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Connecting Theory and Practice: Pre-service Science Teachers' Adoption and Implementation of the Demonstration Method

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Abstract. This study examined adoption and implementation of the demonstration method by Bachelor of Education (BEd) Science students' during teaching practice (TP), which lasted 14 weeks. Data were collected using questionnaires and interview schedules. The data analysis techniques comprised descriptive and inferential analysis. Findings indicated that i) the school-based experiential learning as designed and implemented is not sufficient to modify the Bed (Science) students' prior frame of reference for the integration of interactive instructional practices in the demonstration method; ii) despite pedagogical supervision, the pedagogical knowledge and repertoire of skills learnt was not sufficient to effect a major increase in the instructional practices implemented; iii) the Bed (Science) students' developmental needs persisted to the end of teaching practice because the pedagogical support provided on TP was not sufficient to address them; iv) although pre-service teachers have the potential for immediate improvement of their adoption and implementation of interactive instructional practices, they require a clear frame of reference before exposure to the context of their professional work without which they cannot effectively leverage a significant paradigm shift. The study provides several recommendations based on the findings.

Keywords: instructional practices; constructivist; demonstration method; supervision practices

1. Introduction

Interactive teaching methods are a major focus of the current reform efforts in science education. Research has established that appropriate application of interactive teaching methods facilitates the construction of scientific knowledge and enhances learners' potential for development of critical thinking and problem-solving (Burrows & Slater, 2015). In particular, the demonstration of complex abstract scientific concepts or process skills have been found to promote learning, hence, are considered the hallmark of science teaching. Biadgelign (2010) opines that, because demonstrations entail learners observing while listening to explanations of processes, their critical thinking and creativity are stimulated. Critical thinking and creativity allow for modification of conceptual understanding and generalisations. Learners are then able to connect theory to the demonstrated experiment, and to the natural phenomena and everyday practices. Learning then becomes meaningful.

As observed by Feiman-Nemser (2010), by the time pre-service science teachers enter into teacher education programmes, they have already experienced application of teaching methods from their earlier socialisation and observation of the teaching and learning process as students of science education. They thus hold preconceptions about the application of such methods based on a limited understanding of science teaching. Darling-Hammond (2010) cautions that the preconceptions must be transformed, otherwise the pre-service teachers will teach the way they were taught, which, therefore, will not facilitate knowledge construction among learners. In this regard, pre-service science teachers should be helped to develop adequate conceptual and practical knowledge of teaching methods in their pedagogy courses (Duit et al., 2008; Gunckel, 2013; Ochanji et al., 2015; Odundo et al., 2018).

Problem statement

Teacher education programmes across the world have been criticised over time as being more theoretical and disconnected from professional practice (Beck & Kosnik, 2002; Fraser, 2007; Ketter & Stoffel, 2008; Kosnik & Beck, 2009). Consequently, they produce teachers who are not practitioners and who cannot appropriately apply interactive teaching methods. This has been demonstrated to be the case for Sub-Saharan Africa where the demonstration method and other forms of interactive teaching are not widely applied (Bunyi et al., 2013; Centre for Mathematics, Science and Technology Education in Africa [CEMASTEA], 2009; Strengthening of Mathematics and Science at Secondary Education [SMASSE] Project Impact Assessment, 2007). Remarkably, a survey of science teaching methods in secondary schools in Sub-Saharan Africa confirms that many science subject teachers experience difficulties with the concept of demonstration, and many more do not apply the demonstration method in their lessons even when it is necessary (Cheruiyot et al., 2015; SMASSE Project Impact Assessment, 2007). This implies that many science teachers in Sub-Saharan Africa have inadequate pedagogical knowledge and skills to apply the demonstration method. Furthermore, Nasimiyu (2017) found that teacher preparation programmes in Sub-Saharan Africa are narrow in scope and in their repertoire of skills and opportunities to facilitate the development of learner-oriented pedagogies. Additionally, research has consistently indicated that the gap in the transfer of teaching skills from university-based learning to real classrooms still persists (Korthagen & Kessels, 1999; Leijen et al., 2015; McGarr et al., 2017; Shaharabani & Yarden, 2019). This brings into focus the appropriateness of pre-service teacher adoption and implementation of method-specific instructional practices, as demonstrated during teaching practice.

Purpose of the study

This article contributes to the existing knowledge on pre-service science teacher preparation by focusing on pre-service science teachers' adoption and implementation of the demonstration method. Specifically, the following research question were addressed;

1. Is there any significant difference in the BEd(Science) students' adoption and implementation of the demonstration method at the onset and towards the end of teaching practice?
2. In what ways do the pedagogical supervision practices support the BEd(Science) students' adoption and implementation of the demonstration method?

