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Mathematics Pedagogical Shifts through a Learning Study at an Initial Teacher Education Institution

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ABSTRACT This paper reports on pedagogical shifts in teaching statistics to pre-service student teachers when a staff member's lecture deliveries were evaluated by peers. The staff member was teaching some statistics topics to 85 second year specialist mathematics student teachers when the peer evaluations occurred. Pre-observation and post-observation conferences were held to help with quality lecture preparation and delivery. In the study, the staff member/researcher realised the need to abandon some apparently unproductive teaching habits. He re-learnt the importance of giving relevance of the learning material to students at the beginning of each lecture to motivate them. Also, he re-discovered the importance of giving students tasks to work out during each lecture to slow down the pace of the lecture and increase student participation. He learnt the importance of balancing MS Word, PPT and chalkboard technology to enhance explanations. The overall effect of reflecting on the peer evaluations and enacting suggested advice resulted in students enjoying the lectures. Despite this, the interventions to stop students' lateness to lectures failed. The study recommends more research on how Professional Teacher Learning Communities can help resolve this problem disruptive to lectures.

INTRODUCTION

This paper examines the shifts in mathematics pedagogical approaches that this researcher had as a result of peer evaluations of his teaching by his colleagues from the mathematics, science and languages divisions at an Initial Teacher Education Institution (ITEI) in South Africa. The researcher assumes that lack of critical discourse of one's practice in any vocation including teaching is a common cause of mediocre performance. Self-criticism and the constant search for renewal in one's practice is boosted when one's peers evaluate and comment on one's practice. Reflecting on the evaluations and acting on them is, the researcher believes, the springboard and fountain of quality professional growth. The converse of peer evaluation is one evaluating their peers. That way one becomes aware of some better practices by others. One then benchmarks that in their own work.

In pursuit of best practices, it is important to be self-reflective in one's practice not only to improve one's practice, but also to keep pace with the always increasing new knowledge growth in one's field (Makonye 2014; Makonye and Khanyile 2015). Self-reflection may not be sufficient without the collaboration of peers who help a practitioner to obtain a 360 degree view of their practice. In order to grow, professionals need critics who help them to take note of their imperfections which they ordinarily cannot see. Criticisms of all kinds, whether friendly or not put practitioners on the defensive, and encourage them to think more about their thinking; that is metacognition to help them to relook at their ways.

Even though mathematics is a pervasive curricula subject, many learners and teachers struggle to handle it (Mkhwanazi et al. 2014; Modiba 2011). Why is this so? What can be done about this problem? One of the reasons is that some mathematics teachers themselves do not command mathematics subject matter knowledge. This was refereed by Carnoy et al. (2012) as the underachievement trap as unknowledgeable teachers teach and spawn ignorance. It is incumbent upon Initial Teacher Education Institutions (ITEIs) to ensure that teachers who graduate at least have good mathematics subject matter knowledge for them to more knowledgeable others (Vygotsky 1978) to facilitate the learning of mathematics in schools. Such concerns drove this researcher to seek best practice in teaching mathematics to pre-service student teachers so that they in turn will be able to fulfill their mandatory obligation of adequately teaching mathematics. Indeed the researcher believes strongly that it is important to teach by example; through modelling.

Objectives

This paper examines the possible shifts in teaching approaches resulting from peer evaluation of this author's teaching of some statistics topics to second year pre-service mathematics specialist student teachers at an ITEI South Africa.

The principles of improving the quality of one's teaching are based on the Professional Teaching and Learning Communities (PTLC) (Barron and Darling-Hammond 2010; Carlgren 2012). PTLCs are ongoing, job-embedded, results-driven processes that aim to improve one's professional development (Brown et al. 1989). This process involves gathering data to inform instructional decisions and then implementing teaching strategies to improve students' learning. These communities may be supported by a team of outside experts who are there to help in the coaching of new teaching techniques. In this process, teachers collaboratively plan, implement and observe lessons aligned to state standards.

The principles of PTLC include reflective dialogue about teaching and collective inquiry into effective practices. There is a culture of collective inquiry and collaboration. In doing this it is critical to select and agree on learning objectives and thereupon strategise how these may be achieved. Pang (2010) points out that there is a very strong positive correlation between student learning outcomes and teachers' development in that "the more successfully students learn, the more likely it is that the teacher will adopt practices that encourage further successful learning" (p. 23). In a similar vein, William (2010:6) argues that constructivist theory of learning applies to adults just as it applies to young leaners, "… teachers learn best by doing [teaching mathematics] and building their own understandings rather than being told".

MATERIAL AND METHODS

This study began when this researcher, who is a mathematics education lecturer, wished to have peer evaluation of teaching. The author approached the faculty and was advised to seek evaluation of teaching from at least three colleagues; well qualified and exemplary:- one from the linguistic department, one from science and one from mathematics department. One such staff member from the science division had been awarded the University Teaching Prize for 2014. While the aim of the reviews were to ascertain teaching ability for staff upgrading purposes, the researcher saw it as a suitable time for him to improve his teaching, particularly that this was a cross disciplinary team of whom two of the staff members did not work with him directly in the mathematics division. The author felt that such colleagues would be neutral and would likely give objective assessments that could only help him to really improve.

