A DESCRIPTIVE ANALYSIS OF PRESERVICE TEACHERS' OPPORTUNITIES TO LEARN TO TEACH SCIENCE USING ICTS IN SOUTH AFRICA

Thuthukile Jita, Loyiso C. Jita
University of the Free State, South Africa
E-mail: jitat@ufs.ac.za, jitalc@ufs.ac.za

Abstract

Research suggests that there is not enough integration of Information and Communication Technologies (ICTs) into subject teaching by graduate teachers across a variety of school settings. This points in part to the inadequacy of preservice teacher preparation. Hence, this research explores the question of how preservice teachers develop the necessary competence to teach, particularly science subjects, using ICTs, by examining the opportunities to learn (OTLs) that are provided at three different South African universities.
Keywords: *ICT, opportunities to learn, preservice teachers, science teaching, teacher education.*

Introduction

Among the many issues related to the successful use of Information and Communication Technologies (ICTs) to teach in the classroom, the more salient one is on the training of preservice-teacher education students to teach specific subjects with these modern technologies. A recent study by Aslan and Zhu (2018) on social studies, mathematics and science beginning teachers' integration of ICTs addressed this issue and points to the need for changes in curriculum and assessment systems. Hennessy, Ruthven and Brindley (2005) have made a similar argument on the challenges of ICT integration in English, mathematics and science subject teaching and were concerned by the lack of training of teachers to use ICTs for specific subject teaching. ICT integration has been used in schools as an innovative way to address the challenges facing the quality of teaching and learning in schools, yet the take-up in the use of ICTs to improve learning is itself still very low. Some researchers have referred to the source of the problem as the inadequacy of teacher education, particularly in the way preservice teachers are provided with opportunities to learn (OTLs) and develop competence in the use of ICTs for teaching their subject matter (Cogan & Schmidt, 2015; Hebard, 2016, Schmidt, Cogan, & Houang, 2011). These researchers have argued that a lack of ICT integration in teacher preparation programmes makes it difficult for preservice teachers to use ICTs to teach curriculum subjects in schools after graduation (Baran, Canbazoglu Bilici, Albayrak Sari, & Tondeur, 2019; Gülbahar, 2008). As ICT integration continues to play an important role in education, teacher education programmes are expected to produce innovative preservice teachers that can adapt to different teaching and learning environments and who are able to use different ICTs for content teaching. Without such OTLs in the teacher preparation programmes, the use of ICTs for subject teaching by graduates from the

various teacher education programmes will continue to remain a random occurrence that depends on a combination of innate abilities, opportunistic circumstances and/or the disposition of each college and/or university graduate.

Conceptual Framework

Previous studies that have drawn on OTL as a conceptual framework studied both in- and preservice teachers' development of competence to teach specific subjects. Some scholars have drawn attention to the relationship between OTL and competence to teach specific subjects by preservice teachers (Cogan & Schmidt, 2015; Hebard, 2016; Schmidt et al., 2011). These studies have demonstrated that preservice teachers' OTLs are determined not only by the number of courses taken, but also by the nature of the field experiences provided for them to practise the required skills. The current research is aimed at exploring how preservice teachers develop the necessary competence to teach science subjects using ICTs, thus unpacking the opportunities embedded for preservice teachers to learn to use ICTs during their university-based experiences. The "university experiences" (which define the coursework or modules on offer) and "school-based experiences" (which refer to teaching practice or work-integrated learning experiences) are two of the key contributors to preservice-teacher competence and thus define to a significant extent their OTLs. Hence, they need to explore them by examining the following research question: How can OTLs use ICTs to teach science be understood and explained?

Research Methodology

General Background

Data were drawn from a larger, concurrent mixed methods-design study (Johnson & Onwuegbuzie, 2004; Creswell & Creswell, 2017) using the Technological Pedagogical Content Knowledge (TPACK) questionnaire, document (lesson plan) analysis and semi-structured interviews. However, the focus for this study is on data from the TPACK questionnaire. This method was considered appropriate because it enabled the researchers to unpack the opportunities that a larger sample of preservice-teacher education students have for learning to teach science using ICTs.

Sample Selection

The research sampled four (4) randomly selected university-based teacher education programmes from three universities in close proximity to the researchers' place of work and which represent the range of standard teacher preparation programmes across South Africa. The sample composed of 153 participants representing all the final year science preservice-teacher education students, with specialisation in either physical sciences, natural sciences and/or life sciences. One of the universities has two programmes presented at separate locations, one urban (n=51) and the other rural (n=37), with the other two universities (n=31 and n=34, respectively) both located in urban settings. Among the three universities, one is a historically white university, another is a university of technology, while the third is a relatively new post-apartheid university.

