motivation, Clayton, Blumberg, and Auld (2010) found goal-orientation and self-regulated learning to be significant. Those who are considered highly self-regulated are knowledgeable about their abilities and how to attain their goals, and are also more likely to demonstrate high levels of self-efficacy. Those considered weak self-regulators are often less likely than high self-regulators to sustain efforts to attain their learning objectives, and often select tasks that require little effort to succeed and pose little to no challenge. Educational debates continue about the level of significance of personal characteristics like self-direction and motivational interest in teachers' participation in professional learning activities.

Action research

Several definitions exist for AR. These definitions vary depending on the context and discipline. AR is identified as one aspect of educational research, the purpose of which is mainly to investigate specific problems in certain contexts and school settings (Johnson & Christensen, 2008). AR is conducted by practitioners, such as teachers, counselors, and principals, to solve a problem in a local setting, and not necessarily by academic researchers. According to Johnson and Christensen (2008), AR usually involves a participatory process and its purpose may not be for presenting generalisable findings in academic journals (p.12). Kemmis, McTaggart, and Nixon (2013) further describe AR as a systematic inquiry process undertaken by stakeholders to resolve specific and targeted problems. AR can be defined as a form of self-reflective enquiry undertaken by participants in social (educational) situations, in order to improve the rationality and justice of their own social or educational practices, their understanding of these practices, and the situations in which the practices are carried out (Kemmis, McTaggart, & Nixon, 2013).

AR democratises the process of knowledge production by building on the actions, beliefs and understandings of those working

within a particular social context. It places emphasis on 'insider' experiences, rather than the more generalised observations of teaching and learning that may be advanced by external researchers (Burns, 2015). This type of research differs from outsider research, as the teacher is practitioner and researcher, and not necessarily the subject of the research. Teachers thus become researchers of their own practice in their specific school context.

James and Augustin (2017) postulate that classroom AR provides a mechanism for teachers to adopt a systematic, reflective approach that can address areas of need within their respective curricular domains and can lead to overall school improvement. They described AR as an approach that is based in practical action, known as the action component, while focusing at the same time on generating, informing and building theory, known as the research component. These two components work together, each at the same time informing and supporting the other. It is a constructivist approach to research that encompasses processes of dialogue, collaboration and action among the participants in the surrounding system (James & Augustin, 2017).

There are a number of professional benefits to teachers engaging in AR. James and Augustin (2017) indicate from their review of salient literature that teachers became increasingly reflective and developed research skills (p.11). Kember (2002), in a survey of 90 AR projects in higher education, specifically indicated "development of skills, changes in attitudes and the development of revised practices that endured" (p. 92). Additionally, Seider and Lemma (2004) disclosed that teachers developed an 'inquiry' mindset and enhanced professional efficacy. Ali et al., (2012) showed PGDipEd teachers enjoyed pedagogical benefits related to lesson planning, collaboration with colleagues, and understanding the theoretical foundations of education. Further, Hien (2009) cited AR benefits such as teacher commitment to the AR process, a mechanism for school change and enhancing democratic processes at the school.

Notwithstanding the focus on AR at the SoE, expectations of teacher AR by stakeholders such as the Ministry of Education may not match that of the teacher's. For example, Ali et al. (2012) noted that while some stakeholders were comfortable with the focus on teachers' work within the classroom context, others also expected outcomes related to an understanding of the broad purposes of education and of teachers' role in the society; an outcome that they felt was not being achieved in the PGDipEd. According to the 2012 study, stakeholders also felt that teacher change was not sustained after the PGDipEd ended, a claim supported by prior literature (Rampersad & Herbert, 1999).

TeacherLearning

Wenger (1998, p. 214) describes learning as an "interaction between experience and competence, which must remain in a state of tension for learning to occur". The idea that teaching is a learning profession (Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009) engages a substantial body of literature. Newer, more complex and broad-based ways of looking at teachers' learning have emerged over observations of "discrete" activities like workshops and seminars in teacher professional development (Desimone, 2009). Teacher learning also emanates from informal interactions with colleagues and daily classroom practice (Feiman-Nemser, 2008; Vermunt & Endedijk, 2011).

