

BRIDGING THE THEORY-PRACTICE GAP OF MATHEMATICS AND SCIENCE PRE-SERVICE TEACHERS USING COLLEGIAL PEER AND MENTOR COACHING

Lovemore J. Nyaumwe ljnyaumwe@yahoo.co.uk
Bindura University of Science Education, Zimbabwe.

David K. Mtetwa dmtetwa2002@yahoo.co.uk
University of Zimbabwe, Zimbabwe.

Juet C. Brown juetbrown@yahoo.com
Bindura University of Science Education, Zimbabwe.

Abstract

This study reports the professional skills that mentors and peers coached 115 Mathematics and Science (M&S) pre-service teachers on 12 weeks of teaching practice. Eight mentors and their mentees were interviewed for the purpose of cross method triangulation. It emerged that mentors were more effective than peers to coach overt professional skills of communication, classroom management and assessment of students' achievement. Peers shared common theoretical constructivist perspectives that enabled them to be more effective than mentors to coach covert skills involving planning, reflection and teaching strategies. Findings from this study have strong implications on developing a synergy of professional skills of M&S pre-service teachers and linking their theory with practice.

Background

On attaining independence in 1980, Zimbabwe embarked on a quantitative expansion of schools in order to enable the majority of school going children get access to education. The increased number of schools necessitated an increase in the number of teachers. One cheap strategy that was used to avert the teacher shortage was to make pre-service teachers to practice teaching alone. They got a full teaching load and received monthly stipends equivalent to half a qualified teacher's salary. In 1995 the saturation of qualified teachers caused some pre-service teachers fail to get full teaching loads on which to practice teaching. The saturation of qualified teachers necessitated the Ministry of Higher Education to issue a directive that teaching practice become supernumerary (Mavhunga, 2004). This means that pre-service teachers practice teaching with teaching loads less than those of qualified teachers. They were to practice teaching under the supervision of an experienced teacher in the same placement school and receive stipends as before. The formalized pre-service and experienced teacher partnership opened possibilities for

making pre-service teachers to implement constructivist theories in their practice with the supervision of mentors.

The way mentoring is implemented at secondary school level is full of challenges (Mavhunga, 2004, Nyaumwe, 2001). Unlike in the primary school where mentors and mentees teach the same grade, in the secondary school they teach different classes. Mentor and mentee teaching of different classes result in some mentors failing to provide regular coaching and feedback that are essential for pre-service teachers to know areas they are doing well in or need to improve on (Wilson, 2000; Fish, 1995; Vonk, 1993; Stephens, 1984). Other challenges emanate from mentors' lack of awareness of mentoring roles. Insufficient funding in higher education has not made it possible to train mentors or familiarize them with their roles (Mavhunga, 2004, Ndawi, 1986).

Given these challenges facing mentoring in Zimbabwe, one doubts whether secondary school pre-service teachers on practice teaching receive effective coaching from their mentors to implement constructivist theories in their teaching. The impetus of this study is to find out the extent to which collegial peer and mentor coaching of Mathematics and Science (M&S) pre-service teachers reduce the theory–practice gap and help them to develop a synergy of professional skills. Collegial mentoring is taken here to mean the combined effort of mentors and peers at the same placement school to coach M&S pre-service teachers to implement constructivist theories in their practice teaching. A peer is a pre-service teacher who is practicing to teach at the same time as they are coaching a colleague(s) to implement constructivist theories in their teaching. Specifically the study sought to answer the research question: Does collegial peer and mentor coaching assist secondary school M&S pre-service teachers on twelve weeks of their programme of practice teaching to bridge the theory-practice gap and develop a synergy of constructivist teaching skills?

Answers to the research question may provide insight that helps to design strategies that incorporate peers' theoretical knowledge with mentors' teaching experience to coach M&S pre-service teachers to develop a repertoire of teaching skills.

