Benchmarking Preservice Teachers' Perceptions of their Mentoring for Developing Mathematics Teaching Practices

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A literature-based instrument gathered 147 final-year preservice teachers' perceptions of their mentors' practices related to primary mathematics teaching based on five factors for mentoring (i.e., personal attributes, system requirements, pedagogical knowledge, modelling, and feedback). Results indicated acceptable Cronbach alpha scores for each factor: 0.91, 0.77, 0.95, 0.90, and 0.86, respectively. Furthermore, less than 45% of mentors were perceived to provide specific practices associated with mentoring system requirements. This paper discusses possibilities for using the survey instrument including benchmarking mentees' perceptions of their mentoring for developing their mathematics teaching and as a reference point for delivering professional development for mentors.

University-community engagement is a high national priority. Although university-community collaboration has not been a traditional strength of higher education (Holland, 2004, p. 11), there appear to be considerable benefits through university-community engagement. Institutions have found university-community engagement has strengthened and expanded the scholarship and teaching at the academic level (Brukardt, Holland, Percy, & Zimpher, 2004, p. 1), particularly as "Community-based research can be a bridge between the academy and the community" (Heffner, Zandee, & Schwander, 2003, p. 3). These effective partnerships align goals with adequate time to establish partnerships (Kriesky & Cote, 2003). Determining the progress of university-community engagement requires some form of measurement. Many educators have advocated benchmarking as a means for measuring successful practices and as a useful tool for balancing outcomes and processes (Garlick, 2003). Garlick argues that benchmarking must "…begin with an extensive consultation program" (2003, p. 5) and, certainly, university and community consultation needs to be part of the benchmarking process. There are various types of university-community engagement that have the potential for benchmarking practices.

Mentoring is prominent in education systems throughout the world (Hawkey, 1997; Power, Clarke, & Hine, 2002; Starr-Glass, 2005) and mentors (i.e., supervising teachers or cooperating teachers) in professional experience settings (i.e., practicum, field experiences, internships) are well positioned to assist preservice teachers in developing their practices (Crowther & Cannon, 1998). Mentors' responsibilities for developing preservice teachers' practices are increasing as mentoring continues to amplify its profile in education (Sinclair, 1997). Primary teachers in Australia generally work across all key learning areas (KLAs) and hence, in their roles as mentors, are expected to facilitate quality mentoring to preservice teachers across these KLAs. However, primary teachers will not be experts in all KLAs and research shows some areas receive considerably less attention than others (e.g., science (Goodrum, Hackling, & Rennie, 2001) and art (Eisner, 2001)). As the curriculum is so diverse for primary teachers, they may need assistance in their roles as mentors with particular mentoring practices focused on subject-specific areas (Hodge, 1997; Jarvis, McKeon, Coates, & Vause, 2001), which also appears to be the case for mentoring in mathematics education (Jarworski & Watson, 1994; Peterson & Williams, 1998).

Similar to teaching practices, professional development in mentoring practices may enhance the mentors' knowledge and skills. Also similar to teaching practices, mentors

operate in their own environment, where they may or may not receive further ideas for developing their practices. Yet, mentoring cannot be left to chance (Ganser, 1996) and needs to be purposeful in order to be more effective with explicit practices (Gaston & Jackson, 1998; Giebelhaus & Bowman, 2002; Jarworski & Watson, 1994; Jonson, 2002). Guidelines for subject-specific mentoring can aid the mentors' development by increasing confidence for raising issues, and providing topics for discussion and observation of specific teaching practices (e.g., see Jarvis et al., 2001). Although there are various models for mentoring (e.g., Colley, 2003; Jarworski & Watson, 1994; Jonson, 2002; Herman & Mandell, 2004), there is little literature on subject-specific mentoring in mathematics education for preservice teachers.