2. Literature Review

Constructivism in the pedagogy of science education

Pre-service science teachers' preconceptions of application of teaching methods are more theoretical and abstract, hence difficult to implement in real classrooms. To help pre-service teachers to re-conceptualise their pedagogical knowledge and skills of application of teaching methods, science teacher education programmes need to adopt a practice-based philosophy anchored in constructivism (Ball & Forzani, 2011; Forzani, 2014; McDonald et al., 2013). Drawing from the above epistemological root, the most profound challenge for pre-service science teachers is not the acquisition of knowledge about teaching methods, but making personal sense of constructivist instructional practices (Schön, 1983).

In a bid to reorient the teaching methods to a constructivist pedagogy, researchers (Ball & Forzani, 2011; Grossman, 2018; Kloser, 2014; McDonald et al., 2013; Sherin et al., 2011; Trna & Trnova, 2015; Windschitl et al., 2012) have decomposed teaching methods into short, explicit, learner-oriented specified instructional practices that pre-service teachers can implement. Implementing these instructional practices in a context similar to that of their professional work coupled with adequate pedagogical and technical support has the potential to promote the integration of constructivist instructional practices in teaching (Meyer & Land, 2006; Yilmaz, 2011).

The demonstration method in science teaching

Demonstration in science teaching is a planned manipulation of scientific apparatus and materials so that learners observe first-hand scientific principles or laws. Scientific concepts are made easier to comprehend and connect to real-life experiences if explained alongside an observed demonstration (Basheer et al., 2017). This implies that the teacher must be competent enough to design the learning material in a manner that will explicitly show how theory connects to the process under demonstration, and to the natural phenomena, which then leads to knowledge construction.

Teacher preparation for application of the demonstration method

Over time, researchers have explored pre-service teacher preparation for teaching methods (Amobi & Irwin, 2009; Cardoso et al., 2011; Ciminelli, 2009; Ghousseini & Sleep, 2011; Kazemi et al., 2009; Kloser, 2014; Lampert et al., 2010, 2013; Warner & Myers, 2008). The findings indicate that, for pre-service teachers to adopt and effectively implement a teaching method, they should be helped to prepare appropriate instructional tasks that are short, explicit, learner-oriented and anchored in constructivism. In particular, based on an analysis of literary sources, Trna and Trnova (2015) report that teacher preparation for application of the demonstration method hinges on principles that teachers must put into considerations when implementing the instructional practices embedded in such method. They include: (i) learners predict the outcome of the demonstration; (ii) allowing discussions on the concept under demonstration; (iii) performing the demonstration alongside explanations focused on key aspects; (iv) discussing results obtained; (v) providing appropriate analogies based on the concept demonstrated. These principles inform the instructional practices that teachers must integrate in their application of the demonstration method.

Other researches on teacher preparation report the instructional practices to include:(i) provision of a guideline for engagement in to the activity and engage students in the investigation to provide concrete experience (Kloser, 2014); (ii) elicit and expose learners' existing knowledge of the concept under demonstration, and facilitate classroom discourse so that learners predict the outcome (Grossman, 2018; Kloser, 2014; Windschitl et al., 2012); (iii) facilitate an evidence-based explanations discourse to explain phenomena by making a connection between the target science concept, the process under demonstration and the natural phenomena (Warner & Myers, 2008; Winschitl et al., 2012); (iv) review key points of the learning material, assess students' learning in the context of teaching and provide follow up activities to connect the learning to real-life (Duncan & Clemons, 2012; Webster et al., 2009). Tesfaw and Hofman (2014), Ochanji et al. (2015) and Usman (2015) aver that, for effective adoption and implementation, pre-service teachers should be allowed to rehearse, enact and reflect on their pedagogical understanding and skills of the instructional practices amid support from peers and lecturer; hence experiential learning, which is the underpinning rationale to teacher preparation for application of teaching methods. Thus, a focus on the implementation of short, explicit, learner-oriented constructivist teaching tasks enables the operationalisation of the demonstration method into short, observable and measurable activities.

Experiential learning in pre-service science teacher education

Proponents of experiential learning (Dewey, 1938; Kolb, 1984; Piaget, 1954) assert that it serves to connect theory to practice and comprises reflective activities embedded in practice-based learning and anchored in constructivism. Further, the proponents argue that effective acquisition of pedagogical knowledge occurs if the learner is provided the opportunity to demonstrate their learning to more knowledgeable others who offer support. This implies that effective experiential learning should be mediated in a social learning environment with pedagogical support and opportunities for collaborative reflections. Such collaborative reflections draw on the pre-service teachers' own experiences of exposure to and enacting of the instructional practices and linking the same to research-based knowledge and classroom practices (Leijen et al., 2012; Mannathoko, 2013; Odundo et al., 2017). In particular, collaborative reflective activities in experiential learning elicits and exposes misconceptions, making the pre-service teachers aware of areas of growth, which, if addressed, improves their application of teaching methods to new but similar contexts (Ayot & Wanga, 1987; Gok, 2012; Mannathoko, 2013). Consequently, any mismatch between the pre-service teachers' existing conceptions, and the envisaged future teaching practices get addressed (Britton & Anderson, 2010; Gok, 2012; Grossman et al., 2009 Hismanoglu & Hismanoglu, 2010; Schreiber & Valle, 2013). Ultimately, they build up a repertoire of examples, visions and skills and, hence, make personal sense of the instructional practices. To promote the adoption and integration of interactive instructional practices further, pedagogical supervision and assessment must be conducted by experienced subject specialists who are informed of the current reforms in teaching methods and are well-versed in the criteria for pedagogical supervision and assessment (Idris, 2016; Milanowsik, 2011).

