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Mentoring Pre-Service Elementary Teachers in Mathematics Teaching

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ABSTRACT

Concern with primary teachers' content knowledge in mathematics and science has been extensively documented in the literature. Efforts to improve such knowledge require engaging students through new teaching and learning. One such action has been the development of a Foundations Unit, Scientific and Quantitative Literacy, for all first year pre-service primary teacher education students at Queensland University of Technology and the use of mentoring pre-service teachers' practical experiences with particular attention to mathematical and scientific components of their teaching. The unit and the approach taken has also been adopted by two Education Institutes in Malaysia in a joint Australia/Malaysia venture in which the unit is taught in English, the second language of the Malaysian students. The study explores and describes the perceptions of 147 Australian pre-service teachers, all of whom have completed the new integrated Foundations Unit, with regards to practices of mentors in primary mathematics education. The study initially aims to determine the transferability of a science mentoring instrument to the development of an instrument for mentoring pre-service teachers in primary mathematics teaching. It also aims to articulate existing mentoring practices, content knowledge and confidence in primary mathematics education linked to this instrument. New teaching and learning practices include writing a reflective journal in the Foundations unit and reflecting on mentoring practices in their practical work. This study focuses on the latter of these two. The mentoring focused on a five-factor model; Personal Attributes, System Requirements, Pedagogical Knowledge, Modelling, and Feedback. A survey instrument was then developed which included a component of the perceived mathematical content knowledge and confidence with mathematics of the mentors. It is anticipated that the study will contribute to the evaluation of the effectiveness of these new teaching and learning practices. Further possible actions and outcomes that relate to the theme of engaging diversity will be the evaluation of the effectiveness of adapting the unit to the Malaysian context.

Background to the Study

Preliminary investigations of the Mentoring for Effective Primary Science Teaching (MEPST), (Hudson 2003; Hudson et al. 2005), which focused on a five-factor model for mentoring, namely; Personal Attributes, System Requirements, Pedagogical Knowledge, Modelling, and Feedback was altered to reflect the mentoring practices of primary mathematics teachers. From these investigations a 'Mentoring for Effective Mathematics Teaching' (MEMT) survey instrument was developed which included a component of the perceived mathematical content knowledge and confidence with mathematics of the mentors.

Concern with primary teachers' content knowledge in mathematics has been extensively documented (See, for example, Peard 2005) and the improvement of this has been a topic of interest of one of the authors of the present study for some time (Peard 1999). Efforts to this effect have included the development of a 'Foundations' unit, Scientific and Quantitative Literacy, (Peard

2004)for all first year pre-service primary teacher education students at Queensland University of Technology.

A pilot study was conducted on 29 final-year pre-service teachers by administering the MEMT survey instrument at the conclusion of their professional experiences (Hudson & Peard 2005). The present study explores and describes 147 preservice teachers' perceptions of their mentor's practices, content knowledge and confidence in primary mathematics education using the refined survey instrument. Although there are various models for mentoring in general, there is little or no literature on subject-specific mentoring in mathematics education for pre-service teachers. The above five-factor model for mentoring includes items associated with each factor that have also been identified and justified with the literature (see Hudson et al. 2005). The five factors are well articulated in the literature for which this survey provides a direct link.

Aim of the Study

The present study explores and describes 147 pre-service teachers' perceptions of their mentor's practices in primary mathematics education within the abovementioned five factors linked to a literature-based instrument. The study aims to determine the transferability of the science mentoring instrument (Hudson et al. 2005) to the development of an instrument for mentoring pre-service teachers in primary mathematics teaching. The study also aims to articulate existing mentoring practices, content knowledge and confidence in primary mathematics education linked to this instrument on pre-service teachers' mentoring of primary mathematics teaching.

Data from the study will also be used to explore ways to improve the mathematical content knowledge and confidence in primary mathematics education of pre-service primary teachers by engaging students through these new teaching and learning activities.

Data collection and methodology

A literature-based instrument was used to gather the perceptions of 147 final-year preservice teachers regarding their mentors' practices related to primary mathematics teaching. Five factors that characterise effective mentoring practices in primary mathematics teaching were supported by confirmatory factory analysis. Each of the five factors had acceptable Cronbach alphas, that is, Personal Attributes (mean scale score=3.97, SD [standard deviation]=0.81), System Requirements (mean scale score=2.98, SD=0.96), Pedagogical Knowledge (mean scale score=3.61, SD=0.89), Modelling (mean scale score=4.03, SD=0.73), and Feedback (mean scale score=3.80, SD=0.86) were .91, .74, .94, .89, and .86 respectively.

As noted above, the MEMT survey instrument in this study evolved through a series of preliminary investigations on MEPST (Hudson, 2003; Hudson et al., 2005), which also identified the link between the literature and the items on the survey instrument. The analysis of the pilot study conducted on 29 final-year pre-service teachers indicated the possibility of a relationship between the MEPST instrument and the MEMT instrument; however further investigation was needed to confirm results. For this study, 147 pre-service teachers' perceptions of their mentoring were obtained from a five-part Likert scale survey. The data provided descriptive statistics using SPSS13 for each variable.