A five-factor model for mentoring has previously been identified, namely, Personal Attributes, System Requirements, Pedagogical Knowledge, Modelling, and Feedback (Hudson & Skamp, 2003), and items associated with each factor have also been identified and justified with the literature (see Hudson, Skamp, & Brooks, 2005). For example, statistical analysis of preservice teachers' responses (n=331) from nine Australian universities on the five-factor model indicated acceptable Cronbach alpha scores for internal reliability on each key factor, namely, Personal Attributes (mean scale score=2.86, SD=1.08), System Requirements (mean scale score=3.44, SD=0.93), Pedagogical Knowledge (mean scale score=3.24, SD=1.01), Modelling (mean scale score=2.91, SD=1.07), and Feedback (mean scale score=2.86, SD=1.11) were 0.93, 0.76, 0.94, 0.95, and 0.92, respectively. The five factors and the development of the Mentoring for Effective Primary Science Teaching (MEPST) instrument are well articulated in the literature (see Hudson et al., 2005) for which this study provides a direct link. To illustrate, providing feedback allows preservice teachers to reflect and improve teaching practices, and this includes practices in specific subject areas such as mathematics. Six attributes and practices, which may be associated with the factor Feedback for developing mentees' primary mathematics teaching, require a mentor to: (1) articulate expectations (Christensen, 1991; Ganser, 2002); (2) review lesson plans (3) observe practice (Jonson, 2002; Portner, 2002); (4) provide oral feedback; (5) provide written feedback (Ganser, 1995, 2002); and, (6) assist the mentee to evaluate teaching practices (Long, 2002; Schon, 1987).

This study explores and describes 147 Australian preservice teachers' perceptions of their mentors' practices in primary mathematics education within the abovementioned five factors linked to a literature-based instrument (Appendix 1). This study aims to determine the transferability of the science mentoring instrument (MEPST) to the development of an instrument based on mentoring preservice teachers in primary mathematics teaching. It also aims to benchmark preservice teachers' perceptions of mentoring practices for developing their primary mathematics teaching.

Data Collection Method and Analysis

The "Mentoring for Effective Mathematics Teaching" (MEMT) survey instrument in this study evolved through a series of preliminary investigations on Mentoring for Effective Primary Science Teaching (MEPST) (Hudson, 2003; Hudson & Skamp, 2003; Hudson, 2004a, b; Hudson et al., 2005), which also identified the link between the literature and the items on the survey instrument. A pilot study was conducted on 29 final-year preservice teachers by administering the MEMT survey instrument at the conclusion of their professional experiences (Hudson & Peard, 2005). Analysis of this pilot test indicated the possibility of a relationship between the MEPST instrument and the MEMT instrument; however further investigation was needed to verify results. For this study, 147 preservice teachers' perceptions of their mentoring were obtained from the five-part Likert scale (i.e., strongly disagree=1, disagree=2, uncertain=3, agree=4, strongly agree=5) MEMT instrument

(Appendix 1). The data provided descriptive statistics for each variable, which also provided an indication of the statistical relationship between variables and within each of the factors. Mean scale scores were derived through a statistical analysis package (SPSS) by analysing specific items associated with each factor. For example, there were six items associated with the factor Feedback, that is, the mentee (preservice teacher) perceived the mentor to: review the mentee's lesson plans before teaching mathematics; observe the mentee teach mathematics before providing feedback; provide oral feedback on the mentee's mathematics teaching; provide written feedback on the mentee's mathematics teaching; discuss evaluation of the mentee's mathematics teaching; and, articulate expectations for improving the mentee's mathematics teaching. Cronbach alpha scores were used as an indication of internal reliability with scores greater than .70 considered acceptable (Hair, Anderson, Tatham, & Black, 1995). The data examined preservice teachers' perceptions of their mentors' mentoring in primary mathematics teaching.

Results and Discussion

These preservice teacher responses (109 female; 38 male) 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 (i.e., practicum, field experience).

Backgrounds of Participants

Twenty-five percent of these mentees (n=147) entered teacher education straight from high school, with 93% completing mathematics units in their final two years of high school (i.e., Years 11 & 12). 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. There were no professional experiences under three weeks. Ninety percent of mentees taught at least four mathematics lessons during their last practicum with 81% indicating they had taught 6 or more lessons. Most of the classrooms for the mentoring in mathematics were in the city or city suburbs (69%) with 31% in regional cities and in rural towns or isolated areas. Mentees estimated that most mentors (male=22, female=125) were over 40 years of age (55%) with 28% between 30 to 39 years of age, and 16% under 30. Mentees also noted that 86% of mentors modelled one or more mathematics lessons during their mentees' professional experiences, with 59% modelling five or more lessons during that period. Finally, 41% of mentees perceived that mathematics was their mentors' strongest subject in the primary school setting.

Five Factors for Effective Mentoring in Mathematics

Each of the five factors had acceptable Cronbach alpha scores greater than 0.70 (Kline, 1998), that is, Personal Attributes (mean scale score=3.96, SD=0.81), System Requirements (mean scale score=3.31, SD=0.90), Pedagogical Knowledge (mean scale score=3.58, SD=0.94), Modelling (mean scale score=4.01, SD=0.78), and Feedback (mean scale score=3.76, SD=0.88) were 0.91, 0.77, 0.95, 0.90, and 0.86, respectively (Table 1). Data from items associated with each factor were entered in SPSS13 factor reduction, which extracted one component only for each factor. The associated eignevalues accounted for 59-69% of the variance on each of these scales (Table 1).