Related studies

Concerns that Africa, and Kenya in particular, is substantially underrepresented in the uptake of science-related courses and jobs is linked to the pedagogical practices of teachers, which are below expectations (Mukhwana, 2020; Sichangi., 2018). Specifically, the demonstration method is a pedagogical intervention targeting teachers and advanced for enhancing learner outcomes in science subjects. However, studies conducted on pre-service science teachers' application of the demonstration method are generally comparative or focus on the effectiveness of, or evaluation of the method on learners (Adekoya & Olatoye, 2011; Basheer et al., 2017; Crouch et al., 2004; Daluba, 2013; Giridharan & Raju, 2016; Meyer et al., 2003; Moll & Milner-Bolotin, 2009; Trna & Trnova, 2015; Watson, 2000). Few studies endeavour to address the pre-service science teachers' adoption and integration of interactive instructional practices in the demonstration method at secondary schools (Basheer et al., 2017; Odom & Bell, 2015). Studies on supervision of teachers as they learn to apply interactive methods have been undertaken (Darling-Hammond & McLaughlin, 2011; Fishman et al., 2003; Opfer & Pedder, 2011; Zembal-Saul, 2009), but more research on supervision of pre-service teachers' application of the demonstration method is needed. This indicates a need to examine pre-service science teachers' adoption and implementation of the demonstration method, during teaching practice at secondary school.

3. Methodology

Research approach and design

The study problem and research questions seek to systematically describe the practices of participants (Loeb et al., 2017). As such, the study is anchored on the survey design to explore pre-service science teachers' adoption and implementation of the demonstration method during TP.

Population and sampling procedure

The target population was 145 BEd(Science) students who were stratified into three (3) categories based on the three teaching subjects, namely chemistry, physics and biology, comprising 45, 64 and 36 students, respectively. The categories were homogeneous within themselves. The determination of the sample was obtained using Yamane's (1973) formula.

$$n = \frac{N}{1 + Ne^2}$$

where;

n =The desired sample size
N =The population size
e = The error limit = 0.05 (as suggested by Yamane, 1973)
Source: Yamane (1973)

The resulting distribution of the sample across the strata was 33, 47 and 27 for chemistry, physics and biology, respectively, hence a sample size of 107. Since the population strata were relatively small, disproportionate stratified random sampling was used (Cochran, 1997). The sample (n=107) had completed the mandatory educational foundation and pedagogy courses. An equal number of Head of Department (HoS) (n=107) and pedagogy lecturer (n=3) who taught the subject methods course, namely biology, chemistry and physics, were key informants and, therefore, purposively selected (Cohen et al., 2010).

Methods of and instruments for data collection

Data on participants' adoption and implementation of the demonstration method as well as the data on the pedagogical supervision practices were collected at the beginning and at the end of TP using questionnaires (Appendices 2 and 3). The pedagogy lecturers were interviewed using an interview schedule (Appendix 4) at the end of TP and provided data regarding the *what* and the *how* of the participants' preparation for adoption and implementation of the demonstration method. The TP session last for 14 weeks of supervised teaching.

The instrument analysis for content and construct validity indexes, and sampling adequacy tests were conducted and the results (Appendix 1) revealed that the constructs were valid (Liu, 2010; Williams et al., 2012). The reliability index of the instruments was computed using Cronbach's alpha and found reliable (Drost, 2012; Nunnally, 1978).

Methods of data analysis

Inferential statistics were used and t-test assessed the mean difference in the adoption and implementation of the demonstration method at the beginning and at the end of TP. Pearson product-moment correlation coefficient technique was used to conduct a correlation analysis. SPSS version 23 software was used to perform the analysis.

Ethical issues

The principles of integrity, respect, responsibility and competence were applied throughout the study (Creswell & Creswell, 2017).

4. Results

Is there any significant difference in the BEd(Science) students' adoption and implementation of the demonstration method at the onset and towards the end of teaching practice?

The total average scores for the participants' adoption and implementation of the demonstration method (Appendix 2) and the pedagogical practices of the HoS and university supervisors (Appendix 3) are as in Table 1 below.

