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Examining mentors' practices for enhancing preservice teachers' pedagogical development in mathematics and science

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Abstract

Mentoring is too important to be left to chance (Ganser, 1996), yet mentoring expertise of teachers varies widely, which may present inequities for developing preservice teachers' practices. Five factors for mentoring have been identified herein: personal attributes, system requirements, pedagogical knowledge, modelling, and feedback, and items associated with each factor have also been justified in context of the literature. An original, literature-based survey instrument gathered 446 preservice teachers' perceptions of their mentoring for primary teaching. Data were analysed within the abovementioned 5 factors with 331 final-year preservice teachers from 9 Australian universities responding to their mentoring for science teaching and 115 final-year preservice teachers from an urban university responding to their mentoring for mathematics teaching. Results indicated similar Cronbach alpha scores on each of the five factors for primary science and mathematics teaching; however percentages and mean scores on attributes and practices aligned with each factor were considerably higher for mentoring mathematics teaching compared with science teaching.

Mentoring can develop teaching practices as it provides opportunities for mentors and mentees to engage in pedagogical discourse and reflective thinking (Barnett, 1995; Crowther & Cannon, 1998; Healy, Ehrich, Hansford, & Stewart, 2001). Mentoring has become more prominent in teacher education, which increases the responsibilities assigned to mentors (Power, Clarke, & Hine, 2002; Sinclair, 1997). Universities in Australia produce guidelines that outline mentors' roles and responsibilities for facilitating preservice teachers' in-school experiences (e.g., Griffith University, Queensland University of Technology, Southern Cross University); however the majority of mentors may not be confident in teaching particular subjects such as primary (elementary) science (Mulholland, 1999; National Science Standards, 2002) let alone mentoring in specific subject fields. Primary teachers in their roles as mentors are generally expected to teach several subject areas in the primary school, and it is likely these teachers will not have expertise in all areas. For example, many generalist primary teachers in Australia either teach science inadequately or not at all (Goodrum, Hackling, & Rennie, 2001); hence primary teachers who become mentors may not have mentoring expertise to guide effectively the preservice teachers' learning in primary science education, which may also be the case for other primary subject areas.

Preservice teachers deserve equal opportunities to learn how to teach, which occurs pragmatically with mentors (supervising or cooperating teachers) in professional experience settings (Jasman, 2002). Preservice teachers are learners and "learners need goals" (Edwards & Collison, 1996, p. 11). Mentoring preservice teachers (mentees) should be an intentional process as preparation for mentoring can increase the likelihood of achieving the mentee's needs (Ackley & Gall, 1992; Barrett, 2002). Many educators (e.g., Gaston & Jackson, 1998; Jarvis, McKeon, Coates, & Vause, 2001; Zachary, 2002) claim that mentors must be educated on explicit mentoring practices with well-organised mentor programs. Indeed, primary teachers may need formal preparation for their roles as mentors as, in most cases, "mentors are thrust into the new role of mentoring with only the most meagre guidance" (Edwards & Collison, 1996, p. 11).

Although some mentoring can emerge naturally, educators must ensure that mentoring is not left to chance (Carter & Francis, 2000; Ganser, 1996). It is therefore necessary to plan mentoring to enhance the preservice teachers' learning experiences (Barrett, 2002). Mentors may "need explicit training in the stimulation of novice teachers to reflect on their actions in order to move them to higher levels of professional thinking" (Veenman, de Laat, & Staring, 1998, p. 6). In Australia, there are some developments for educating primary teachers on effective mentoring practices. For example, the New South Wales Department of Education and Training (NSW DET, 2003) has selected and trained a small number of teachers to become mentors, and the Joint Council of Queensland Teachers Association (JCQTA, 2006) has promoted mentoring as a way to enhance teaching practices across a range of subject areas. Even though these courses aim to provide mentoring strategies for a select group of mentors, not all potential or existing mentors may be prepared to participate in formal mentoring training courses. To illustrate, Hulshof and Verloop's study (1994) reports that 74% of mentors claimed education in mentoring was necessary but considered such education more important for new mentors. Just as teachers can always improve their methods of teaching, so too can mentors improve their methods of mentoring (Boss, 2001; Garvey & Alred, 2000). Those who receive training on effective mentoring practices have a greater impact on the mentee's development than those who are not (Giebelhaus & Bowman, 2000). As curricula continually change for primary education, teachers are required to develop further understandings and skills to advance their primary teaching practices. Similarly, mentors need to ensure their understandings and skills are aligned with current mentoring practices, and mentoring models such as the following five-factor model may present specifics for advancing practices.

Five-factor model for mentoring in teaching

Five factors for mentoring have previously been identified herein: personal attributes, system requirements, pedagogical knowledge, modelling, and feedback (Hudson & Skamp, 2003,

see Figure 1), and items associated with each factor have also been identified and justified in context of the literature (Hudson, Skamp, & Brooks, 2005).
[Insert Figure 1 here]

In relation to the five factor model, learning to teach requires social interaction, and the social relationship between mentor and mentee can have an impact on the mentee's development as a teacher (Wang & Odell, 2002). Mentors need to display personal attributes that facilitate a supportive learning environment (Ganser, 1991; Kennedy & Dorman, 2002; Rippon & Martin, 2003). The mentor's personal attributes can aid towards instilling positive attitudes and confidence in the mentee (Beck, Czerniak, & Lumpe, 2000; Matters, 1994), and promoting an environment conducive for the mentee to reflect constructively on teaching practices (Abell & Bryan, 1999; Upson, Koballa, & Gerber, 2002; Zachary, 2002). In addition, education systems require regulation as part of quality assurance and equity among providers. Mentors' articulation of system requirements provides mentees with departmental directions for teaching (Lenton & Turner, 1999). Curriculum documents, systemic aims, and school policies present a framework for regulating the quality of teaching practices and demonstrate to mentees specific school directives, which may have legal implications for practice (e.g., Alexander, 1997).