Research into teacher learning is not as well developed as that of student learning (Vermunt & Endedijk, 2011), as theories abound for student learning. These include but are not limited to cognitivism, behaviourism, constructivism, and brain-based leaning. However, when in-service teachers adopt the role of learners, they bring experiences from the school into the university. This could lead to what Barr and Tagg (1995) call paradigm shift in learning as schools/colleges of education are now producers of learning rather than providers of knowledge. Borko (2004) suggests that teacher learning needs to be studied while taking into account "both the individual teacher-learners and the social systems in which they are participants" (p.4), an idea often called situated learning. Vermunt and Endedijk (2011) conducted empirical research into models of patterns in teacher learning and found that teacher-learning patterns were directly related to both personal (personality characteristics, personal experience in teaching and learning, and gender), and contextual factors. These researchers suggest that the most direct factor in teacher learning is the learning environment which, for in-service student teachers, includes the social environment, the type of intervention used in learning (such as formal instruction, informal learning, collaboration, online learning) as well as the wider school climate (in terms of openness to innovation) (p. 298).

Opfer and Pedder (2011), in their review of literature on teacher learning, also identified the role of the learning activity (or process) as important as that of school factors and individual teacher characteristics. They used a complexity theory lens to study the interrelations among factors in teacher learning, and critiqued the linearity and discreteness of other approaches to studying teacher learning. In a longitudinal study of secondary school teacher learning at their workplace (schools), Bakkenes, Vermunt, and Wubbels (2010) adopt a definition of teacher learning as:

> an active process in which teachers engage in activities that leads to a change in knowledge and beliefs (cognition) and/or teaching practices (behaviour) (p. 538).

In analysing digital logs of teacher learning experiences, these researchers distinguished between learning activities (experimenting, considering own practice, getting ideas from others, experiencing friction, struggling not to revert to old ways, and avoiding learning) and learning outcomes (changes in cognition and behaviour).

Even the way teacher learning is measured is problematic. Hoekstra and Korthagen (2011) suggest that the way student learning is measured, as scores in tests and exams, is inappropriate in measuring teacher learning, and literature on social and informal learning can provide a useful lens for framing teacher learning, especially if participation in activities can lead to desirable learning outcomes. The idea that teachers are knowers and thinkers, and that the school is a learning community, has gained considerable support (Cochran-Smith & Lytle, 1999). These authors argue that there is little difference between teacher learning as social inquiry, practical inquiry or ways of knowing in communities.

Learning can be categorised in a number of ways. A debate exists between what is termed formal and informal learning, sometimes described politically as non-formal (Malcolm, Hokinson, & Colley, 2003). Informal learning is considered as learning through everyday practice or in non-formal education spaces while formal learning refers to what is acquired through lectures, tutorials and seminar/workshops within the University. Advocates for informal learning suggest a change in structure for learning and that schools lack the infrastructure to support workplace learning (Kwakman, 2003). Additionally, informal learning might take place individually or collaboratively, intentionally or unintentionally (Jokisalo &Riu, 2009 as cited in Rowell & Hong, 2013).

Social learning theory proposes that individuals can learn in formal and informal settings, such as the workplace, classroom or other spaces including online (Kamalodeen, 2014). This learning is horizontal, sometimes not intentional but emerges through an incidental outcome of interactions with others. Bandura (1977) also stressed that individuals construct learning through observing others, as it is where individuals learn attitudes, beliefs and behaviours.

In-service teachers navigate formal instruction in the educational institution, and informal learning in the workplace, continuously, while constructing knowledge of themselves, students and learning itself during the PGDipEd. These collective experiences may influence teacher learning in desired directions. In this scenario, educators, student-teachers

and even students co-create knowledge of the classroom that is practical and useful (Cochran-Smith & Lytle, 1999).