Table 1: Statistics for application of the demonstration method and pedagogical practices of the HoS and university supervisors

Variables	Total average score						
	N	Mean	%Mean	SE	SD	Skewness	SE
Onset of teaching practice	107	3.8526	77.1%	0.0382	0.3933	-0.167	0.235
End of teaching practice	107	4.0349	80.7%	0.0431	0.446	0.021	0.234
HoS Pedagogical Supervision Practices	107	2.1761	43.2%	0.0451	0.4669	0.511	0.234
University Supervisors' Pedagogical Supervision Practices	107	3.1939	63.9%	0.0921	0.9486	-0.409	0.235

Results of the adoption and implementation of the demonstration method (Appendix 2) showed:
Items 1-2: towards the end of TP, 97% (66, 38) of participants demonstrated adequate ability to design the procedure of activities for the lesson, while 82.3% (37, 51) were able to formulate appropriate objectives to guide their teaching towards an instructional goal. This suggests that the majority had adequate conceptual and pedagogical knowledge of the instructional practices.

Items 3-6: most participants appear to have come into TP with a clear frame of reference regarding instructional practices of assembling the demonstration equipment, facilitating learners to predict the outcome of the demonstration and assessing learner thinking. However, only 20% (3, 18) at the onset and 31.8% (14, 20) towards the end of TP explained the demonstration process and made connections to the scientific concept and natural phenomena. This suggests that 68.2% persistently failed to implement the practice. Notably, there was an increase in the instructional practices implemented during TP.

Items 7-8: the participants appear to have come into TP with a concrete frame of reference of the instructional practices of directing learners' observation on specific aspects/processes of the demonstration activity. However, only 21.9% (3, 20) at the onset and 31.7% (13, 21) towards the end of TP could facilitate evidence-based argumentation, suggesting that 79.1% found the practice difficult to implement. Nonetheless, the participants who implemented the practice increased during TP.

Items 9-10: the participants highlighted key points of a demonstration activity and provided follow-up assignments. This suggests that the majority had a concrete frame of reference for the practices. However, towards the end of TP, the number of participants who provided follow-up assignments to the demonstration reduced from 95.3% (64,37) to 93.4% (62,38), suggesting that 1.9% participants likely had only superficial pedagogical knowledge because they refrained from use of the practice.

Effect of TP on the application of the demonstration method

The total average score results on the application of the demonstration method (Table 1) was M= 4.0349, SD=0.446, up from M= of 3.8526, SD=0.03933. This revealed an increase in the instructional practices implemented, suggesting that some participants learnt the practices on TP. However, the fact that the increase was low suggests that the demonstration method as learnt at university and implemented on TP is not as efficient as it should be. The participants appear to have had a persistent inadequate frame of reference for the implementation of the instructional practices.

On the effect of TP on the integration of instructional practices in the demonstration method (Table 2), the results show [Mean Difference=0.19020 (3.6%), SE = 0. 05641, (t (105) = 3.372, p < .001).

Table 2: Mean difference in adoption and implementation of the demonstration method on teaching practice

	Paired Differences					**T**	**Df**	**Sig.(2-tailed)**
	Mean Difference	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1	.19020	.58078	.05641	.07835	.30205	3.372	105	.001

The difference, even though small, is statistically significant and affirms that, despite pedagogical supervision, the pedagogical knowledge and skill held were not sufficient to effect a major increase in the instructional practices implemented.

In what ways do the pedagogical supervision practices support the BEd(Science) students' adoption and implantation of the demonstration method?

The pedagogical supervision practices were as indicated in Appendix 3. The results at the onset (Table 1) show the total average score on pedagogical supervision practices as M=2.1761 (43.2%), SD=0.4669 and when "often" and "always" are combined, the majority of the HoS were reported not to have guided the participants in lesson preparation and implementation, nor to have guided them appropriately to link theoretical knowledge and classroom practices. Additionally, the timeliness and adequacy of the feedback they provided did not support the implementation of instructional practices among the participants. As noted earlier, the HoS were not obligated to provide pedagogical supervision. Nevertheless, 69.8% (32, 42) participants reported that they used the supervision feedback for subsequent teaching, suggesting that, if mandated and empowered, the HoS can provide appropriate pedagogical support, which can increase the instructional practices implemented by the participants.

The total average score for the pedagogical supervision practices of university supervisors (Table 1) was M=3.1939 (M%=63.9%), SD=0.9486, revealing mixed results when "often" and "always" are combined. Specifically, the majority of the participants reported having received timely feedback of the supervision which was linked to their classroom practices. Further, the feedback informed the participants' subsequent teaching, with areas pointed out to improve their implementation of the demonstration method. On the flip side, when "rarely" and "never" are combined, the results showed that the university supervisors did not regularly attend lessons, neither did they hold a pre-observation meeting ahead of the lesson, or guide on teaching methods to be applied and how to integrate them in a lesson. In other words, they were hands-off in as far as preparation for teaching is concerned. The HoS and university supervisor's practices rendered the pedagogical supervision practices unsupportive to subsequent teaching.