Mentors need to have adequate pedagogical knowledge to facilitate effective mentoring programs (Hodson & Hodson, 1998; Zanting, Verloop & Vermunt, 2003). The mentee's development of pedagogical knowledge can be enhanced in the school setting, particularly when guided by a competent and experienced mentor (Allsop & Benson, 1996). Mentors need to articulate pedagogical knowledge for the range of teaching experiences that promote effective learning. Pedagogical knowledge can be further enhanced by the mentor's modelling of teaching practices (Carlson & Gooden, 1999; Van Ast, 2002). Generally, mentees view their mentors as experts who model practice for developing understandings of their own strengths and weaknesses (Moran, 1990).

Researchers over two decades (Christensen, 1991; Griffin, 1985; Monk & Dillon, 1995; Zachary, 2002) stress that mentors require specific outcomes as a focus for providing feedback. Feedback will be more useful if it addresses the mentee's needs in relation to the outcomes for producing effective teaching (Jarvis et al., 2001). Outcomes that are linked to indicators of effective practices may provide clearer directions for both mentors and mentees, which can lead towards offering evidence on the achievement of such outcomes (Hudson, 2004). Coates, Vause, Jarvis, and McKeon (1998) emphasise that teachers' experiences of mentoring and teaching vary widely and, as mentors do not receive specific mentoring training in primary subject areas such as primary science or primary mathematics, there is a need to develop a set of mentoring standards.

There is little evidence that mentors encourage mentees to think critically about their practices and this is why mentoring must be planned in a similar way as teachers plan for students' learning (Edwards & Collison, 1996). For example, primary teachers who have been educated in mentoring for teaching (e.g., primary science teaching) are more confident in raising issues, expect specific learning outcomes, place greater emphasis on pedagogical knowledge, and aim to improve their own skills of observing teaching practices (Jarvis et al., 2001). Jarvis et al. further argue that effective mentoring practices require the provision of specific objectives to guide mentors. The literature suggests five factors (i.e., personal attributes, system requirements, pedagogical knowledge, modelling, and feedback) and associated practices and attributes for mentoring that may assist the mentees' development. What are mentees' perceptions of their mentors' practices in relation to these five factors?

Purpose of this study

This study explores and describes final-year preservice teachers' perceptions of their mentoring in primary science and primary mathematics education within the aforementioned five factors that are linked to a literature-based instrument (see Appendix 1 for final instrument).

Data collection method and analysis

The "Mentoring for Effective Primary Science Teaching" (MEPST, Appendix 1) survey instrument in this study evolved through a series of preliminary investigations on mentoring for effective primary science teaching. Steps for developing and validating the survey instrument included small-scale interviews with mentors and mentees (*n*=10) on their perceptions of mentoring preservice primary science teaching at the conclusion of a three-week professional experience. The literature-based survey instrument was pilot tested on 21 first-year preservice teachers (Hudson, 2003) and later with 59 final-year preservice teachers (Hudson & Skamp, 2003) at the conclusion of their professional experiences.

Analysis of these pilot tests provided data for refining the instrument that was administered to 331 final-year preservice teachers from nine Australian universities. Responses to these items were on a five-part Likert scale (i.e., strongly disagree=1, disagree=2, uncertain=3, agree=4, strongly agree=5). These data were subjected to confirmatory factor analysis (CFA; Hair, Anderson, Tatham, & Black, 1995), which defined a relationship between the variables (items) assigned to each factor (see Hudson et al., 2005). Eigenvalues greater than one also indicated a relationship between factors and associated items (Hair et al., 1995). Data analysis provided reliability for scoring each item on the survey (Appendix 2). The MEPST survey instrument was then altered to reflect mentoring for effective mathematics teaching (MEMT). That is, the word "science" was replaced with "mathematics" and the survey was administered to 115 final-year preservice teachers at one university. For this study, data were analysed within each of the five factors (i.e., personal attributes, system requirements, pedagogical knowledge, modelling, and feedback) for developing primary science and primary mathematics teaching and descriptive statistics were derived using a statistical analysis package SPSS.

Results and discussions

The 331 completed responses (284 female; 47 male) from final-year preservice teachers received from nine Australian universities provided data on mentoring in primary science education, and 115 completed responses (80 female; 35 male) from one Australian university provided data on mentoring in primary mathematics. Both sets of data were compared in relation to the five factors and associated variables. All responses were gathered at the conclusion of their final professional experience (i.e., practicum/field experience), which also presented descriptors of the participants (i.e., mentees and mentors).