Instrument and Procedures

A modified TPACK questionnaire was piloted to ensure reliability and validity (Schmidt et al., 2009). The adapted version of the TPACK questionnaire for preservice teachers was used to map out preservice teachers' OTLs to teach science using ICT knowledge and skills.

Ethical Considerations

Permission to conduct the study was sought from the research ethics committees at each of the four selected research sites. The researchers explained the purpose of the study to the participants, informed them that participation was strictly voluntary and that their responses would be kept confidential. Pseudonyms were used to protect the names of the institutions and participants (Creswell, 2017; Yin, 2014).

Data Analysis

Data were generated from a 5-point Likert-scale questionnaire administered to all 153 participants across the four research sites. Nine (9) items specifically measured the OTLs provided to the participants at each site. Six (6) of these items specifically refer to structured opportunities that are part of the teacher education programme at each site. Of these six, the first item probed whether the participants have completed a "computer-related module" as part of their teacher education programme. In this item, the response option was either a "yes" or "no". The next five items investigated the extent to which the participants attributed their learning about the integration of ICTs for teaching and learning to various sources and/or opportunities: viz. "computer-related education module" on offer at their campus; "exemplary practices from their science education lecturer"; "exemplary practices from their ICT-related education module lecturer"; "exemplary practices from any of the other education lecturers"; and, finally, from "mentor-teachers" who supervised them during teaching practice. Descriptive and inferential statistical techniques were used to analyse the data.

Research Results

Table 1 presents the descriptive analysis of the frequency counts for the six items that measured participants' OTLs. The positive responses of "agree" and "strongly agree" were aggregated to give a frequency count for each preservice-teacher participant. The total number of participants at each site and their aggregate response (agree and strongly agree) for each of the six items are displayed below.

Table 1. Number of participants (frequency counts; n) identifying specific OTLs at the different university campuses or programme sites.

Campus (University) ***(pseudo-nyms)***	Item 1: Curriculum includes a computer-related module (%)	Item 2: Learning to use ICTs from one or more university module(s) (%)	Item 3: Learning to use ICTs from a science education lecturer (%)	Item 4: Learning to use ICTs from an ICT-related education module (%)	Item 5: Learning to use ICTs from another education module lecturer (%)	Item 6: Learning to use ICTs from a school-based mentor teacher (%)
Knowledge (Urban)	53 (*n*=27/51)	71 (*n*=36/51)	45 (*n*=23/51)	37 (*n*=19/51)	51 (*n*=26/51)	39 (*n*=20/51)
Knowledge (Rural)	70 (*n*=26/37)	81 (*n*=30/37)	46 (*n*=18/37)	41 (*n*=16/37)	44 (*n*=17/37)	36 (*n*=14/37)
Diamond	85 (*n*=29/34)	59 (*n*=20/34)	59 (*n*=20/34)	47 (*n*=16/34)	56 (*n*=19/34)	41 (*n*=14/34)
Goldfields	94 (*n*=29/31)	77 (*n*=24/31)	61 (*n*=19/31)	65 (*n*=20/31)	61 (*n*=19/31)	42 (*n*=13/31)

Table 1 shows that participants at all the sampled teacher education sites seem to have access to one or more computer-related module(s) designed to broaden access to ICT skills. While such modules are useful for skills development, they are hardly adequate to support the use of ICTs for teaching and learning specifically. Documentary evidence suggested that at all research sites, the "computer-related module" was a skills module that focused on the use of Microsoft Word and Excel and other Microsoft programmes. Interestingly though, only about half of the participants at the rural Knowledge university even had access to such a module(s). This was in spite of the confirmation by the majority of the participants that they learn most of their ICT skills from a "university module or class". In instances where only about half of the participants seem to have access to such a university module, their OTLs might thus be limited, unless a structured intervention is provided for in the curriculum. The last column in Table 1, on whether participants learned to use ICTs from a school-based mentor, clearly shows aggregate counts of less than 50% for all the cases studied. This finding was a surprise and should be a cause for concern for teacher education in general given the major expectation for teaching practice to provide a platform for preservice teachers to put into practice and try out some of their learning and skills in the context of a real classroom.

Conclusion and Implications

This research has established that the distribution of OTLs to use ICTs for teaching science varies across and within programmes. Furthermore, the findings also suggest that school-based experiences may lack in terms of OTLs to teach science using ICTs. There is no better opportunity for preservice science teachers to learn to integrate ICTs into the teaching of science in schools than by doing it under supervision and careful guidance in the schools during teaching practice. With the missed opportunities as described in this paper, it should thus not be surprising that most preservice teachers and/or other beginning teachers continue to struggle to integrate ICTs into the teaching and learning of their subjects.

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