5. Discussion

The current study employed constructivism as the underpinning theory to examine the adoption and implementation of the demonstration method by Bed (Science) students.

Is there any significant difference in the BEd (Science) students' adoption and implementation of the demonstration method at the onset and towards the end of teaching practice?

The study found that the participants were able to design guidelines and formulate objectives for engaging learners, which means they had a concrete frame of reference to design tasks to determine the extent of learner engagement and the support needed (Warner & Myers, 2008). This finding is consistent with the explanation of the lecturer who, when asked how the methods course supports the participants' adoption and implementation of the demonstration method on TP, stated:

> *"The methods course links the academic component to the professional component during TP. The course helps the BEd (Science) student to learn and visualise teaching activities which they then enact in real classrooms."*
>
> *(Lecturer for TCT 332: Subject Methods-Chemistry, September, 2019).*

This finding implies that, by the time the participants teach in real classrooms during TP, they have already refined their conceptual and pedagogical understanding of how to implement the demonstration method. The increase in students who implemented the instructional practices that constitute the demonstration method suggests that initial theoretical and abstract knowledge requires consistent practice in a professional context for meaningful learning to occur (Korthagen & Kessels, 1999; Warner & Myers, 2008).

The study further found that the majority of the participants had difficulties in explaining a process and how it connects to the experiment and the natural phenomena under the demonstration. This reveals lack of a clear frame of reference, and it was likely students had not experienced the practice. To make sense of a practice requires sustained enactment, reflection, rehearsal and implementation, with pedagogical support (Korthagen & Kessels, 1999; Sherin et al., 2011).

Additionally, the study found that the majority of the participants asked learners to predict the outcome of the demonstration, indicating they had adequate pedagogical knowledge for the practice. Requiring learners to make predictions calls for evidence and serves to stimulate learners' thinking and creativity (Crouch et al., 2004; Trna & Trnova, 2015). The increase in students who implemented the instructional practices suggests that meaningful learning to implement theoretical and abstract knowledge can occur within the classroom context if opportunity for consistent practice is provided (Korthagen & Kessels, 1999; Warner & Myers, 2008).

Further, the study found that the majority of the participants found implementing evidence-based argumentation difficult. Likely, they had not, as learners, participated in evidence-based argumentations and explanations. This implies that the practice was superficially developed and, therefore, difficult to implement (Grossman, 2018; Korthagen & Kessels, 1999). This resonates with findings (Zembal-Saul, 2009) that scientific discourse and argumentation is not common in science education because teachers themselves have had few opportunities to apply evidence-based argumentation as learners.

On lesson closure and follow-up, the study found that participants had adequate pedagogical knowledge and skills at the onset of TP. A review of learning points and a follow-up on the content taught informs the teachers' instruction in the future lessons (Duncan & Clemons, 2012; Webster et al., 2009, yet, remarkably, the study revealed that a few participants refrained from providing follow-up practice of a lesson. Grossman (2018) posits that practices cannot be sustained if the understanding is only partial.

The slight increase indicates that, prior to TP, the majority of the participants had pedagogical knowledge of the instructional practices that constitute the demonstration method. As such, the majority of the participants were, to some extent, able to apply such method. This contributed to the high total average score. During interview, a lecturer stated:

> *"We prepare student teachers on use of teaching resources. So that when they get to a school with limited laboratory equipment they ably adopt demonstration."*
>
> *(Lecturer for TCT 333: Subject Methods - Physics, September 2019).*

Further clarification regarding the participants' adoption and implementation of the demonstration method was made by the lecturer during interview who revealed that:

> *"The student teachers individually carry out practical related to secondary school experiments in their various course units at university. Therefore, the BEd(Science) students should be in a position to ably handle all practical effectively."*
>
> *(Lecturer for TCT 331: Subject Methods-Biology, September 2019)*

The slight improvement likely occurred as a result of regular demonstrations in the course of TP.

The effect of teaching practice on the adoption and implementation of the demonstration method

The results of the total average score (M= 4.0349, SD=0.446, up from M= of 3.8526, SD=0.3933) (Table 1) on the participants' adoption and implementation of demonstration method revealed a small but statistically significant improvement. This suggests that adoption occurred during TP, despite the persistence of unaddressed developmental issues among the participants. This suggests that simply exposing the pre-service teachers to the context of their professional work without a clear frame of reference as a pre-requisite cannot effectively leverage a significant paradigm shift (Grossman, 2013; Idris, 2016; Kazemi et al., 2009; Windschitl et al., 2012).