Descriptors of mentees (final-year preservice teachers)

Fifty-six percent of mentees (*n*=331) involved in primary science teaching entered teacher education straight from high school, with 52% completing biology units at school. Whereas, 31% of mentees (*n*=115) involved in primary mathematics teaching entered teacher education straight from high school, with 91% completing mathematics units at school. All mentees had completed at least one methodology unit at university in science (*n*=331) and mathematics (*n*=115), and all mentees had completed at least three block professional experiences (practicums). There were no professional experiences under three-week's duration, and 66% of mentees involved in science had professional experiences of five-week's duration or more (57% for those involved in mathematics). Although 84% of mentees (*n*=115) taught more than six mathematics lessons during their last practicum, the number of science lessons taught by mentees (*n*=331) varied considerably (11% taught one lesson; 6% two lessons; 22% three or four lessons; 38% six lessons or more; and 15% did not teach science at all).

Descriptors of mentors

Most mentors were over 40 years old, although 17% were under 30 years of age for both science and mathematics. Mentees indicated that 27% of mentors did not have an "interest" or a "strong interest" in science, whereas this was lower for mathematics (i.e., 20%). Eighty-six percent of mentors modelled at least one mathematics lesson including 57% who modelled five or more lessons compared with 40% of mentors who did not model a science lesson during their mentees' professional experiences.

Five factors

The five factors were analysed through confirmatory factor analysis on mentoring practices for developing final-year preservice teachers' science and mathematics teaching. Cronbach alpha scores were considered acceptable for each factor (Table 1), and there were similarities between the science factors and the mathematics factors. The Pedagogical Knowledge factor had the same Cronbach alpha scores for each subject area (i.e., .94) and System Requirements was the lowest on the scale (i.e., .76 [science] & .74 [mathematics]). In addition, the other factors were not overly dissimilar in their Cronbach alpha scores (see Table 1). Although a relationship may be drawn between the mentoring practices for developing science teaching and those provided for mathematics teaching, percentages and mean scores on specific attributes and practices associated with each factor were different. These differences will be discussed in the following sections under each of the key factors for mentoring (i.e., personal attributes, system requirements, pedagogical knowledge, modelling, and feedback).
[Insert Table I here]

Personal Attributes.

When analysing the mentees' responses on their mentors' "Personal Attributes", a majority of mentors (64%) were supportive towards their mentees' primary science teaching, and 56% of mentors appeared comfortable in talking about science teaching. A little more than half the mentors (53%) attentively listened to their mentees and less than half instilled confidence (46%) and positive attitudes (45%) for teaching primary science. Aiding the mentee's reflection on teaching practices is considered a key element in the mentoring processes but 65% of mentors did not display this characteristic (Mean item score range [*M*]: 2.72 to 3.46; Standard Deviation [*SD*] range: 1.22 to 1.31; Table 2).

Mentees' perceptions of their mentoring in mathematics teaching were considerably higher than mentoring for science on each item associated with "Personal Attributes" (Table 2). Mentees also indicated that a majority of mentors facilitated mentoring practices for mathematics on all Personal Attributes, whereas three items (instilled confidence, instilled positive attitudes, and assisted in reflection) were less than 50% for mentoring in science education. Even though listening attentively to the mentee was only 14% higher for mathematics, 38% more mentors were perceived to assist the mentees to reflect on mathematics practices (*M* for mentoring mathematics: 3.67 to 4.35; *SD* range: 0.85 to 1.08; Table 2). Anecdotally, the mentor's personal attributes can affect the mentee's performance, that is, mentors who are supportive versus those who are unsupportive are more likely to elicit positive results. Attributes to instil positive attitudes and confidence for teaching, and to assist mentees to reflect on their teaching practices, require mentors to be attentive, supportive, and comfortable in talking about the subject area.
[Insert Table II here]

System Requirements.

Items displayed under the factor "System Requirements" presented a different picture from the previous factor. Both primary science mentoring practices and primary mathematics mentoring practices associated with System Requirements were all below 50% (Table 3). Nevertheless, mentoring in mathematics teaching was significantly higher than science. That is, 44% of mentors discussed the aims of mathematics teaching (only 23% for science), 29% outlined mathematics curriculum documents (18% for science), and 41% of mentors discussed mathematics policies with

their mentees (only 16% for science) (*M* range for science: 2.22 to 2.40, *SD* range: 1.07 to 1.11; *M* for mathematics: 2.71 to 3.15; *SD* range: 1.14 to 1.24; Table 3).
[Insert Table III here]

At this foundational level of learning about System Requirements, mentees perceived they received minimal mentoring experiences towards planning for their science and mathematics teaching experiences. This study does not take into account previous professional experiences and tertiary education, nevertheless, more than half these preservice teachers due to enter the profession may have no or little in-school understanding of mandatory requirements such as aims, curriculum, and policies. Generally, departmental directives linked to primary science and primary mathematics education reform may not be implemented at the professional experience level and, hence, reform for future teaching practices may be compromised. Education systems have curriculum requirements for each school subject. The curriculum, its aims, and the related school policies for implementing system requirements are fundamental to any educational system as they provide uniformity and direction for implementing education.

Pedagogical Knowledge.