Table 1
Confirmatory Factor Analysis for Each of the Five Factors (n=147)

Factor	Eigenvalue*	Percentage of variance	Mean scale score	*SD*	Cronbach alpha
Personal Attributes	4.13	69	3.96	0.81	0.91
System Requirements	2.05	68	3.31	0.90	0.77
Pedagogical Knowledge	7.19	65	3.58	0.94	0.95
Modelling	4.70	59	4.01	0.78	0.90
Feedback	3.64	61	3.76	0.88	0.86

* Extracting only one component with an eigenvalue >1 is considered acceptable (see Hair et al., 1995).

The following provides further insight into specific data on mentees' perceptions of mentors' attributes and practices associated with each factor.

Personal Attributes.

When analysing the mentees' responses on their mentors' "Personal Attributes", a majority of mentors were supportive towards their mentees' primary mathematics teaching (89%) with mentors appearing comfortable in talking about mathematics teaching (86%, Table 2). However, more than a quarter of mentees believed that their mentors had not aided their reflection on mathematics teaching practices (i.e., 73% of mentees agreed or strongly agreed their mentor facilitated this practice), instilled positive attitudes for teaching mathematics (69%), listened attentively to their mentees about mathematics teaching (67%) or instilled confidence for teaching mathematics (64%). Table 2 provides mean item scores (range: 3.67 to 4.35; *SD* range: 0.85 to 1.08) and percentages on mentees' perceptions of their mentors' Personal Attributes.

Table 2
"Personal Attributes" for Mentoring Primary Mathematics Teaching (n=147)

Mentoring Practices	%*	*M*	*SD*
Supportive	89	4.35	0.85
Comfortable in talking	86	4.25	0.88
Assisted in reflecting	73	3.87	1.01
Instilled positive attitudes	69	3.92	0.88
Listened attentively	67	3.67	1.07
Instilled confidence	64	3.75	1.08

* %=Rank-order percentages of mentees who either "agreed" or "strongly agreed" their mentor provided that specific mentoring practice.

System Requirements

Items displayed under the factor "System Requirements" presented a different picture from the previous factor. The percentages of mentees' perceptions of their 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 (Table 3). Implementing departmental directives and primary mathematics education reform needs to also occur at the professional experience level, yet the data indicated (mean item scores range: 2.71 to 3.15; *SD* range: 1.14 to 1.24, Table 3) that many preservice teachers may not be provided these mentoring practices on System Requirements for developing their mathematics teaching within the school setting.

Table 3
"System Requirements" for Mentoring Primary Mathematics Teaching

Mentoring Practices	%*	*M*	*SD*
Discussed aims	44	3.15	1.14
Discussed policies	41	3.06	1.18
Outlined curriculum	29	2.71	1.24

%=Rank-order percentages of mentees who either "agreed" or "strongly agreed" their mentor provided that specific mentoring practice.

Pedagogical Knowledge

Mean item scores (3.31 to 3.84; *SD* range: 1.08 to 1.24, Table 4) indicated that the majority of mentees "agreed" or "strongly agreed" their mentor displayed "Pedagogical Knowledge" for primary mathematics teaching. However, in this study, more than 20% of mentors may not have mentored pedagogical knowledge practices (see Table 4 for rank-order percentages). For example, 64% of mentors were perceived to assist in the planning stages before teaching mathematics, 67% discussed timetabling the mentee's mathematics teaching, and 71% assisted with mathematics teaching preparation (Table 4). 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 was not considered a high priority (61%, Table 4). This implies that many final-year preservice teachers may not be provided with adequate pedagogical knowledge in the primary school setting to develop successful mathematics teaching practices.

Table 4
"Pedagogical Knowledge" for Mentoring Primary Mathematics Teaching

Mentoring Practices	%	*M*	*SD*
Discussed implementation	77	3.84	1.08
Assisted with classroom management	73	3.77	1.08
Guided preparation	71	3.69	1.14
Assisted with teaching strategies	68	3.73	1.16
Assisted with timetabling	67	3.74	1.16
Assisted in planning	64	3.61	1.04
Provided viewpoints	61	3.51	1.17
Discussed problem solving	57	3.51	1.08
Discussed questioning techniques	57	3.45	1.11
Discussed content knowledge	52	3.31	1.24
Discussed assessment	52	3.50	1.19

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

Modelling

Modelling mathematics teaching provides mentees with visual and aural demonstrations of how to teach and, indeed, mean item scores (3.81 to 4.30; *SD* range: 0.83 to 1.19, Table 5) indicated that the majority of mentors were perceived to model mathematics teaching practices. Even though more than 75% mentees believed their mentors modelled practices for teaching mathematics including modelling a rapport with their primary 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 of mentees indicated their mentors had not modelled a well-designed lesson or effective mathematics teaching (see Table 5 for rank-order percentages).