Five evaluations by the three peers were done from 10th March to 25th May, 2015. At the beginning of each evaluation, the peer evaluator and the researcher had a pre-observation conference. Here, the objectives for the lectures were discussed as well as the teaching approaches to be implemented. One reviewer decided to observe the researcher's lesson first before we had the pre-observation conference for the next lecture. This peer observed three lectures. The others observed one lecture each. The researcher found the pre and post observation meetings very empowering and confidence boosting - at least the researcher had some people to share with his teaching challenges. After pre-observation conferences, this author taught lectures observed by a peer who sat silently among the students. The peer's main aim was to observe the strength and perceived weaknesses of the researcher's lecture delivery. The peers wrote down their reports to be discussed with the researcher at post-observation conferences. The researcher found that these reports were quite free and fair. The peer evaluators always asked the researcher if he agreed or not with any aspects of the reports before committing to writing formal reports.

The class had 84 second year mathematics major student teachers from diverse home backgrounds. They were training to be high school mathematics and science teachers. The teaching was on probability and statistics concepts; box-plots, skewed distributions, statistics of two variables including, correlations, equation of least squares and tree diagrams and related concepts. The use of the Fathom statistics package was embedded in the course. The textbook that was used was Statistics in Action.

Ethics and Rigour

The research paper was on raising the quality of lecture delivery through gleaning what

the researcher's colleagues had to say about his teaching. The researcher thinks that the study was reliable and valid in that three different lecturers from three different divisions observed the teaching. This means that they had different stress points on their observations. The different specialisations of the peer reviewers were strengths rather than a weakness. Non-mathematics reviewers focused on pedagogy and management of learners while the mathematics reviewer focused on both the mathematics and the pedagogy. The study was reliable because the reviewers actually sat in the researcher's lectures as the researcher was teaching. Their observations were captured in the peer reports which were discussed with the researcher.

All ethical considerations for this research were followed and students gave their informed consent to participate in the research. Also confidentiality and anonymity in reporting was ensured.

RESULTS

The fact that peers sat in the researcher's observed lectures throughout their duration, and were intent on evaluating his teaching compelled the researcher to be conscientious, more thoughtful and careful in his teaching in order to project a good image of himself. The comments that one colleague made at the first post-observation conference enabled the researcher to get an insight into his teaching habits; issues that the researcher took for granted yet they did not really enhance teaching and lesson delivery. The researcher decided to extinct these. Was it not for these observations, the researcher would still be teaching in these ways to this very day. The researcher highlights these in the following;

The first peer evaluator raised the importance of; 'reference to the applicability of the mathematics outside the classroom'. The researcher was surprised that the peer never mentioned the fact that he clearly stated learning objectives at the beginning each lecture. The researcher had the belief that spelling out objectives at the beginning of the lecture was important as it set a psychological contract with the students as to what they were to learn in each lecture. Instead, she raised other issues such as stating the relevance of what the researcher was about to teach with regard to students' life outside the school. That peer indicated that it was crucial to do that to motivate the students why at all that material was to be learnt.

Delivery of Lecture

A peer raised the issues of; 'interaction with the students; few opportunities were created for active participation by the students' and, 'there was limited use of examples to support his explanations'. Prior to the peer evaluations, the researcher focused his teaching on the exposure of subject matter as much as possible; on the content, skills and techniques of statistics (Skemp 1987). The researcher was keen to deliver as much content as possible since the work to be covered in the statistics course outline was a lot. The researcher had envisaged that if he gave students some classwork practice, that would slow him down and not be able to cover all the work set in the course outline. The researcher's justification of that approach was that even though some students could not understand some concepts in the class, they would read for themselves later to get understanding. Also, the researcher always assured himself that the learning material that students did not understand in class could always be dealt with more fully during ensuring tutorials, where students were free to ask anything they had not understood during lectures. A peer complained that the pacing of the lecture was too fast and that the researcher did not explain concepts thoroughly enough. It was pointed out that the researcher's usual comment that 'this is easy' was not helpful at all as what he felt easy was often not so easy or obvious to many students. She said the researcher needed to explain everything.

The researcher always concluded his lectures by giving students homework to do. The belief being that the homework will give students opportunity to consolidate and revise material taught in class. That was fine but; a peer raised the question, 'What if students do not do the work?' It turned out that in actual fact many students did not do the work. They often asked the researcher 'Is it for marks, sir?' If it wasn't they were often not bothered to do the exercises at all, so it turned out that his assumption that they would do the exercises was did not hold.

Management Issues

The researcher feels strongly about being democratic with the students, always respecting their diversity and viewpoints. But there were always problems of some students abusing this through making noise in class. Some will be listening to their cellphone music through headphones. Some students often came late even if the lecture started well after 10am. The researcher's thinking had been that the students who come late are those who live out of residence and have transport problems. It turned out that living in or out of residence life did not fully explain their lateness. One of the researcher's peer evaluators explained that she too was struggling with the students' lateness problem.