In this study, a little more than a third of mentors (37%) provided necessary "Pedagogical Knowledge" for effective primary science teaching. In the planning stages before teaching science only 37% of mentors assisted in planning, with 44% discussing the timetabling of the mentee's teaching and 45% assisting with science teaching preparation (Table 3). In addition, 65% of mentors did not discuss the implementation and knowledge of science lessons, and a further 69% did not discuss questioning techniques towards more successful learning. The majority of mentors did not assist with classroom management (44%), teaching strategies (41%), assessment (31%) or problem solving strategies (25%) for effective science teaching practices, and mentees indicated that providing different viewpoints on teaching science was not a high priority with mentors (35%; *M* range: 2.60 to 2.91; *SD* range: 1.10 to 1.32; Table 4). This implies that the majority of final-year preservice teachers were not provided with adequate Pedagogical Knowledge in the school setting to develop successful primary science teaching practices.

The picture for mentoring in primary mathematics indicated higher positive responses from mentees on each of the items associated with Pedagogical Knowledge. Percentages were more than doubled for mentors discussing implementation and problem solving for developing mathematics teaching compared with science. Unlike science, the majority of mentees perceived their mentors to provide mentoring practices for enhancing their mathematics teaching (*M* for mentoring mathematics: 3.31 to 3.84; *SD* range: 1.04 to 1.24; Table 4). The mentor's pedagogical knowledge is required for guiding the mentee with planning, timetabling, preparation, implementation, classroom management strategies, teaching strategies, content knowledge, questioning skills, problem solving strategies, and assessment techniques. It is implied that the mentor would be able to assist the mentee to improve teaching practices because of a focus on these aspects. Expressing various viewpoints on teaching a particular subject may also assist the mentee to formulate a pedagogical philosophy of teaching.
[Insert Table IV here]

Modelling.

Modelling teaching provides mentees with visual and aural demonstration of how to teach, yet other than modelling a rapport with their students involved in science lessons (58%) less than half the mentors were perceived to have "Modelled" science teaching practices. Mentees indicated that 48% of mentors displayed enthusiasm for science teaching and only 44% modelled science teaching, which included having well-designed science lessons (Table 5). It may be that those who modelled science teaching may have modelled classroom management (43%), and most of these mentors may have modelled effective science teaching (42%) or demonstrated a hands-on lesson (40%). Yet, 60% of mentors were perceived not to model language used within current science syllabus documents, which is required to scaffold the mentee's learning about how to teach science (*M* range: 2.68 to 3.41; *SD* range: 1.22 to 1.41; Table 5).

Conversely, more than 70% of mentors were perceived to provide practices associated with Modelling mathematics teaching (*M* for mentoring mathematics: 3.81 to 4.30; *SD* range: 0.83 to 1.19; Table 5). As mathematics is considered a higher priority than science, particularly with state-wide testing, there would be more opportunities to model mathematics teaching in the weekly timetable. Nevertheless, as no practicum was under three weeks, there was ample opportunity for mentors to model at least one science lesson. Although modelling effective practice appears key to many successful mentoring programs (Barab & Hay, 2001), "non-expert" mentors of primary subjects may not be able to model or discuss effective teaching practices in these subject areas. An effective mentor models teaching practices, consistent with current system requirements. This requires mentors to have enthusiasm for their subject, and model for mentees effective teaching with well-designed, hands-on lessons that display classroom management strategies and exemplify a rapport with students. In addition, the mentor's discourse on modelling teaching practices needs to be consistent with current syllabus language.
[Insert Table V here]

Feedback.

It is argued that mentors need to review their mentees' lesson plans and provide feedback at these formative planning stages, which was practised in this study by a borderline majority of mentors involved with mentoring primary science teaching (54%). Mentors may not guide the mentees adequately enough for teaching science effectively as 67% of mentors did not articulate their expectations for science teaching. Even so, 74% of mentors observed their mentees' teaching of science with 62% providing oral feedback on the mentee's science teaching. Written feedback was considerably less (45%), as was the mentor's feedback on towards evaluating the mentee's science teaching (46%, *M* range: 2.75 to 3.72; *SD* range: 1.23 to 1.38; Table 6). Once more, the pattern for mentoring primary mathematics teaching was higher on each of the items associated with this factor (*M* for mentoring mathematics: 3.53 to 4.17; *SD* range: 0.96 to 1.36; Table 6). Double the percentage of mentors articulated expectations for teaching mathematics than for teaching science, yet there was only a marginal difference for reviewing mentees' mathematics lesson plans (Table 6). Mentors need to review their mentees' lesson plans and programs in order to make suggestions for improving practices before the commencement of a lesson. Observing the mentee's teaching provides content for the mentor to express oral and written feedback on the mentee's developing practices, which facilitates reflective practices (Desouza & Czerniak, 2003). A mentor who discusses with the mentee evaluation techniques may further assist the mentee to reflect upon practice for further enhancement of teaching and learning.
[Insert Table VI here]

Further discussions and conclusion

This study indicated that there appeared to be more mentoring in primary mathematics than primary science; however for a mentee to receive adequate mentoring in specific subject areas such as primary science teaching, allocating an expert "science teaching" mentor in the primary school will be extremely difficult, particularly as implementing primary science education remains largely inadequate (Goodrum et al., 2001). Expert primary science teachers who are skilled in mentoring would be best suited as mentors for preservice teachers of science, and this is the crux of the mentoring problem, that is, educating primary teachers to be sufficiently skilled for mentoring in all primary subjects. A major part of the mentor's role in primary education is to develop the mentee's overall teaching ability, yet each mentor has individual beliefs about what is and what is not important. These individual mentor views will vary on any aspect of teaching and mentoring, from the planning through to the choice of classroom procedures for implementing a teaching strategy. There were also a considerable number of mentees who perceived their mentors had not provided adequate guidance for teaching mathematics. The results from this study imply that many mentors require further education on establishing clear and obtainable objectives so that mentoring specific subjects such as science and mathematics become more purposeful.