RESULTS AND DISCUSSION

The 147 completed pre-service teacher responses (109 female; 38 male) from one Australian university provided descriptors of the participants (mentors and mentees) and data on each of the five factors and associated attributes and practices. Responses were gathered at the conclusion of their final professional experience.

Backgrounds of Participants

Twenty-five percent of these mentees (n=147) entered teacher education straight from high school, with 93% completing a mathematics unit in their final two years of high school (i.e., Years 11 & 12). All mentees had completed the Foundations unit described above and at least one mathematics methodology unit. Seventy-seven percent of mentees had completed two or more mathematics

methodology units at university, and 86% had completed three or more block professional experiences (practicums) with 54% completing four professional experiences. Ninety percent of mentees taught at least four mathematics lessons during their last practicum with 81% of these mentees indicating they had taught 6 or more lessons.

FIVE FACTORS FOR EFFECTIVE MENTORING IN MATHEMATICS

Personal Attributes

When analysing the mentees' responses on their mentors' Personal Attributes, a majority of mentors (89%) were supportive towards their mentees' primary mathematics teaching. In addition, a clear majority (86%) of mentors appeared comfortable and confident in talking about mathematics teaching and were perceived as demonstrating a positive attitude towards the subject. However, less than one quarter of mentees believed that the mentor aided their own reflection on teaching practices (73% agreed or strongly agreed to this practice), or instilled positive attitudes in them (69%), listened attentively to their mentees (67%) or instilled confidence in them (64%) for teaching primary mathematics.

System Requirements

Items displayed under the factor System Requirements presented a different picture from the previous factor. The primary mathematics mentoring practices associated with System Requirements were all below 50%, that is, 44% of mentors discussed the aims of mathematics teaching, 41% of mentors discussed the school's mathematics policies with the mentee, and only 29% outlined mathematics curriculum documents. Implementing departmental directives and primary mathematics education reform needs to also occur at the professional experience level, yet the data indicated that many pre-service teachers may not be provided these mentoring practices on System Requirements within the school setting.

Pedagogical Knowledge

Mean item scores indicated that the majority of mentees 'agreed' or 'strongly agreed' their mentor displayed Pedagogical Knowledge for primary mathematics teaching. In this study, more than 20% of mentors may not have mentored pedagogical knowledge practices. For example, in the planning stages before teaching mathematics 64% of mentors assisted in planning, and 67% discussed the timetabling of the mentee's teaching and assisted with mathematics teaching preparation (71%). Furthermore, teaching strategies need to be associated with the assessment of students' prior knowledge, yet nearly half the mentors were perceived not to discuss assessment or questioning techniques for teaching mathematics (52%). Many mentors also appeared not to consider content knowledge and problem-solving strategies for teaching mathematics (57%) and providing viewpoints on teaching mathematics as a high priority (61%). Of these, 45% of mentees perceived this as a weakness in mathematical content knowledge on the part of the mentee. This implies that many final-year preservice teachers may not be provided with adequate Pedagogical Knowledge, due mainly to lack of content knowledge, in the primary school setting to develop successful mathematics teaching practices.

Modelling

Modelling teaching provided mentees with visual and aural demonstrations of how to teach. Mean item scores indicated that the majority of mentors were perceived to model mathematics teaching practices. Even though more than 75% mentees perceived they received modelled practices for teaching mathematics including modelling a rapport with their students (85%), modelling the teaching of primary mathematics (79%), displaying enthusiasm for teaching mathematics (78%), and using language from the mathematics syllabus (78%), more than a quarter (27%) of mentees indicated their mentors had not modelled a well-designed lesson, effective mathematics teaching, or appeared confident with mathematics.

Feedback

Mean item scores indicated that the majority of mentees 'agreed' or 'strongly agreed' their mentors provided 'Feedback' as part of their mentoring practices in primary mathematics teaching. Yet, surprisingly, mentees perceived that 82% of mentors observed their mathematics teaching with

only 66% articulating their expectations for the mentees' teaching of mathematics. More surprising is that 3% of mentors provided oral feedback without observation. Fifty-eight percent were perceived to provide written feedback and only 55% of mentors reviewed lesson plans, which is necessary to provide feedback before teaching commences for enhancing instructional outcomes.

CONTENT KNOWLEDGE, CONFIDENCE AND ATTITUDE OF MENTORS

Satisfactory modelling of mathematics lessons requires adequate content knowledge, a degree of confidence and a positive attitude towards mathematics (Peard 2005). The fact that 14% of mentors did not satisfactorily modelled one or more mathematics lessons during their professional experiences and only 59% modelled five or more lessons during that period may be an indication of deficiencies in these regions. Of those who did model five or more lessons only 41% of mentees perceived that mathematics was their mentors' strongest subject in the primary school setting and agreed that the mentees' content knowledge was closely related to good pedagogical knowledge. Nevertheless, none perceived that lack of content knowledge was sufficient to prevent satisfactory Modelling or Pedagogical Practices of any of the 86% who modelled one or more lessons. Further investigation of the relationship between content knowledge and the Pedagogical Knowledge factor, and of confidence and attitude towards mathematics and the Personal Attribute factor needs to be undertaken.