Teaching practice organization at Bindura University of Science Education (BUSE)

Final year BScEd M&S pre-service teachers from BUSE go for twelve weeks of their programme on full time teaching practice. They practice teaching in Advanced Level schools (18+) in the capital city, Harare, and surrounding provinces after passing a course on M&S didactics. In the didactics course the pre-service teachers are encouraged to adopt constructivist strategies in their teaching. The course encourages them to view M&S as tentative, intuitive, subjective, and dynamic disciplines that originate from observations, experimentation and abstraction using senses (Davis, 1990). They are also encouraged to take teaching as a cooperative entrepreneur that encourages dialogue between learners and teachers in order for students to develop deep understanding of M&S content and process skills.

The didactics course exposes the pre-service teachers to a variety of instructional theories that involve planning, assessment, communication, management and reflective practice. Planning involves making schemes of work for the whole duration of teaching practice and daily lesson plans. Post-lesson reflection involves active, persistent and careful consideration of the level of success of decisions, actions and teaching plans (Opitz 2003). At the end of the didactics course the pre-service teachers engage in peer teaching. Peer teaching enables them to demonstrate their level of understanding constructivist theories by implementing them in a miniature class. Faculty members and peers critique the peer teaching in order to help pre-service teachers to improve their implementation strategies when they go for teaching practice.

During teaching practice the pre-service teachers are encouraged to coach each other strategies of implementing constructivist theories in their teaching. Peer coaching promote discussions of teaching plans and post-lesson reflections in ways that facilitate the pre-service teachers' implementation of constructivist theories in their teaching. Collegial peer and mentor coaching is an initiative that the university trial tested in order to evaluate the extent to which M&S pre-service teachers on teaching practice implement

the constructivist theories they are encouraged to adopt. To promote this coaching, the pre-service teachers are encouraged to go for practice teaching in at least pairs.

Theoretical framework

The constructivist theories that pre-service teachers learn during teacher education are either rhetoric or reality depending on the extent to which they are applicable in the classroom. Teaching practice enables pre-service teachers to experiment with constructivist theories in their teaching with coaching from various sources (Peterson and Williams, 1998). Feedback on how they implement the theories from faculty members, peers, mentors and school authorities assist the pre-service teachers to marry theory with practice in ways that lead to a holistic professional development. Professional development is taken here to mean *the acquisition of an interrelated whole of knowledge, insight, attitudes and repertory a teacher needs for the day to day adequate practice of teaching in a given school environment* (Vonk and Schras 1987: 97).

Mentoring is a strategy that is acclaimed for helping pre-service teachers to develop teaching skills of novices. It pairs a pre-service teacher with an experienced teacher in the placement school. Collaboration in the development of teaching skills is now a worldwide phenomenon (Sanders, 2000). Immersion in a community of peers and mentors facilitate the sharing of experiences, building of instructional skills and construction of a professional identity (Kiggins, 2002). Peer and mentor collaboration in coaching pre-service teachers facilitates a continuous assessment of personal conceptions on M&S instruction in the light of their applicability in school contexts (Ashcroft and Griffiths, 1989). An understanding of the conditions, which favour constructivist theories in the school context, bridges the theory-practice gap of pre-service teachers. This is possible because mentors use their teaching experience to interpret student actions and responses to classroom events whilst peers coach each other appropriate ways of implementing constructivist strategies (Stephens, 1984).

Methodology

Data for answering the research question was obtained from a questionnaire filled by two cohorts of BScEd M&S pre-service teachers of 2003 and 2004. A questionnaire made it possible to evaluate the degree to which mentors and peers coach pre-service teachers to develop teaching skills that the university encourages. M&S pre-service teachers filled the questionnaire during a semester after teaching practice. Fifty-three (53) M&S pre-service teachers in the 2003 group and 62 in the 2004 group (N = 115) present in the first methods lectures formed the sample that filled the questionnaire.

The 19 items on the questionnaire were constructed using the professional skills that appear on teaching practice supervision and assessment form, which the university encourages pre-service teachers to develop. The questionnaire items covered the six professional skills of planning, pedagogy, assessment, classroom management, communication and post-lesson reflection that the university emphasizes. Both mentors and faculty members use the form, from which the questionnaire items were drawn, during clinical supervision and assessment of the pre-service teachers. Items on the questionnaire were randomly placed in order to determine the consistency of responses. Responses on completed questionnaires were triangulated with in-depth interviews of eight mentors and their mentees in order to determine their consistency.