Mentees claim the in-school context is pivotal to their development as teachers (Gaffey, Woodward, & Lowe, 1995; Jasman, 2002), yet the current state of mentoring in primary teaching without subject expertise implies that many preservice teachers will not receive equitable mentoring in either science or mathematics, and possibly other curriculum areas. Mentees should receive equitable mentoring in their designated teaching subject areas, which requires subject-specific mentoring skills. The inadequate mentoring highlighted in this study may be initially addressed through specific mentoring interventions that focus on each of the items associated with the survey instrument (Appendix 1). Additionally, tertiary institutions may employ the instrument to gauge the degree and quality of mentoring in specific subject areas and, as a result of diagnostic analysis, plan and implement mentoring programs that aim to address specific needs of mentors in order to enhance the mentoring process. This survey instrument may be used to identify and benchmark current mentoring practices (see Appendix 2 for scoring). The survey may also assist mentors with a way to measure their own mentoring practices for enhancing these practices. As the mentoring attributes and practices in this study were derived from the generic literature on mentoring, this survey instrument (Appendix 1) can be amended to reflect other curriculum areas, for example, by changing the word "science" to "music" or "English". The instrument may also be altered to gather information on strands within subject areas (e.g., substituting "science" with "reading" or "writing").

This study only focused on the mentees' perceptions of their mentors' practices. Even so, if the mentees perceived they had not received adequate mentoring in particular areas then either the mentors had not provided that practice or it was not explicit enough for the mentees to recognise it. There is no research in this study on the mentees' involvement in the mentoring process. Indeed, mentoring is a two-way dialogue and the other part of the picture needs to investigate mentees' practices and roles in quantitative and qualitative terms. Finally, and extending past this study, educating mentors may require expert mentors who are recognised for their expertise in both mentoring and teaching in order to have credibility within the teaching profession. Expert mentors may also need to: display personal attributes, articulate system requirements, model effective mentoring (which also requires modelling effective teaching practices), provide clear pedagogical knowledge, and articulate methods of feedback towards enhancing mentoring practices. Further research would be needed to determine if the five factors for mentoring in teaching may be the same factors applicable to mentor educators.

In conclusion, the mentor's involvement in facilitating the mentee's learning for more effective teaching cannot be indiscriminate or handled haphazardly; instead it must be predetermined and sequentially organised so the mentor's objectives are specific, clear, and obtainable. Thus knowledge of these five factors (personal attributes, system requirements, pedagogical knowledge, modelling, and feedback) and associated attributes and practices provide a stronger definition to mentoring, which may enhance the mentoring process. Mentors who are aware that personal attributes, system requirements, pedagogical knowledge, modelling, and feedback are paramount to effective mentoring programs may prompt them to incorporate such attributes and practices. Mentoring programs can focus on these factors as an approach for mentors to enhance their mentoring skills. Effective mentoring aims at facilitating mentees' real-life learning experiences with opportunities for developing teaching practices within school settings; educating mentors on subject-specific mentoring practices may augment this process.

References

Ackley, B. & Gall, M. (1992, April) *Skills, strategies and outcomes of successful mentor teachers,* Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Alexander, R. J. (1997) *Policy and practice in primary education* (London, Routledge).

Barab, S. A. & Hay, K. E. (2001) Doing science at the elbows of experts: Issues related to the science apprenticeship camp, *Journal of Research in Science Teaching,* 38(1), pp. 70-102.

Barnett, B. G. (1995) Developing reflection and expertise: Can mentors make the difference? *Journal of Educational Administration*, 33(5), pp. 45-59.

Barrett, R. (2002) Mentor supervision and development: Exploration of lived experience, *Career Development International,* 7(5), pp. 279-283.

Boss, S. (2001) Building a teacher's "repertoire" takes time, training, *Northwest Education,* 7(2), pp. 10-11.

Carlson, R. D., & Gooden, J. S. (1999, February) *Mentoring pre-service teachers for technology skills acquisition,* Paper presented at the Society for Information Technology & Teacher Education International Conference, San Antonio, TX.

Carter, M. & Francis, R. (2000, November) *Mentoring and beginning teachers' workplace learning,* Paper presented at the Australian Association of Research in Education (AARE) Conference, Sydney, Australia.

Christensen, L. (1991) *Empowerment of preservice teachers through effective mentoring: Course requirements* (Alabama, University of Alabama).

Coates, D., Vause, J., Jarvis, T. & McKeon, F. (1998) *Mentoring in primary science* (Leicester, SCI Centre, University of Leicester).

Crowther, D. T. & Cannon, J. R. (1998, January) *How much is enough? Preparing elementary science teachers through science practicum,* Paper presented at the Annual Meeting of the Association for the Education of Teachers of Science, Minneapolis, MN.