Further, the t-test results on Table 2 [Mean Difference=0.19020 (3.6%), SE = 0. 05641, (t (105) = 3.372, p < .001) showed a small statistically significant difference. Notably, this improvement occurred over the course of TP while the participants were under supervision. The implication is that TP supervision has potential to promote participants' application of the demonstration method. The significance of the pedagogical supervision on TP was confirmed during interview with a lecturer who intimated that TP supervision exposes gaps in the BEd(Science) students' pedagogical knowledge which can then be addressed. Nevertheless, the small difference suggests that, despite pedagogical supervision, the pedagogical knowledge and skill held were not sufficient to effect a major increase in the instructional practices implemented. This finding affirms Korthagen and Kessels', (1999) argument that key challenges for pre-service teachers relate to lack of competency and experience prior to implementation of instructional practices, and their limited status in professional growth. To promote further adoption and implementation of instructional practices that were initially theoretical and abstract within the classroom context requires intensive, sustained and coherent learning activities that reflect teachers' professional work coupled with appropriate pedagogical support (Korthagen & Kessels, 1999; Opfer & Pedder, 2011; Warner & Myers, 2008).

Thus evidently, school-based experiential learning as implemented was not sufficient in quality and quantity to further build on the pedagogical knowledge for the adoption and the subsequent application of the demonstration method and the embedded instructional practices. This exposes a disconnect between the university-based learning and classroom practice.

In what ways do the pedagogical supervision practices support the BEd(Science) students' adoption and implantation of the demonstration method?

The study found that the total average score on pedagogical practices for the HoS was low, suggesting they provided insufficient pedagogical support even though they are experienced teachers and subject specialists. Important to note is that pedagogical expertise is required for an effective approximation of practices to attain a high standard of implementation of instructional practices. This finding supports the findings of a study by Gunckel (2013) who established that collaborating teachers are not well-versed with the current university-based learning of pre-service teachers and the pedagogic requirements for instructional practices. However, the fact that the feedback provided by the HoS was useful to the participants for subsequent teaching indicates that, if capacity is built for pedagogical supervision, the HoS can provide sufficient and appropriate pedagogical support to leverage the adoption, honing and implementation of the "difficult" instructional practices.

The university supervisors, on the other hand, had a limited schedule to adequately offer pedagogical support. Additionally, the study found there was limited modelling of the instructional practices and, therefore, the inherent reflection in-and-on practice. Grossman et al. (2013) posit that modelling by the teacher educator is a crucial representation of practice as it enables the pre-service teachers to visualise application of a teaching method and, hence, is critical in closing the gap between their present and their possible accomplishment. Clearly, the principles of effective pedagogical supervision and support as advanced (Ayot & Wanga, 1987; Idris, 2016; Leijen et al., 2012, 2015; Usman, 2015) were not embraced.

Overall, the limited schedule for university supervisors coupled with the fact that the HoS offered inadequate pedagogical support denied the participants a firm base on which to build instructional practices, particularly those that may have been deemed "difficult" to adopt, enact and implement. This finding supports findings by Ochanji et al. (2015) and Odundo et al. (2017) that teaching practice as provided in public universities in Kenya is insufficient in quality and quantity.

Limitation of the study
The respondents were drawn from the School of Education and this violated the ecological validity and limited the findings' generalisations to graduate science teachers with characteristics represented in the sample.

6. Conclusions and Implications

The study findings highlighted the following issues;

- The BEd(Science) students successfully implemented some instructional practices but not others, and, even though some instructional practices seemed to have been adopted in the course of TP, this was to a small extent. This means that the school-based experiential learning as designed and implemented is not sufficient to modify the BEd(Science) students' prior frame of reference for the integration of interactive instructional practices in the demonstration method. There is, therefore, a need to reorient TP by increasing and prolonging the sessions and adopting the principles of effective pedagogical supervision.
- The BEd(Science) students did not possess adequate pre-requisite for application of the demonstration method. This can be enhanced by re-conceptualising the content and design of the teaching methods component to comprise specified short explicit instructional practices that are learner-oriented and grounded in constructivism.
- The limited and inadequate pedagogical support denied the BEd(Science) students a firm base on which to build pedagogical knowledge and skills to adopt and implement instructional practices. There is, therefore, a need to capacity-build the HoS in principles of pedagogical supervision.
- The BEd (Science) students have potential to improve their adoption and implementation of the demonstration method and the embedded instructional practices, the unaddressed developmental needs notwithstanding. This can be promoted by designing a portfolio of TP experiences that relate to varied contexts to inform experiential learning tasks and pedagogical support.

Recommendation for future research
There is need for longitudinal studies to examine the effect of experiential learning on novice teachers' performance.