Further discussion

There appeared to be transferability of the MEPST survey instrument (Hudson et al., 2005) to the MEMT instrument, which was supported by acceptable Cronbach alpha scores and descriptive statistics. The MEMT instrument appeared to provide a way to collect data for articulating perceptions of existing mentors' practices in primary mathematics teaching currently occurring in various Queensland schools. Even though the Likert scale differentiated the degree of mentoring (e.g., strongly disagree to strongly agree), the quality of these mentoring practices needs to be investigated further. Anecdotal evidence suggests mentors vary their mentoring practices considerably, and as there are national standards for teaching and assessing mathematics such as those specified by the National Council for Teaching Mathematics (NCTM, 1995), a set of standards for mentoring practices for mathematics appears a logical sequence.

The growing literature is more clearly defining mentoring practices and mentees also claim that the in-school context is pivotal to their development as teachers (e.g., Ganser, 1995; Giebelhaus & Bowman, 2002). Indisputably, 'generalist' primary teachers will not be experts in all subjects in primary school, and some may not have adequate content knowledge, skills, or confidence for teaching primary mathematics (Peard 2005). Mathematics education is considered a priority by education departments (e.g., Education Queensland; NSW Department of Education and Training [DET]), yet there are primary teaching mentors who may either not have the skills in mathematics education or lack content knowledge for effective mentoring strategies. There needs to be more emphasis on the mentoring of mathematics particularly as more importance is placed on this key learning area.

CONCLUSION

The perceived inadequacies in some of the mentoring outlined in this study is cause for concern and may be widespread. This study argues that for mentees to receive equitable mentoring in primary mathematics teaching there must be a set of specific mentoring attributes and practices for mentors. These attribute must include adequate content knowledge, confidence in and attitude towards mathematics. Such a set of 'standards' may aid mentors to focus more specifically on their mentoring and may also aid mentees in determining what to expect from their mentors. It may further promote more definitive mentoring relationships. However, mentors and mentees must work together to establish their roles and responsibilities, and such standards would need to be flexible in order to cater for the diversity of practices and needs. Just as teachers can always improve their methods of teaching, so too can mentors improve their methods of mentoring, and those who are professionally developed in mentoring have a greater impact on the mentee's development than those who are not (Giebelhaus & Bowman, 2002). If pre-service teachers are to receive quality

mentoring in primary mathematics teaching then teachers, in their roles as mentors, will require further education, both in pedagogy and content. The form this education takes will require rethinking and new teaching and learning, as experienced primary teachers may be reluctant to be educated on their mentoring practices (See, for example, Hulshof & Verloop, 1994).

Even though further research using qualitative data would be needed with more focus on mentees' roles in the mentoring processes, the inadequate mentoring outlined in this study may be initially addressed through specific mentoring interventions that focus on effective procedures as proposed by Hudson (2003).

As each item associated with the MEMT instrument is linked to the literature, a mentoring intervention may be based around these items. A well-constructed mentoring intervention may then provide professional development for mentors for enhancing not only their own mentoring practices but also their teaching practices. It may also aid induction processes for early career mathematics teachers, particularly for those who may not receive adequate mentoring support for their teaching of mathematics. Additionally, the MEMT instrument may be used (by tertiary institutions or departments of education) to gauge the degree of mentoring in primary mathematics and, as a result of diagnostic analysis, plan and implement mentoring programs that aim to address the specific needs of mentors in order to enhance the mentoring process.

Utilising the mentor's time efficiently is crucial for developing the mentee's practices for effective primary mathematics teaching, and this is further justification for educating mentors. The mentor's involvement in facilitating the mentee's learning for more effective primary mathematics teaching cannot be indiscriminate or random; instead it must be predetermined and sequentially organised so that the mentor's objectives are focused, specific, clear, and obtainable. This means educating mentors on such practices whether for a preservice teacher level or a beginning teacher induction level. This study outlines that in broad terms, effective mentoring requires mentors to: display personal attributes, provide guidance on system requirements, model effective mentoring and provide pedagogical knowledge and feedback towards enhancing teaching practices. The last two of these attributes imply that mentors display confidence in teaching mathematics and demonstrate content knowledge in the subject. Of the five mentoring factors identified, these results suggest that to improve mentoring in Pedagogy, Modelling and Personal Attributes, improved content knowledge of the mentors is required. Thus, the results support the calls for improved mathematical content knowledge of primary teachers expressed elsewhere. Educating mentors aims at ultimately targeting the development of pre-service teachers' practices, and hence a way to enhance primary students' learning experiences and opportunities towards developing higher standards of mathematics education.

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