Proximity to the university is the only criterion used to select the mentors who were interviewed. These mentors had many years of mentoring experience. The fluctuating annual enrolments of M&S pre-service teachers causes schools close to the university to engage in more mentoring years than their counterparts further away. By virtue of their mentoring experience, mentors close to the university possess typical mentoring skills.

The hierarchical focusing interview technique was employed (Tomlison, 1989). It comprised semi-structured questions that sought to gain in-depth accounts of the nature of coaching that M&S pre-service teachers received from their peers and mentors. The interviews started with relatively general questions. For instance, *Tell me the aspects of practice teaching that striked you most? Or do you think your mentee will make a good teacher?* A gradual coverage of the focal questions of the study followed (Hobson, 2003).

For instance, *can you tell me the pedagogical skills that your peer coached you better than your mentor? Or do you think there are some pedagogical aspects that you did not have enough knowledge to share with your mentee?* Concrete evidence or examples were asked to make the responses explicit. This strategy gives interviewees an orientation that enables them to gradually get confidence and familiarity with the interview in ways that allow well thought out responses on focal questions of the study.

Results

The results reported here are based on the six main themes on the questionnaire and data analysis of the sixteen interview transcripts from M&S pre-service teachers and their mentors. Inter-rater reliability checks with the authors were conducted in order to correctly place responses in the rightful themes. Both the questionnaire and interview data are reported selectively in order to highlight typical professional skills that peers or mentors coached M&S pre-service teachers.

To facilitate data interpretation, each response was placed in the six themes as percentages in order to determine the group that coached M&S pre-service teachers more than the other (Appendix I). The items falling within the same theme were further grouped together and their sum expressed as percentages. This was necessary in order to determine the theme(s) with higher percentages of peer or mentor-coached skills. Table I displays the percentages of professional skills that peers and mentors coached the pre-service teachers.

Table I: Mean percentages of the skills M&S pre-service teachers were coached.
N = 115

Skill coached	Percentage per coaches		
	Mentors (%)	Peers (%)	Both (%)
Planning	28.6	53.0	15.0 *
Constructivist pedagogues	33.5	57.8	12.5 *
Assessment	77.4	12.2	0 *
Classroom management	65.5	13.9	0 *
Communication skills	62.6	20.9	16.5
Reflection on lessons	6.1	88.7	0 *

Key: * Some M&S pre-service teachers did not give responses on the skill

Table I shows that mentors coached M&S pre-service teachers more than peers in three overt skills of assessment (77.4%), classroom management (65.5%) and communication (62.6%). Peers provided more coaching than mentors in the covert skills of reflection (88.7%), pedagogy (57.8%) and planning (53.0%).

Planning skills

The majority of the M&S pre-service teachers (53.0%) reported of receiving more coaching from peers than mentors on planning (Table I). This was also revealed in the interview where peers said that they coached one another to frame lesson plan objectives and scheme aims. Ellah, a science pre-service teacher was explicit on the coaching she received from a peer. She said, *my mentor was not helpful in constructing scheme aims and lesson plan objectives. My peer, Joyce, helped me to frame them*, (Ellah: Interview March 2003).

The mentor avoided coaching planning skills because he rarely frame scheme aims and lesson plan objectives. He posited: *I seldom frame behavioural lesson plan objectives. The pre-service teachers helped each other to frame them*. (Mentor 1: Interview March 2003).

Pedagogical skills

Peers coached each other more (57.8%) than mentors (33.5%) to implement constructivist pedagogies in their lessons. Some mentors discouraged pre-service teachers to use constructivist-teaching methods in their teaching because they consumed a lot of time. For example Mentor 5 argued: *I discouraged Christopher to drag behind when deriving a circle theorem from student explorations. It was time consuming that the class was going to remain behind the one I teach*, (Mentor 5: June 2004).

Assessment skills

Mentors coached M&S pre-service teachers more on assessment of students' work (77.4%) than peers (12.2%). Mentors coached student assessment regularly in order to enforce school policy. Simon elaborated, *the science department expected weekly*

homework, assignment, practical work and an end of topic test. The mentor monitored students' achievement profiles in order to account for their progress on consultation and prize giving day. (Simon: Interview April 2004).