Teacher learning in AR may be considered as complex as it requires the synthesis of new materials, comprehension, reasoning and inquiry into practice. It calls for new ways of 'seeing' what has been routine, and this requires effort. According to Graesser and D'Mello (2012), this effort in learning may place student-teachers in a state of cognitive disequilibrium where social-cognitive-affective-behavioural-psychological mismatched states are experienced. Equilibrium is restored when learners disengage from the process. This may occur at the end of a successful study or if a student exits from the study at an earlier time. Student-teachers (undergraduates) "may feel overwhelmed at best". Helm and Bailey (2013) recommend that student-teachers require mentoring and supervision throughout the process.

The literature reviewed provides lens for teacher learning in AR at the SoE and in the school setting. This study seeks to explore three aspects of teacher learning for in-service teachers conducting AR at their schools. These are the learning activities in which teachers were engaged in the AR course, changes in learning outcomes in cognition and practices, and challenges faced during their learning.

Research Setting-The AR course in PGDipEd Programme 2014/2015

The AR course was delivered in a blended mode through lectures, tutorials and independent study. Students were required to do readings around a research focus, developed after examining their practice. At the end of semester one, students individually produced an AR proposal, with supporting unit and lesson plans that were aligned to the relevant and current IT/CS curricula. An intervention strategy was carefully designed and implemented in the classroom during the second semester, in each school, by the teacher, all with the lecturer's close supervision. Data were collected and analysed to answer the research questions. Students were mentored in the AR process on a one-to-one basis by the lecturer, who acted as a research supervisor. Communications between lecturer and student, and among students, were primarily online with limited face-to-face interaction. *Moxtra*, a free online collaborative tool, allowed independent and group chatrooms, group meets and filesharing. The lecturers also used *Zoom*, a free online meeting tool, to facilitate online classes as well as individual and group mentoring sessions. Additionally, *Google Drive* allowed for the annotation and sharing of documents, thus giving lecturers and students the ability to collaborate. Write-up and

editing of the AR reports by students took another two months with close supervision. These AR reports of approximately 5,000 words were submitted in order to satisfy the course requirements. Two examples of these studies were '*Digital game-based learning to promote engagement among sixth form IT/CS students at a rural government secondary school in Trinidad'* and '*The teaching of reading in IT at an at-risk school in East Port-of-Spain'*. The authors of this paper were the AR course lecturers.

Methodology

Combining Qualitative and Quantitative Methods in one Instrument

Participants were given online questionnaires: one developed to evaluate the teachers' views of the larger PGDipEd by James et al. (2013), and one specifically designed for the views of PGDipEd IT/CS student-teachers by the AR lecturers. The first questionnaire consisted of 15 questions, both open and closed-ended, and was developed and tested by a PGDipEd in-house team. The second questionnaire consisted of 5 open-ended questions to elaborate on exploring the learning activities of the students, and the challenges faced during AR course. This instrument was developed by the course lecturers, and was piloted and tested in previous IT/CS courses at the SoE.

There is a debate about whether this type of combination of qualitative and quantitative data collected from the questionnaire can be described as concurrent mixed methods (Bryman, 2006), or is simply adding on open-ended responses to a close-ended survey. In his survey of 252 social science articles, Bryman (2006) found that the majority of researchers (62.9% of all articles) employed a cross-sectional design for the collection of both quantitative and qualitative data; by far the most common design combination. We therefore justify the use of this design for completeness of the data, which refers to the notion that the researcher can bring together a more comprehensive account of the area of enquiry in which he or she is interested if both quantitative and qualitative research are employed (Bryman, 2006).

Participants

Participants in the study were IT/CS student-teachers in a PGDipEd at the SoE, UWI. There were 3 males and 16 females from 19 secondary schools. Fifteen (15) of those schools were Government Secondary schools (or high schools), thirteen (13) from Trinidad and two (2) from sister island

Tobago, as Trinidad and Tobago is a twin-island republic in the Caribbean. Of the remaining four schools, one was government-assisted and the other three were private. Five (5) of the Government secondary schools were considered at risk schools (Trinidad and Tobago, Parliament, n.d., p. 12). Years of experience before doing the programmes varied from 5 to 18 years. All 19 teachers in the group were selected for participation in the study.