Desouza, J. M. S. & Czerniak, C. M. (2003) Study of science teachers' attitudes toward and beliefs about collaborative reflective practice, *Journal of Science Teacher Education,* 14(2), pp. 75-96.

Edwards, A. & Collison, J. (1996) *Mentoring and developing practice in primary schools: Supporting student teacher learning in schools* (Buckingham, Open University Press).

Gaffey, C. S., Woodward, H. & Lowe, K. (1995) Improving school experience: An Australian perspective, *Action in Teacher Education,* 17(2), pp. 7-17.

Ganser, T. (1996) What do mentors say about mentoring?, *Journal of Staff Development,* 17(3), pp. 36-39.

Garvey, B. & Alred, G. (2000) Educating mentors, *Mentoring and Tutoring,* 8(2), pp. 113-126.

Gaston, J. S. & Jackson, J. F. (1998) *Mentoring and its implications,* Idaho, US, ERIC Clearinghouse (ERIC Document Reproduction Service No. ED 426 990).

Giebelhaus, C. R. & Bowman, C. L. (2002) Teaching mentors: Is it worth the effort?, *Journal of Educational Research,* 95(4), pp. 246-254.

Goodrum, D., Hackling, M. & Rennie, L. (2001) *The status and quality of teaching and learning in Australian schools* (Canberra, Department of Education, Training and Youth Affairs).

Griffin, G. A. (1985) Teacher induction: Research issues, *Journal of Teacher Education,* 36(1), pp. 42-46.

Hair, J. F., Anderson, R. E., Tatham, R. L. & Black, W. C. (1995) *Multivariate data analysis with readings* (4th Ed.) (New York, Prentice-Hall).

Healy, L., Ehrich, L. C., Hansford, B. & Stewart, D. (2001) Conversations: A means of learning, growth and change, *Journal of Educational Administration,* 39(4), pp. 332-345.

Hodson, D. & Hodson, J. (1998) Science education as enculturation: Some implications for practice, *School Science Review,* 80(290), pp. 17-24.

Hudson, P. & Skamp, K. (2003). Mentoring preservice teachers of primary science, *The Electronic Journal of Science Education,* 7(1). Available online at: http://unr.edu/homepage/jcannon/ejse/ejse.html (accessed 2 August, 2006).

Hudson, P. (2003) Mentoring first-year preservice teachers, *Action in Teacher Education*: *The Journal of the Association of Teacher Educators,* 15(3), pp. 91-99.

Hudson, P. (2004) Specific mentoring: A theory and model for developing primary science teaching practices, *European Journal of Teacher Education,* 27(2), pp. 139-146.

Hudson, P., Skamp, K. & Brooks, L. (2005) Development of an instrument: Mentoring for effective primary science teaching, *Science Education,* 89(4), pp. 657-674.

Hulshof, H. & Verloop, N. (1994) The collaborating teacher as co-educator in teacher education, *Australian Journal of Teacher Education,* 19(2), pp. 25-29.

Jarvis, T., McKeon, F., Coates, D. & Vause J. (2001) Beyond generic mentoring: Helping trainee teachers to teach primary science, *Research in Science and Technological Education,* 19(1), pp. 5-23.

Jasman, A. (2002, October) *Initial teacher education: Changing curriculum, pedagogies and assessment,* Paper presented at Challenging Futures Conference, University of New England, Armidale, Australia.

Joint Council of Queensland Teacher Associations. (2006) JCQTA, Available online at: http://www.jcqta.qld.edu.au (accessed 2 August, 2006).

Monk, M. & Dillon, J. (Eds). (1995) *Learning to teach science: Activities for student teachers and mentors,* (London, Falmer Press, Taylor & Francis, Inc).

Mulholland, J. A. (1999) *Beginning teachers and primary science: Learning and teaching science in the preservice to inservice transition,* Unpublished PhD thesis, Perth, Curtin University.

NSW Department of Education and Training. (2003) *Mentoring the mentors,* Available online at: http://www.det.nsw.edu.au/newsroom/yr2003/mar/mentor.htm (accessed 2 August, 2006).

Power, A., Clarke, M. & Hine, A. (2002, February) *The internship: A journey of professional learning through reflection*, Paper presented at Challenging Futures Conference, University of New England, Armidale, Australia.

Rippon, J. & Martin, M. (2003) Supporting induction: Relationships count, *Mentoring and Tutoring,* 11(2), pp. 211-226.

Sinclair, C. (1997). Redefining the role of the university lecturer in school-based teacher education, *Asia-Pacific Journal of Teacher Education,* 25(3), pp. 309-324.

The National Science Standard Committee/ Australian Science Teachers' Association (ASTA). (2002) *National professional standards for highly accomplished teachers of science,* (Canberra, ASTA).

Van Ast, J. (2002) *Community college mentoring program mentor-mentee handbook,* (Ames, IO, College of Education, Iowa State University of Science and Technology).

Veenman, S., De Laat, H. & Staring, C. (1998, September) *Coaching beginning teachers,* Paper presented at the European Conference on Educational Research, Ljubljana, Slovenia.

Zachary, L. J. (2002) The role of teacher as mentor, *New Directions for Adult and Continuing Education,* 93, pp. 27-38.