Classroom management

Mentors coached M&S pre-service teachers more on classroom management (65.5%) than peers (13.9%). Interview results revealed that mentors' knowledge of students' behaviour at a school influenced the classroom management styles that they encouraged M&S pre-service teachers to adopt.

Communication skills

Mentors coached M&S pre-service teachers more (62.6%) than peers (20.9%) on communication in the classroom. Mentors used their experience of classroom practice to coach pre-service teachers how to ask questions or probe students' alternative conceptions. They also encouraged M&S pre-service teachers to keep their verbal and non-verbal communication consistent in order for communication to be effective.

Post lesson reflection

M&S pre-service teachers received more coaching from peers (88.7%) than mentors (6.1%) on post-lesson reflections. Some mentors were reluctant to reflect on lessons taught by M&S pre-service teachers. Nyasha elaborated, *my mentor had a degree in mathematics without teaching qualifications. He hesitated to hold post-lesson reflective discussions with me. (Nyasha: Interview April 2003).*

Some mentors agreed that they lacked skills to hold post-lesson reflective discussions with their mentees because they rarely reflected on their practice. A mentor said, *I teach without a critical reflection of how I develop teaching skills because we do not write reflections on lessons we teach in this school. (Mentor 3: Interview June 2004).*

Discussions

Findings from this study amplify the complementary roles that peers and mentors can play in bridging the theory-practice gap of M&S pre-service teachers. Where mentors encourage pre-service teachers to teach by rote, peers supported each other to implement constructivist-teaching strategies. On the other side of the coin mentors supported the pre-service teachers with the mechanics of teaching that were possible in schools and not the expert pedagogy that is presented in theory. This is evidenced by their effectiveness to coach the professional skills they practice on a daily basis such as competency in assessment (77.4%), classroom management (65.5%) and communication (62.6%).

The classroom management encouraged by mentors sometimes contradicted with the constructivist methods that pre-service teachers were to adopt. The contradictions seem to originate from the polemic conception of science teaching and learning between mentors and pre-service teachers. For instance, some mentors conceived student quietness during instruction as an indication of good classroom management. They believed that effective teaching occur when teachers are firmly in control of all classroom events. Such mentors believed that students, through passive means, may master mathematics and science concepts. The mentors developed this conception from experience of contexts at their schools. Using personal experience, they discouraged M&S pre-service teachers to engage in student negotiations of mathematics and science knowledge. The mentors were not convinced that the level of noise during student negotiations is acceptable to allow students to construct understanding of concepts under review.

Mentors were better than peers to coach assessment skills (77.4%). Their successful coaching of this skill was influenced by their effective employment of techniques that elicit students' attention. Their assessment techniques were tailored on school expectations that teachers adhere to their departmental policies.

Communication in the classroom is a skill that mentors coached M&S pre-service teachers more (62.6%) than peers. This can be attributed to a number of factors that give mentors advantages over peers. A mentor's duration at a school influence their interactions with students. These interactions increase mentor awareness of students'

performance in other subjects and their level of communication. Mentors' knowledge of students' performance in other subjects enabled them to use a language that is comprehensive to the students.

Mentors assiduously concentrated on coaching observable instructional skills of classroom practice, assessment and communication. They neglected critical issues of evaluating the rationale and effectiveness of the decision-making systems of M&S pre-service teachers in the light of students' outcomes (Nyaumwe, 2001; Rodd, 1995). Some mentors were not confident to coach covert skills of planning, constructivist pedagogies and post-lesson reflections because they avoided contradicting with M&S pre-service teachers' theory. Peers coached the covert skills that involved teacher decision-making better than mentors. Peer coaching in developing these skills facilitated the marriage of theory with practice in ways that broaden pre-service teachers' chances to experiment with a variety of constructivist theories.

The M&S pre-service teachers' desire to experiment with constructivist pedagogues were not forbidden but met with little support from some mentors (Vonk and Schras, 1987). Mentors were mostly concerned with institutional expectations that they encouraged pre-service teachers to limit their experimenting with a variety of teaching approaches (Zuzovsky, Feiman-Nemser and Kremer-Hayon, 1998). The practicality of school expectations such as preparing students for summative examinations made some mentors to believe that mathematics and science can be taught effectively using transmission methods.