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APPENDICES

Appendix 1

Test of Sampling Adequacy and Sphericity

Factors	KMO Test	Bartlett's Test of Sphericity		
		Approx. Chi-Square	**df**	**Sig.**
Discussion teaching method	.702	84.431	45	.000
Demonstration method	.818	120.946	45	.000
Lab practical teaching method	.714	86.804	45	.000
Lecture teaching method	.700	79.333	45	.000
Moderator (TP supervision/guidance)	.722	89.771	45	.000
TP performance of BEd(Science). teachers on TP	.843	162.082	36	.000

Appendix 2

Descriptive Statistics for Application of the Demonstration Method at the Beginning and End of Teaching Practice

SD = Strongly Disagree, D= Disagree, U = Uncertain, A = Agree, SA= Strongly Agree

At the beginning of TP		**SD**	**D**	**U**	**A**	**SA**
1. The teacher used an outline to guide the demonstration	**Count**	1	2	1	36	66
	%	0.9%	1.9%	0.9%	34.0%	62.3%
2. The teacher specified the objective of the demonstration to focus attention	**Count**	2	23	3	62	16
	%	1.9%	21.7%	2.8%	58.5%	15.1%
3. The teacher arranged the equipment so that each student could observe the demonstration	**Count**	1	5	3	65	32
	%	0.9%	4.7%	2.8%	61.3%	30.2%
4. The teacher manipulated the apparatus and explained the process at the same time	**Count**	20	62	2	18	3
	%	19.0%	59.0%	1.9%	17.1%	2.9%
5. The teacher asked questions to gauge students' ideas of the topic/subtopic	**Count**	0	3	0	35	68
	%	0.0%	2.8%	0.0%	33.0%	64.2%
6. The teacher asked students to predict the outcome of the demonstration	**Count**	1	23	3	62	17
	%	0.9%	21.7%	2.8%	58.5%	16.0%
7. The teacher asked questions to direct student observation to the demonstration	**Count**	0	5	2	65	33
	%	0.0%	4.8%	1.9%	61.9%	31.4%

8. The teacher pressed students to provide evidence-based explanation	**Count**	17	64	1	20	3
	%	16.2%	61.0%	1.0%	19.0%	2.9%
9. The teacher summarised the essential points at the end of the demonstration	**Count**	0	1	2	35	68
	%	0.0%	0.9%	1.9%	33.0%	64.2%
10. The teacher gave follow-up assignments to the demonstration	**Count**	1	1	3	37	64
	%	0.9%	0.9%	2.8%	34.9%	60.4%

Total average score at onset of TP	N	Mean	%Mean	SE	SD	Skewness	SE
	107	3.8526	77.1%	0.0382	0.3933	-0.167	0.235

End of TP		**SD**	**D**	**U**	**A**	**SA**
1. The teacher used an outline to guide the demonstration	**Count**	0	2	1	38	66
	%	0.0%	1.9%	0.9%	35.5%	61.7%
2. The teacher specified the objective of the demonstration to focus attention	**Count**	1	12	6	51	37
	%	0.9%	11.2%	5.6%	47.7%	34.6%
3. The teacher arranged the equipment so that each student could observe the demonstration	**Count**	0	5	2	57	43
	%	0.0%	4.7%	1.9%	53.3%	40.2%
4. The teacher manipulated the apparatus and explained the process at the same time	**Count**	10	53	10	20	14
	%	9.3%	49.5%	9.3%	18.7%	13.1%
5. The teacher asked questions to gauge students' ideas of the topic/subtopic	**Count**	0	0	1	39	67
	%	0.0%	0.0%	0.9%	36.4%	62.6%
6. The teacher asked students to predict the outcome of the demonstration	**Count**	0	13	5	53	35
	%	0.0%	12.3%	4.7%	50.0%	33.0%
7. The teacher asked questions to direct student observation to the demonstration	**Count**	0	6	1	59	41
	%	0.0%	5.6%	0.9%	55.1%	38.3%
8. The teacher pressed students to provide evidence-based explanation	**Count**	11	55	7	21	13
	%	10.3%	51.4%	6.5%	19.6%	12.1%
9. The teacher summarised the essential points at the end of the demonstration	**Count**	0	0	3	42	62
	%	0.0%	0.0%	2.8%	39.3%	57.9%
	Count	0	1	6	38	62

10. The teacher gave follow-up assignments to the demonstration	%	0.0%	0.9%	5.6%	35.5%	57.9%

Total average score towards end of TP	N	Mean	%Mean	SE	SD	Skewness	SE
	107	4.0349	80.7%	0.0431	0.446	0.021	0.234