Data Collection and analysis

Data were collected through two surveys. The first was an online survey to all PGDipEd students using *Fluidsurveys.com* at the end of the 2014/15 AR course. The second was disseminated to 19 IT/CS participants using *Google Forms.* All participants consented to take part in the study and were granted anonymity through the online questionnaire as names were not submitted. Anonymity was essential to maintain confidentiality and to build trust in order for the participant to feel comfortable sharing valuable information required for the study. A limitation of this study was the variability in the length of the responses to the open-ended questions where participants may have offered 'weak satisficing' (Krosnick, 2018). In this scenario, respondents may have put the first answer they thought of, rather than exerting effort in providing optimal answers.

A clear advantage of electronic data collection, through online survey, was the ease of obtaining participant data and maintaining data integrity, as data were captured in their original form together with relevant activity histories. The availability of born digital data eliminated the need for data transcription and possible introduction of errors, as well as allowed data analysis to be easier and more efficient. Data from the online survey were captured on an Excel sheet by question and relevant respondent. Data per question were extracted into a table and coded for themes identified from the literature. This was done by one researcher and then by the other independently. A constant comparative analysis was used across all categories, themes were generated, and significant statements elicited (Butler-Kisber, 2010). Quotations were extracted according to each code and presented in support of the finding. Since statements were written in the first language of participants (Trinidad Creole), insertions and explanations were inserted for clarification where needed. It is to be noted that 'curriculum study' was the term used in 2015 to represent the AR report.

Findings

This section is organised according to the three research questions and presents findings related to each.

RQ1: What Learning Activities do IT/CS Teachers Engage in During the Action Research Course in the PGDipEd at the SoE, UWI?

Findings revealed themes for learning activities that engaged teachers which were: considering one's own practice; innovating under supervision; interacting face to face and online; getting feedback from the lecturer; interacting with others; and planning for continued AR.

Considering one's own practice

IT/CS student-teachers thought about the teaching strategies they employ and remarked "m*y teaching strategies were not as effective before".* Another student-teacher reported,

> *"I would [now] attempt a more student-centered approach as I am learning to put my students at the center of my lessons. Thus, instead of imparting my knowledge and teaching my students, I am trying to help them learn".*

Innovating under supervision

Teachers attempted to adapt to and adopt new pedagogical strategies in the classroom. Some of these were problem-based learning, technology integration, gamification, game-based learning and differentiated instruction. A benefit of attempting new strategies was the supervised visits by the lecturer, and engaging in reflection. There were some tensions and challenges to being supervised while experimenting. For instance, one teacher who used an innovative approach of gamification to teach the topic 'Data Types' commented,

> *"I became a bit nervous knowing I had to teach in the presence of my curriculum supervisor… However, I was very pleased with the delivery of the lesson, my supervisor approach made me very comfortable".*

Another student, who, during a supervised visit, chose to experiment with the use of a rubric as a means of evaluating his students, expressed

> *"I had certain doubts with regard to using of the rubric to score students activities, but these doubts or misconceptions were properly rectified by her [lecturer] ideas and comments...Overall, her [lecturer] comments were well received and will be*

> *implemented so as to have an effective and properly managed curriculum study".*

Interacting face to face and online

IT/CS student-teachers favoured a mix of online and face-to-face classes.*Moxtra.com* and *zoom.com* helped to facilitate chats and meetings with students. One student noted this about the online format,

> *"It made me more interested in the program that I did not have to drive long distances to sit in a class. I was able to sit in the comfort of my home with my family than be stressed out in traffic getting to and from UWI. It also helped me to think critically during these sessions as it was stress free to sign on".*

Students rated *Moxtra* highly for chatting and favoured asynchronous modes of communication. Participants claimed that they used *moxtra* mostly for "*clearing up ambiguity*", but also for "*giving information", "giving answers to specific questions"* and "*for socialisation". Zoom* helped to facilitate classroom-like sessions. One student commented that the online space was *"Great! Still learnt a lot.... like a classroom.... there was interaction".* Phone calls were used to "*clear up any misconceptions*". It was particularly beneficial to those living in Tobago as this student indicated, "*It was very engaging. As a Tobago [Tobago is the sister island to Trinidad and quite a distance] student I will welcome more online courses*". Lecturers were "*knowledgeable*" and were "*successful in facilitating an environment conducive to learning".*