Besides preparing students for summative examinations some mentors encouraged pre-service teachers to use transmission methods in their teaching so that they could cover content at a fast pace. The M&S pre-service teachers were encouraged to cover content at the same pace with teachers teaching the other streams of the class level. Covering content with students at the same class level was encouraged so that when pre-service teachers go back to the university mentors can easily take the class and teach them the same content as the classes they were teaching previously.

M&S pre-service teachers' learning to implement constructivist pedagogues in their teaching is analogous to learning science content. Both are student activities that are gained through experiential learning. In both activities it is imperative for learners to reflect on how they are understanding what they are learning through immersion in typical situations that may require the use of trial and error to discover knowledge from first hand experience. In the case of learning to implement constructivist pedagogues, post-lesson reflections involves thinking and acting on teaching aspects that confuse, frustrate or perplex. Examinations of these aspects with a peer result in reframing teaching strategies, re-experimenting and re-examining the consequences of certain actions (Ross, 1989). The re-examination and re-experimentation of the consequences of implementing constructivist pedagogues in the real classroom leads to a higher understanding of the conditions and contexts under which they are effective. The utilization of mentors and peers to coach pre-service teachers to implement constructivist pedagogues enable pre-service teachers to examine and experiment possible ways of integrating theory with practice in their instructional practice.

Institutionalization of mentor and peer collegiate coaching encourages M&S pre-service teachers to bridge the theory practice gap and develop a synergy of professional skills. The institutionalization allows peers to coach professional skills to each other that mentors do not concentrate on (covert and overt instructional skills). Mentors base their coaching on the contexts of schools where pre-service teachers implement constructivist theories. Peers on the other hand coach each other strategies of implementing constructivist pedagogues. The complementary function of mentors and peers may promote the development of pre-service teachers' instructional skills that are anchored on a critical and informed theoretical framework (Stephens, 1984). Without peer and mentor collegial mentoring, theories that encourage pre-service teachers to improvise, promote student explorations or advocate for student construction of scientific knowledge may remain campus rhetoric without being practiced in mathematics and science classrooms.

Conclusion

This study has shown that collegial peer and mentor coaching of M&S pre-service teachers promotes the marriage of theory with practice by anchoring constructivist pedagogues on a theoretical and practical framework. Despite their lack of teaching experience, peers help each other to implement constructivist pedagogues in their teaching practice. The wealth of experience that mentors possess make them effective to coach overt skills in line with school contexts and expectations. That peer and mentor collegial mentoring is effective to narrow the theory-practice gap and the development of instructional skills need further investigations to establish the conditions that are conducive for the two to operate effectively. Findings from this study open up a debate on ways of creating an amniotic relationship between mentors and peers in ways that call for the deployment of M&S pre-service teachers to placement schools in at least pairs. The changes in deployment patterns may facilitate peers to coach each other to implement theories they learn and narrow the theory-practice gap.

One study cannot reveal all the strengths and weaknesses of collegial mentoring. Other studies may delve into gathering empirically tested strategies that guide M&S pre-service teachers to function at optimal levels in their new roles of collegial mentoring. They may also establish the logistics for strengthening mentor and peer collegial functions in ways that narrow the theory-practice gap and help M&S pre-service teachers to develop a synergy of professional skills.

References

- Ashcroft, K. and Griffiths, M. (1989). Reflective Teachers and Reflective Tutors: Experience in an Initial Teacher Education Course. *Journal of Education for Teaching*. 15(1), 33-40.
- Davis, R. B. (1990). *Constructivist views on the teaching and learning of Mathematics*. NCTM. Reston.
- Fish, D. (1995). *Quality Mentoring for Student Teachers*. London: David Fulton.
- Hobson, A. J. (2003). *Student Teachers' Conceptions and Evaluations of Theory in Initial Teacher Training*. *Mentoring & Tutoring*. 11(3), 245-261.
- Kiggins, J. (2003). The Evolution of an Alternative Teacher Education Model. *English Teaching: Practice and Critique*. 2 (3), 15 - 21