Appendix 3

Pedagogical Supervision

Head of Subject (HoS) Supervision

		Never	Rarely	Sometime	Often	Always
1. The HoS checks that my lesson plan is aligned to my schemes of work	**Count**	0	16	68	19	3
	%	0.0%	15.1%	64.2%	17.9%	2.8%
2. The HoS guides me on how to integrate instructional practices in my teaching.	**Count**	15	46	37	5	3
	%	14.2%	43.4%	34.9%	4.7%	2.8%
3. My HoS advises me on the appropriate instructional practice during lesson development	**Count**	61	29	11	2	3
	%	57.5%	27.4%	10.4%	1.9%	2.8%
4. My HoS provides prompt feedback	**Count**	1	45	46	8	4
	%	1.0%	43.3%	44.2%	7.7%	3.8%
5. My HoS attends my lessons to observe my teaching practices regularly.	**Count**	11	72	18	3	1
	%	10.5%	68.6%	17.1%	2.9%	1.0%
6. The feedback my HoS gives me is about my teaching practices	**Count**	7	49	39	8	4
	%	6.5%	45.8%	36.4%	7.5%	3.7%
7. The feedback my HoS gives is timely	**Count**	18	56	27	4	1
	%	17.0%	52.8%	25.5%	3.8%	0.9%
8. I am able to apply the feedback in successive lessons.	**Count**	13	1	18	42	32
	%	12.3%	0.9%	17.0%	39.6%	30.2%
9. The HoS feedback supports me to progressively improve my application of the demonstration method.	**Count**	50	46	8	3	0
	%	46.7%	43.0%	7.5%	2.8%	0.0%
10. The feedback shows gaps in my implementation of the demonstration method.	**Count**	88	14	5	0	0
	%	82.2%	13.1%	4.7%	0.0%	0.0%

Average score	N	Mean	%Mean	SE	SD	Skewness	SE
	107	2.1761	43.2%	0.0451	0.4669	0.511	0.234

Supervision by university lecturer

		Never	Rarely	Sometime	Often	Always
1. The supervisor checks that my lesson plan is aligned to my schemes of work	**Count**	10	15	57	13	11
	%	9.4%	14.2%	53.8%	12.3%	10.4%
2. The supervisor guides me on how to integrate instructional practices in my teaching.	**Count**	13	29	29	23	12
	%	12.3%	27.4%	27.4%	21.7%	11.3%

3.	The supervisor advises me on the appropriate instructional practice during lesson development	**Count**	63	9	13	8	12
		%	60.0%	8.6%	12.4%	7.6%	11.4%
4.	The supervisor provides prompt feedback	**Count**	8	9	32	34	22
		%	7.6%	8.6%	30.5%	32.4%	21.0%
5.	The supervisor attends my lessons to observe my teaching practices regularly	**Count**	12	43	29	9	12
		%	11.4%	41.0%	27.6%	8.6%	11.4%
6.	The feedback my supervisor gives me is about my teaching practices	**Count**	13	1	18	42	32
		%	12.3%	0.9%	17.0%	39.6%	30.2%
7.	The feedback I am given is timely	**Count**	13	3	17	34	39
		%	12.3%	2.8%	16.0%	32.1%	36.8%
8.	I am able to apply the feedback in successive lessons	**Count**	13	1	18	42	32
		%	12.3%	0.9%	17.0%	39.6%	30.2%
9.	The supervisor feedback supports me to progressively improve my application of the demonstration method.	**Count**	13	3	17	34	39
		%	12.3%	2.8%	16.0%	32.1%	36.8%
10.	The feedback shows gaps in my implementation of the demonstration method.	**Count**	14	2	13	29	48
		%	13.2%	1.9%	12.3%	27.4%	45.3%

Total average score

N	Mean	%Mean	SE	SD	Skewness	SE
107	3.1939	63.9%	0.0921	0.9486	-0.409	0.235

Appendix 4

Guided Interview Schedule

Bio-data

S/N	QUESTION	
1	How many years have you taught Subject methods - Biology? TCT 332: Subject methods - Chemistry? TCT 333: Subject methods - Physics? TCT 333 (as applicable)	
2	How many years have you supervised students on teaching practice?	
4	How many BEd(Science) students' teaching did you supervise in the last teaching practice session?	
5	How many times did you supervise and assess the BEd(Science) students teaching biology/chemistry/physics (as applicable) in the last teaching practice session?	
6	Has the university oriented/trained you on how to supervise and assess BEd(Science) students during teaching practice?	

Teaching of subject methods course

What is the significance of the subject methods course in BEd(Science) teacher preparation?

How does the methods course support the participants' classroom instructional practices?

Please outline the teaching methods for science subjects that you focus on when preparing pre-service teachers to apply during TP.
What instructional practices did you want the BEd(Science) students to master so as to effectively apply the demonstration method?
Please suggest. with reasons, any change(s) you would like to be made so as to improve on the delivery of the current subject method course?

Ability of BEd(Science) students to apply teaching methods in lessons
Basing on your observation and assessment of the BEd(Science) students on teaching practice, which instructional practice(s) did the students find

a) Easy to apply at the beginning of teaching practice? Why was this the case?
b) Difficult to apply at the beginning of teaching practice? Why was this the case?

Was your observation any different towards the end of teaching practice? How?

Teaching practice supervision and assessment of teaching methods
During your teaching practice supervision, what considerations did you base on to decide that the demonstration method was effectively applied?
What support did you provide the pre-service teachers who experienced problems in the application of the demonstration method in science lessons?
Please suggest with reasons, any change(s) you would like to be made regarding the supervision process of BEd(Science) students during teaching practice.

Thank you for your time.