Teaching Technology

The researcher had welcomed the introduction of data projectors in the lectures in 2012, and had abandoned use of overhead projectors and the chalkboard. As a result the researcher came to lectures with readily prepared notes in MS Word or PPT. Despite this preparation, there were times when students did not understand the explanations and the researcher needed to write some things down. He did that on the computer. At first, the researcher thought that that was fine, but it turned out that this technology was not 100 per cent effective in teaching mathematics. This was noted by peer evaluators as they said *'you can only do so much with computers'*.

From the second lecture, the researcher was convinced to go back to using the chalkboard. The chalkboard availed him versatility to explain mathematics concepts much more than MS Word or PPT.

DISCUSSION

So What Were the Shifts in Lesson Delivery Resulting from Peer Evaluation?

To begin with, it was pointed out that there was need for the lecturer to think deeply about the relevance of statistical concepts that student teachers were to learn in each lecture in order to motivate them. For example in teaching correlation between two variables, the lecturer gave the reason that it is important to understand how two variables co-vary. I asked students to think about the relationship of the number of hours students spend studying for a subject and the grade they get had in the exam. He convinced them that there was a positive correlation between these variables as the more hours a student spent studying course material, the more likely they were to pass it, and the converse is the holds. Another example was the relationship between the amount of food regularly consumed and weight gain. So I said to them, 'the study of correlation helps us to understand prediction models and to control phenomena'. Another example was; 'Would you rather enroll your child at school with a track record of high pass rate or not?' A parent who is concerned about their child passing (as most do) will normally choose the school with a higher pass rate because the probability that her child will also pass is higher; that school will be correlated with higher students pass rates. This way, I argued for the relevance of understanding statistics as it helped in everyday decision making. I heard one student saying *'Eish, I thought statistics was just theoretical, now I see its quite important!'*

Another major shift occurred when the researcher decided to go back to the use of chalkboard in working out statistics examples. As raised in the peer evaluation, the researcher realized that the MS Word or PPT presentations encumbered some explanations. In that the researcher realized that one should not always discard old technology for the sake of it; blindly replacing it with new technology as new technology might not always serve all the way we really want. The best is to have a compromise between old and new technology. The researcher asked Faculty to supply a document camera that works very well like a chalkboard to help him explain through his handwriting. Support staff put in the document camera on which one could write with a ballpoint pen or pencil and it was much easier and clearer than the chalkboard or PPT. It has all the versatility and the old handwriting that the researcher is proud of was in use once more in his life.

To slow down the pace of the lesson the researcher introduced worksheets. After doing any example, students were issued with worksheet practice questions. To his surprise the researcher realized that students opened up more and began to ask question and interact more

with their colleagues. They really were engaged with the learning material and began to actually enjoy the lesson. From this, the researcher learnt that student activity during the lecture, far from slowing down the lecture, actually helped to enliven the lecture and helped students to focus more on the learning material resulting in conceptual and procedural understanding (Skemp 1987). This to the researcher was an answer to a long held dilemma of unexplained students' silence in his lectures. The researcher has been aware for a long time that even though he threatened students who did not participate in class, the threats fell on deaf ears. This was a brilliant answer he had been seeking. What did he re-learn? One can do much by doing little, and one actually does little by attempting to do too much! So the key is to involve the students!

Another issue learnt but that the researcher already knew was the need for thorough preparation. Though initially demanding, it saves time and wins the lecturer favour from many students. The researcher also observed that students get highly motivated by a well prepared lecturer and are quite willing to create knowledge and challenge the lecturer; which thing is wonderful as it shows that students' productive disposition in mathematics is in action. This is the ultimate goal of teaching mathematics; for student' learning mathematics to be self directed.

CONCLUSION

To a large extent the PTLC in the form of peer evaluations of teaching greatly helped the researcher to return to good old teaching ethos he learnt in the 1980s at Gweru Teachers' College in Zimbabwe. What he learnt is that teaching mathematics at universities is much the same as teaching mathematics at high school. While some university students are academically mature, one must accept that in any group there are some who often struggle to learn. To leave them to learn on their own helps little. Self-reflective practice through peer evaluation helps a practitioner to be aware of his/her need for improvement to shift to practices that benefit of all students.

Not all problems were resolved by the PTLCs. Some students continued to come late even after threatening the reduction of their marks or to ask those who come ten minutes late not to enter the classroom. As of now the interventions had little effect on impacting students' lateness.

RECOMMENDATIONS

The participants in the PTLCs need to take into consideration the issue of balancing professionalism and trust. This is because the issue of colleagues observing another's teaching borders on invasion of professional privacy. It is tempting to insincerely praise a colleague to please them. A great deal of trust is required to negotiate unsuitable practices and to find diplomatic ways to discuss that without offending a colleague. In no way should colleagues breach confidentiality by labelling colleagues as incompetent. So building trust and collegiality is crucial. A recurring issue mentioned is students' lateness to lectures. The study recommends that research be done on why students continue to be late despite efforts - threats and/or negotiations to stop students being late. This is because students arriving late in a lecture not only disrupts the lecture, but in a way shows disrespect to the lecturer and fellow students already in class.

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