Getting feedback from the lecturer

The quality of feedback from the lecturer was significant to teacher learning in AR. The majority of student-teachers described the quality of the supervision they received during their AR as "*excellent*" while the rest responded "*good*". One student elaborated,

> *"My Lecturer was very accommodating. She responded to my problems/issues at any time of the day or night. I appreciated her kindness, patience and interest she took, and I am very grateful for this. I learnt a lot from her both professionally and otherwise. Overall, it was an excellent experience. I am now a better teacher/educator/person".*

Other students lauded *individualised coaching* and *guidance* as important to their learning. Another student claimed, "*lecturers were always ready to respond to questions and give feedback for all projects in a timely manner*".

Interacting with others

Sixty-five percent (65%) of the students chose the option "*pleasant*" to indicate their experience in conducting AR at their school, while 29% indicated that it was "*comfortable*". 6% selected "other" and further indicated that it was "*refreshing*". Perhaps the most significant indicator of transformational learning is the desire to share experiences with others. One favourable response describes the need for "*... a digital space to share findings with fellow/prior dip-Eders/lecturers.... continued communication from lecturers.... email of informative link, etc. [sic]*". They attributed success of the AR to "*My [IT/CS] Curriculum lecturer and the cooperation of my students*" while others indicated interactions with "*HOD, UWI lecturers, fellow Dip. Ed. colleagues*" [sic] were significant to their learning. Further, others enjoyed "*meaningful discussions*" with peers and this comment offers support, "*Other colleagues helped and gave advice*". Mostly, findings reveal satisfaction with "*interacting with teachers from different types of schools*" and '*networking of teachers*'.

Planning for continued research on practice

Participants indicated that they would continue AR into their practice post Dip/Ed for "*personal benefit and benefits to staff and school and students"*. For example, one student indicated that after the PGDipEd, "*I would be more relaxed and less stressed [so I can continue AR]*." Another student indicated a continued "*desire to improve my practice*." One participant indicated *"she developed new strategies in understand[ing] how to teach my [IT/CS] class better".* Participants stated that while they rated the AR course highly for "*personal and professional growth*", they felt certain challenges would affect their ability to continue doing AR.

RQ2: What are IT/CS Teachers Learning Outcomes While Conducting Action Research in Schools?

Findings for IT/CS teacher learning outcomes are categorised into two areas: changes in cognition (knowledge, beliefs and attitudes) and changes in pedagogical practice (behaviours).

Changes in cognition (knowledge and beliefs)

IT/CS teachers indicated a growth in knowledge in several areas, mostly related to pedagogy. The majority indicated that they gained insight into effective teaching strategies. For example, one of the teachers stated that "*strategies do exist to engage my digital native students*", which signaled that the teacher realised there were strategies for the students born in the digital era (sometimes called millennials). Another teacher acknowledged that she gained "*an awareness of new teaching strategies that can be used in the classroom*". IT/CS teachers also claimed they

gained insight into their practice in areas of student understanding, assessment feedback, and student-centered learning. Mostly they claimed that they gained insight into their "*individual strengths and weaknesses*". One student indicated learning research skills and specified that it was "*the help from the lecture[r]s [sic]in how to conduct the research*".

Beliefs about teaching seemed to have been impacted as some student-teachers indicated the importance of unit and lesson planning, along with student-centred learning. Additionally they pointed out that teaching literacy is the job of all teachers. There were a few comments that seemed to indicate a change in teacher beliefs may have taken place. One student-teacher, for example, indicated that having done the AR course she now believes that, "*students can contribute to their learning*" and another teacher stated that she now realised that, "*students need a lot of motivation and support*". These beliefs did not come without some amount of uncertainty, as one student stated that,

> *"I must admit I was a bit skeptical of this strategy in the curriculum study teaching practice however I decided to go brave and allow myself to be a guide in the lesson and allow my students to show their true potential".*

The student-teacher seemed to have made a judgement about her practice and took action.