- Mavhunga, P. J. (2004). A Study of the Role of Teacher-Mentors in the Supervision of Secondary School Student Teachers on Teaching Practice Attachment. *Zimbabwe Journal of Educational Research*. 16(1), 53 – 69.
- Ndawi, O. P. (1986). Teaching Practice Supervision: A Curriculum Problem of Consensus between Lecturers and Local Supervisors. *Unpublished Master of Education Dissertation*, University of Zimbabwe.
- Nyaumwe, L. (2001). A Survey of Bindura University of Science Education Student Teachers' Perceptions of the Mentoring Model of Teaching Practice. *Zimbabwe Journal of Educational Research*. 13 (3), 230 – 256.
- Opitz, M. (2003). Knowledge base for teacher education.
<http://www.csbsju.edu/education/knowledgebase/knowledgebaseIX.htm> 01/04/03
- Peterson, B. E. and Williams, S. R. (1998). Mentoring beginning teachers. *The Mathematics Teacher*. 91, 730-734.
- Ponte, J. P. and Brunheira, L. (2000). Analyzing Practice in Pre-service Mathematics Teacher Education. www.educ.fc.ul.pt/cie/publicacoes/autores.htm 3/08/04.
- Rodd, M. (1995). Dimensions of Mathematics Mentors in School based Initial Teacher Education. *Teachers & Teaching: theory and practice*. 1(2), 229 – 246.
- Ross, D. D. (1989). First Steps in Developing a Reflective Approach. *Journal of Teacher Education*. 40(2), 22 – 30.
- Sanders, (2002). What do U.K. Schools think makes a Good Mathematics Teacher? *Educational Studie.*, 28(2), 181-191.
- Stephens, P. (1984). *Essential Mentoring: A Practical Handbook for School-based Teacher Educators*. Cheltenham. Stanley Thornes Ltd
- Tomlison, P. D. (1989). Having it both ways: hierarchical focusing as research interview method, *British Educational Research Journal*. 15(2). 155-176.
- Vonk, J. H. C. (1993). *Supervision of Instruction: Mentor Knowledge and Skills Base*. Maseru: EPIC Printers.
- Vonk, J. H. C. and Schras, G. A. (1987). From Beginning to Experienced Teacher: a study of the professional development of teachers during their first four years of service. *European Journal of Teacher education*. 10(1), 95 – 109.
- Zuzovsky, R., Feiman-Nemserand, S. and Kremer-Hayon, L. (1998). Introduction. *European Journal of Teacher Education*. 21(1), 7-10.

Appendix I: Percentage responses of skills M&S pre-service teachers were coached.

N = 115

Skill coached	Theme	Percentage per coaches		
		Mentors (%)	Peers (%)	Both (%)
1. Scheming	P	24.3	34.7	41
2. Questioning techniques	C	62.6	20.9	16.5
3. Student achievement mark lists	A	73.0	24.3	*
4. Assessment of students' work	A	81.7	0	*
5. Choice of media	Ped	12.2	75.7	*
6. Introducing a lesson	Ped	35.7	64.3	0
7. Choosing constructivist teaching methods	Ped	7.8	72.2	*
8. Framing scheme aims	P	14.8	67	18.2
9. Framing lesson objectives	P	6.1	73.9	*
10. Pacing of content in a lesson	Ped	52	37.4	10.6
11. Organising class discussions	CM	58.3	41.7	0
12. Interpreting the syllabus	P	71.3	22.6	6.1
13. Planning for lessons	P	0	82.6	17.4
14. Organising group work	Ped	45.2	40.9	13.9
15. Classroom management	CM	70.4	0	*
16. Reflecting on lessons taught	R	6.1	88,7	*
17. Depth of covering content in a lesson	P	55.2	37.4	7.4
18. Catering for students' individual differences	Ped	28.7	58.3	13
19. Using multiple teaching methods	Ped	53.0	47	0

Key: * Some M&S pre-service teachers did not give responses on the question.

P- Planning skill

Ped- Pedagogy skill

A- Assessment skill

CM- Classroom Management skill

C- Communication skill

R – Reflection skill