Zanting, A., Verloop, N. & Vermunt, J. D. (2003) How do student teachers elicit their mentor teachers' practical knowledge?, *Teachers and Teaching: Theory and Practice,* 9(3), pp. 197-211.

Appendix 1

Mentoring for Effective Primary Science Teaching (MEPST)

The following statements are concerned with your mentoring experiences in primary science teaching during your last practicum/internship. Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate scale to the right of each statement.

Key

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

During my final professional school experience (i.e., internship/practicum) in primary science teaching my <u>mentor</u>:

1. was supportive of me for teaching science. …………………………	SD	D	U	A	SA
2. used science language from the current primary science syllabus.	SD	D	U	A	SA
3. guided me with science lesson preparation. …………..……………	SD	D	U	A	SA
4. discussed with me the school policies used for science teaching. ..	SD	D	U	A	SA
5. modelled science teaching. ………………………………………	SD	D	U	A	SA
6. assisted me with classroom management strategies for science teaching.	SD	D	U	A	SA
7. had a good rapport with the primary students doing science. ……..	SD	D	U	A	SA
8. assisted me towards implementing science teaching strategies. ….	SD	D	U	A	SA
9. displayed enthusiasm when teaching science. ……………………..….	SD	D	U	A	SA
10. assisted me with timetabling my science lessons. …………………	SD	D	U	A	SA
11. outlined state science curriculum documents to me. ………………	SD	D	U	A	SA
12. modelled effective classroom management when teaching science.	SD	D	U	A	SA
13. discussed evaluation of my science teaching. ………………………	SD	D	U	A	SA
14. developed my strategies for teaching science. …………………….	SD	D	U	A	SA
15. was effective in teaching science. …………………………………	SD	D	U	A	SA
16. provided oral feedback on my science teaching. …………………	SD	D	U	A	SA
17. seemed comfortable in talking with me about science teaching. ….	SD	D	U	A	SA
18. discussed with me questioning skills for effective science teaching.	SD	D	U	A	SA
19. used hands-on materials for teaching science. …………………….	SD	D	U	A	SA
20. provided me with written feedback on my science teaching. ……..	SD	D	U	A	SA
21. discussed with me the knowledge I needed for teaching science.	SD	D	U	A	SA
22. instilled positive attitudes in me towards teaching science. ……….	SD	D	U	A	SA
23. assisted me to reflect on improving my science teaching practices.	SD	D	U	A	SA
24. gave me clear guidance for planning to teach science. ……………	SD	D	U	A	SA
25. discussed with me the aims of science teaching. …………………..	SD	D	U	A	SA
26. made me feel more confident as a science teacher. ……………….	SD	D	U	A	SA
27. provided strategies for me to solve my science teaching problems.	SD	D	U	A	SA
28. reviewed my science lesson plans before teaching science. …….	SD	D	U	A	SA
29. had well-designed science activities for the students. …………….	SD	D	U	A	SA
30. gave me new viewpoints on teaching primary science. …………...	SD	D	U	A	SA
31. listened to me attentively on science teaching matters. …………...	SD	D	U	A	SA
32. showed me how to assess the students’ learning of science. …...	SD	D	U	A	SA
33 clearly articulated what I needed to do to improve my science teaching.	SD	D	U	A	SA
34. observed me teach science before providing feedback. …………..	SD	D	U	A	SA

NB: The instrument “Mentoring for Effective Mathematics Teaching” (MEMT) replaced the word “science” with “mathematics”.

Appendix 2

Factor	**Survey item**	**Score**[a]
Personal Attributes:	1, 17, 22, 23, 26, 31	(30)
System Requirements:	4, 11, 25	(15)
Pedagogical Knowledge:	3, 6, 8, 10, 14, 18, 21, 24, 27, 30, 32	(55)
Modelling:	2, 5, 7, 9, 12, 15, 19, 29	(40)
Feedback:	13, 16, 20, 28, 33, 34	(30)

[a]Scoring: SD=1; D=2; U=3; A=4; SA=5

Figure 1. Five-factor model for mentoring.