The idea that learning is situated in the field emanates from teacher observation of students in the classroom setting, and in answering higher order thinking skills (HOTS) questions. One student-teacher noted,

> *"My students motivated me when I observe their struggles in answering HOTS and the challenges in answering HOTS question on the final examination paper".*

Findings also indicate that student-teachers gained increased confidence in themselves and, at least, an awareness that they could impact their students positively. A typical response was "*I better understand what motivates the students to take part in class*". Another student-teacher indicated he gained "*confidence in trying new strategies, discerning students' strengths.... abilities...and looked for areas for improvements*".

IT/CS student-teachers seemed to experience delight about the AR process and said,

> "*The idea that my action research would potentially help my students with their comprehension skills and surprise, I now have students who like programming" [a core component in IT/CS]*.

An important change in belief came from understanding AR itself. This is exemplified by a student saying, "*with proper planning and thorough research we can improve learning in the classroom*".

Changes in pedagogical practices (behaviour). IT/CS student-teachers indicated they used a number of teaching/learning strategies that they found to be effective in their classrooms including, teaching literacy in the classroom, problem-based learning, and effective use of technology. These strategies formed part of the pedagogical interventions in their AR studies, all specific to their classroom. One participant elaborated,

> *"I have learnt how to incorporate Bloom's Taxonomy in my lessons so that I can train my students for the real world and their final exams. I also apply The Socratic Method to help when I need to break-down questions so that students can gain a better understanding. I have also learnt to push my stronger students by using depth of knowledge questions to challenge them".*

Participants seemed to have gained satisfaction from engaging in the AR, as well as heightened self-esteem. One student-teacher remarked that her source of motivation was, "*to see my students succeed and in making my school a better learning environment*". Yet another said that her reason for doing AR was a "*desire to improve my practice*". While their classroom students motivated some teachers, others noted that their colleagues were motivating for them and thanked "*staff at school, Dip Ed. group and supervisors, my students' attitude towards the program*" for success. Finally, the statements from two teachers, "*I have become a much better teacher. Thanks to Dip Ed*." and,

> *"This curriculum study has opened my eyes as a glance in the past of my teaching characteristics of mainly through the use of textbooks and writing on the board. I have now realized that future problems associated with any topic besides problem solving can be researched and a proven strategy can be implemented to get better results from the students".*

contribute to showing how positively teachers felt about the difference that the course made to their practice.

RQ3: What are the Barriers/challenges to IT/CS Teachers Learning While Conducting Action Research in Schools?

Notwithstanding the participation in learning activities and obtaining desirable learning outcomes through the AR course, IT/CS teachers did indicate that there were three major challenges that hindered their learning. These challenges included time management, inadequate

resources, and insufficient administrative support, and are elaborated below.

Time management: This seemed to be the greatest factor hindering teachers' engagement in AR. Student-teachers are challenged to work with a lengthy IT/CS curriculum, sometimes unwilling students, and high academic expectations while performing extra duties in IT/CS. They indicated that they needed more time to properly conduct the AR. A suggestion was made that:

> *"More time is needed to conduct the research to obtain more comprehensive data for analysis"*.

Another student in the study, who also felt that time was indeed a major factor stated,

> *"The time allotted for each study, since it's interesting to do the research but sometimes can feel overwhelming".*

One other student indicated that "*It should be full-time for a year*." The lack of time caused student-teachers to feel rushed and unable to enjoy the research process. As one student stated, "*deadlines are sometimes too soon and given my daily schedule I am unable to do enough background reading to give comprehensive answers to questions*."

Lack of resources, such as technology and Internet: This was also cited as a major concern among the student-teachers; it was the second highest concern after time management. Two teachers cited, "L*ack of resources (computers/laptops)*" as a major concern, while three teachers, listed "*no internet*", "*internet problems*" and "*lack of resources (..., internet service)*".