Table 5
"Modelling" Primary Mathematics Teaching

Mentoring Practices	%	*M*	*SD*
Modelled rapport with students	85	4.30	0.83
Modelled classroom management	82	4.11	0.97
Demonstrated hands-on	81	4.03	1.04
Modelled mathematics teaching	79	4.14	0.90
Displayed enthusiasm	78	4.02	1.00
Used syllabus language	78	3.97	0.89
Modelled a well-designed lesson	73	3.81	0.99
Modelled effective mathematics teaching	71	3.83	1.19

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

Feedback

Mean item scores (3.31 to 4.18; *SD* range: 0.97 to 1.38, Table 6) 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 63% articulating their expectations for the mentees' teaching of mathematics. More surprising is that 4% of mentors provided oral feedback without observation. Fifty-nine 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 (Table 6).

Table 6
Providing "Feedback" on Primary Mathematics Teaching

Mentoring Practices	%	*M*	*SD*
Provided oral feedback	86	4.18	0.97
Observed teaching for feedback	82	4.08	1.00
Discussed evaluation on teaching	81	3.97	1.08
Articulated expectations	63	3.55	1.16
Provided written feedback	59	3.48	1.38
Reviewed lesson plans	55	3.31	1.25

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

Further Discussion and Conclusions

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 (Table 1). Even though the Likert scale differentiated the degree of mentoring (e.g., strongly disagree to strongly agree), the quality of these mentoring practices requires further investigation. Also, the mentoring indicated in this study only focused on the mentors' practices and attributes and not on mentees' involvement in the mentoring processes. Nevertheless, 93% of these preservice teachers had completed at least three professional experiences (practicums) and nearly four years of a tertiary education degree in teaching before responding to this survey on their final-year Mentoring for Effective Mathematics Teaching (MEMT, Appendix 1). Mentees' perceptions of mentors not providing the above practices may be interpreted in two ways: the mentor did not provide the particular mentoring practice or the mentoring practice was not apparent enough for the mentee to perceive it. Either way, mentors need to provide such practices that are clearly evident to their mentees. Anecdotal evidence suggests mentors vary their mentoring practices considerably, and as there are national standards for teaching and assessing mathematics (e.g., NCTM, 1991, 1992,

1995), a set of standards for mentoring practices for mathematics appears a logical sequence. The MEMT instrument provided a way to collect data for benchmarking mentees' perceptions of their mentors' practices in primary mathematics teaching occurring in various Queensland schools. Such benchmarks can aid toward developing mentoring programs that enhance mathematics teaching practices.

The inadequate mentoring outlined in this study may be initially addressed through specific mentoring interventions that focus on effective mentoring (i.e., attributes and practices associated with the five factors: Personal Attributes, System Requirements, Pedagogical Knowledge, Modelling, and Feedback). As each item associated with the MEMT instrument is linked to the literature, a mentoring intervention for developing mentees' mathematics teaching can be based around these items. Benchmarking mentees' perceptions can provide starting points for designing well-constructed mentoring programs that provide professional development for mentors to enhance not only their own mentoring practices but possibly their mathematics teaching practices. Further benchmarking may occur using the MEMT instrument with mentoring early-career mathematics teachers. For example, a mentoring intervention based on early-career teachers' perceptions of their mentoring may aid induction processes, particularly in the form of programs for mentors to provide adequate mentoring support for mathematics teaching. Additionally, the MEMT instrument may be used by tertiary institutions or departments of education to benchmark the degree of mentoring in primary mathematics and, as a result of diagnostic analysis, plan and implement mentoring programs that aim to address perceived issues.

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Appendix 1

Mentoring for Effective Mathematics Teaching (MEMT)

The following statements are concerned with your mentoring experiences in mathematics teaching during your last professional experience (practicum/internship). Please indicate the degree to which you agree or disagree with each statement below by circling only one response 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., field experience, internship, practicum) in mathematics teaching my <u>mentor</u>:

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