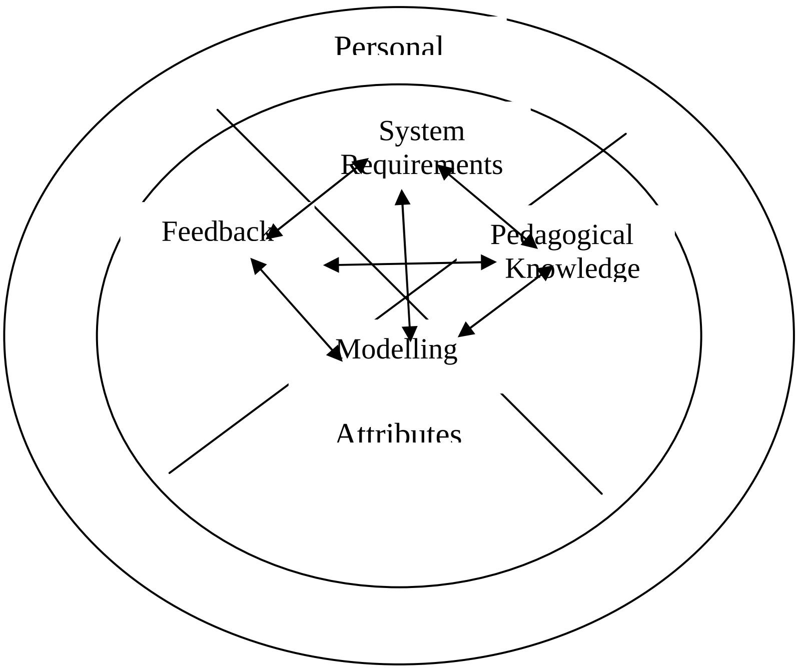

Table I. Confirmatory factor analysis for each of the five factors

Factor	Science (*n*=331)			Mathematics (*n*=115)		
	M	*SD*	Cronbach alpha	*M*	*SD*	Cronbach alpha
Personal Attributes	3.14	1.08	.93	3.97	0.81	.91
System Requirements	2.29	0.93	.76	2.98	0.96	.74
Pedagogical Knowledge	2.76	1.01	.94	3.61	0.89	.94
Modelling	3.09	1.07	.95	4.03	0.73	.89
Feedback	3.14	1.11	.92	3.80	0.86	.86

NB: Only one component extracted with an eigenvalue >1 for each factor.

Table II. "Personal Attributes" for mentoring primary teaching

Mentoring Practices/Attributes	Science (*n*=331)			Mathematics (*n*=115)		
	%[a]	*M*	*SD*	%[a]	*M*	*SD*
Supportive	64	3.46	1.31	89	4.35	0.85
Comfortable in talking	56	3.30	1.22	86	4.25	0.88
Attentive	53	3.19	1.31	67	3.67	1.07
Instilled confidence	46	3.10	1.28	64	3.75	1.08
Instilled positive attitudes	45	3.07	1.23	69	3.92	0.88
Assisted in reflecting	35	2.72	1.25	73	3.87	1.01

a %=Percentage of mentees who either "agreed" or "strongly agreed" their mentor provided that specific mentoring practice/attribute.

Table III. "System Requirements" for mentoring primary teaching

Mentoring Practices	Science (*n*=331)			Mathematics (*n*=115)		
	%[a]	*M*	*SD*	%[a]	*M*	*SD*
Discussed aims	23	2.40	1.11	44	3.15	1.14
Outlined curriculum	18	2.27	1.11	29	2.71	1.24
Discussed policies	16	2.22	1.07	41	3.06	1.18

a %=Percentage of mentees who either "agreed" or "strongly agreed" their mentor provided that specific mentoring practice.

Table IV. “Pedagogical Knowledge” for mentoring primary teaching

Mentoring Practices	Science (*n*=331)			Mathematics (*n*=115)		
	%[a]	*M*	*SD*	%[a]	*M*	*SD*
Guided preparation	45	2.87	1.27	71	3.69	1.14
Assisted with timetabling	44	2.91	1.27	67	3.74	1.16
Assisted with classroom management	44	2.85	1.32	73	3.77	1.08
Assisted with teaching strategies	41	2.86	1.23	68	3.73	1.16
Assisted in planning	37	2.72	1.23	64	3.61	1.04
Discussed implementation	35	2.70	1.19	77	3.84	1.08
Discussed content knowledge	35	2.73	1.19	52	3.31	1.24
Provided viewpoints	35	2.81	1.23	61	3.51	1.17
Discussed questioning techniques	31	2.67	1.21	57	3.45	1.11
Discussed assessment	31	2.64	1.22	52	3.50	1.19
Discussed problem solving	25	2.60	1.10	57	3.51	1.08

[a] %=Percentage of mentees who either “agreed” or “strongly agreed” their mentor provided that specific mentoring practice.

Table V. "Modelling" primary teaching

Mentoring Practices	Science (*n*=331)			Mathematics (*n*=115)		
	%[a]	*M*	*SD*	%[a]	*M*	*SD*
Modelled rapport with students	58	3.36	1.24	85	4.30	0.83
Displayed enthusiasm	48	3.08	1.23	78	4.02	1.00
Modelled a well-designed lesson	44	3.09	1.26	73	3.81	0.99
Modelled teaching	44	2.68	1.25	79	4.14	0.90
Modelled classroom management	43	2.96	1.30	82	4.11	0.97
Modelled effective teaching	42	3.11	1.22	71	3.83	1.19
Demonstrated hands-on	41	3.01	1.26	81	4.03	1.04
Used syllabus language	40	3.04	1.22	78	3.97	0.89

[a] %=Percentage of mentees who either "agreed" or "strongly agreed" their mentor provided that specific mentoring practice.

Table VI. Providing "Feedback" on primary teaching

Mentoring Practices	Science (*n*=331)			Mathematics (*n*=115)		
	%	*M*	*SD*	%	*M*	*SD*
Observed teaching for feedback	74	3.72	1.37	82	4.10	0.98
Provided oral feedback	62	3.32	1.28	85	4.17	0.96
Reviewed lesson plans	54	3.13	1.32	55	3.30	1.24
Provided evaluation on teaching	46	2.96	1.29	84	4.05	1.02
Provided written feedback	45	2.95	1.38	58	3.53	1.36
Articulated expectations	33	2.75	1.23	66	3.67	1.13

[a] %=Percentage of mentees who either "agreed" or "strongly agreed" their mentor provided that specific mentoring practice