*Lack of cooperation from administrators***:** Students often claimed that the structure of the school, a lack of resources and technology support, and school disruptions made it difficult to "*follow the research implementation schedule*".

Student-teachers indicated that the UWI SoE could do more to improve student experiences of conducting AR in schools, by increased support and resources, reduced number of assignments, scheduled times for AR, more time to conduct AR, and the offering of incentives.

Discussion

Three major findings of the study were that IT/CS teachers engaged in learning activities during the AR course of the PGDipEd programme, positive changes occurred in cognition and pedagogical practices, and the major barrier/challenge to AR was time management.

With regard to the IT/CS teachers' engagement in learning activities, the following were revealed: reflection on practice and innovating, interacting face-to-face and online, getting feedback from the lecturer, interacting with others, and planning for continued AR. IT/CS teachers experienced desirable changes in learning outcomes, incognition (knowledge, beliefs and attitudes), and in practice (behaviours). They also indicated challenges to learning. Of these, time management seemed to pose the greatest challenge. Others were linked to school contexts, such as lack of cooperation from school administration, staff and students. It was also noted that a number of minor challenges were linked to technology. Parental support did not seem to be a challenge. Programme limitations, such as lack of knowledge of AR and dedicated time to conduct AR, were least mentioned. Personal factors, such as lack of confidence to do the AR, was considered a minor hindrance.

From these findings, four assertions about teacher learning in AR are made below.

1. Learning Activities are Central to Teacher Learning

IT/CS teachers in this AR course seemed to have engaged in several learning activities, such as considering their practice, innovating under supervision, interacting face to face and online, getting feedback from the lecturer, interacting with others, and planning for continued AR. Lecturers devised ways of intentional knowledge sharing of AR theories and processes for students who had no prior knowledge. Additionally, lecturers facilitated a learning environment, which Vermunt and Endedijk (2011) believe is the most direct factor in teacher learning. Supervised visits by the lecturer, while the teacher experimented in the classroom, allowed for immediacy in feedback, which student-teachers seemed to favour. Helm and Bailey (2013) do highlight the key role of mentoring and supervision in learning new concepts.

Additionally, facilitating reflection, supporting innovative practice and fostering engaging face-to-face and online classroom, seemed important to teacher learning. These findings align with ideas of teacher learning espoused by Bakkenes, Vermunt, and Wubbels (2010) as engagement in active learning processes leads to change in cognition and behaviour. Where the theory of the course is carefully meshed with field experience and carefully mentored (Darling-Hammond et al., 2009), teacher educators are better able to accomplish their goals in preparing teachers to successfully enact complex teaching practices (Zeichner & Conklin, 2008).

2. Teacher Learning is Co-constructed in Both Formal and Informal Learning Spaces

As IT/CS teachers engaged in AR, they experienced positive shifts in their cognition and practices, which support the definition of learning purported by Bakkenes, Vermunt, and Wubbels (2010). They developed research skills and became increasingly reflective, as previously indicated by James and Augustin (2017). Systematic data collection and observation were used in reflection, decision-making and the development of more effective classroom strategies (Ali et al., 2012). In particular, teachers held reflective dialogues with the lecturer and meaningful discussions with peers (Ali et al., 2012). This reflection allowed for what Seider and Lemma (2004) called an 'inquiry mindset'. Observation, discussion, collaboration, reflection and interrogating practice activities helped teachers to co-construct their learning at the institution (UWI) and the workplace (school), and even in online learning spaces. The availability and accessibility of lecturers during independent study, and in clearing up ambiguity, was also critical to student informal learning. This informal learning was often facilitated through skillful leveraging of online collaborative tools, *zoom* and *moxtra*. Thus, the learning environment seemed to have enabled teachers to experience success in AR. Further, it is suggested that the School of Education acted as a producer of learning, which according to Barr and Tagg (1995), was a needed shift in the way Colleges/Schools of Education should operate.

3. Teacher Learning is Grounded in Adult Learning Theory Linked to Motivation and Self-regulation

Motivating factors for learning in the AR course of PGDipEd program such as support from supervisors, colleagues and peers, plus a desire to become a better teacher (Deci, 1980), are indicative of intrinsically motivated factors for success. In spite of the purported lack of time to read, enjoy the research process and to acquire research skills, IT/CS student-teachers were all successful in submitting AR reports. This implies that motivators, both extrinsic and intrinsic, such as confidence and enjoyment, helped student-teachers to persist in their learning. Participants claimed that their students were their inspiration to conduct the AR.

At the beginning of challenging courses, Graesser and D'Mello (2012) suggest student teachers usually experience some form of cognitive disequilibrium where they feel confusion and frustration in knowledge building. This may have occurred because of the length of time it took to learn and design the research project, and engage in the research process, (three months). However, findings from this research indicate

perseverance in completion of tasks, and do not seem to suggest that negative emotions from cognitive disequilibrium (Graesser & D'Mello, 2012), sufficiently disrupted teachers' ability to conduct or complete their AR. Perhaps the ongoing support by IT/CS course lecturers through online tools during periods of independent work assisted in success.

Self-regulation is a key aspect of adult learning according to Clayton, Blumberg, and Auld (2010). This group of teachers seemed knowledgeable about their abilities, figured out how to attain their goals, and remained committed to the AR process. This may indicate the presence of self-regulation. Educational debates continue about the level of significance of personal characteristics like self-direction and motivational interest in teachers' participation in professional learning activities. It is important that teacher educators are able to understand their student-teachers' own beliefs about their ability as learners and motivating factors for learning. However, while IT/CS teachers claimed they experienced a change in cognition (knowledge and beliefs) and practice/behaviour during the AR course, it is beyond the scope of this paper to predict whether teachers would do AR in their schools after the course is completed.

4. Teacher Learning is Related to the Learning Environment

The IT/CS teachers in this study came from diverse school settings - government and government-assisted, rural and urban. In the PGDipEd programme, students were able to build knowledge of research methods and processes in a relatively short time frame, and implement an action in their classroom/school. While time was identified as an issue in teacher-learning (Kamalodeen, 2014), success in IT/CS teacher learning may be attributed to the learning environment (the School of Education), the types of intervention used in learning (such as formal instruction, informal learning, collaboration, online learning), and the openness of the teacher's school to innovation (Vermunt & Endedijk, 2011, p. 298). Bereiter and Scarmalia (2014) defined schools as 'problem spaces' where AR is much needed. We propose that classrooms can evolve to be places of learning (Cochran-Smith & Lylte, 1999), if the learning environment supports teachers while conducting AR in these spaces. This would require schools to attend to improving structures and policies to support workplace learning (Kwakman, 2003).

Conclusion and Recommendations

Teacher learning was explored through the learning activities that IT/CS

teachers engaged in, the change in learner outcomes and the challenges they faced in implementing AR projects in their school. Teacher learning included consideration of one's practice and the freedom to explore change in their classrooms. While some of these AR projects may not serve the wider community, as they are case specific and cannot be generalised, there were positive changes in cognition and practice. Student-teachers also gained confidence and competence in practice; an important learning outcome. Analyses of submitted AR reports can enhance understanding of what student-teachers learnt during the course. Student-teachers seemed motivated throughout the process even though they had much to learn in a short period of time and faced various challenges at their schools. Further research is needed to describe the processes of self-regulation that participants may have adopted throughout the course. Teacher learning in this study indicates the critical role of the learning environment in the PGDipEd's AR course, which may have directly led to successful AR projects. Learning activities were designed to engage the participants. Research skills were gained, and it is likely that the quality of academic supervision was also significant in mitigating cognitive disequilibrium. This study highlighted the pivotal role of research supervision. After the course is over and supervision has ended, exploring a system of mentoring after the PGDipEd can be considered for teacher continued involvement in AR.

These findings are particular to that of the IT/CS PGDipEd experience, and are helpful to course lecturers and authors of this paper. Data across year groups combined with interviews and analyses of documents, such as reflection journals and AR reports, can provide even deeper understanding of teacher learning.

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