How Primary Pre-service Teachers Perceive Mathematics Teacher Educators' Practice: A Case Study

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Teacher educators play a part in trying to shape the nature of classroom mathematics teaching by their work with pre-service student teachers There is usually an established curriculum that is underpinned by some particular philosophical or political agenda Is, however, the intended curriculum what is perceived by the students to be occurring in their academic mathematics teacher education learning environments Here the perceptions of primary student teachers of their mathematics education lecturers' practice are considered using constructivism as a referent

That teachers will teach as they were taught is increasingly acknowledged in research literature (eg Cooney & Wiegel, 2003; Tirosh & Craeber, 2003; Zaslavsky, Chapman & Leikin, 2003) While teacher educators will have strong ideas about their practice and what they hope it conveys to pre-service student teachers, how it is perceived may be quite different In light of this, teacher educator practice from the perspective of student teachers is an issue worth examining to determine what they 'learn' from their teacher education experience, as opposed to the formal curriculum, and thus how they might teach

In the last few decades, consideration of constructivist theory has had a significant impact on theoretical debate and over time constructivism has developed to incorporate a number of viewpoints including cognitive, socio-cultural and critical (transformative) factors (Ernest, 1995) As a result constructivism has become the learning theory of choice among many mathematics teacher educators Despite this apparent widespread adoption, constructivist aligned pedagogy has had a lesser effect on the system-wide pedagogical practices of classroom teachers (Airasian & Walsh, 1997; Aldridge & Bobbis, 2001; Clements, 2003) These developments suggest that constructivism may be an appropriate and productive theory of learning to use as a referent for examining mathematics educators' practice

The significance and power of constructivism as a referent is stressed by Tobin and Tippens (1993) It is also inherent in the work of Taylor (1996) where the limitations of using a cognitive based "learning as conceptual change" model as a referent are discussed and compared to the advantages of using a critical constructivist model as a referent in shifting from a *weak* to a *strong* view of constructivism with a consequent greater probability of change being generated / promoted The first model largely ignores the effects of social aspects and cultural contexts In ignoring these effects, this model minimises any possibility of reform other than in a narrow range of pedagogical techniques and approaches The second model acts as a referent for cultural reform, providing a framework for exposing and deconstructing repressive cultural myths that disempower the individual by distorting social roles and discourse It provides a rationale for empowering teachers and learners as negotiators of curriculum and allows for transformative aspects of education, as opposed to replicative ones, to develop

As a referent, constructivism provides a backdrop for critical reflection of any teaching / learning situation to determine the degree of congruence between practice and constructivist approaches It can ensure identification and examination of factors affecting

the degree of congruence and indicate how situations might be adjusted to enhance learning in keeping with constructivist approaches While the focus of the radical constructivist perspective is cognitive development, and the focus of the socio-cultural constructivist perspective is the social and cultural aspects of classrooms, the critical emancipatory constructivist perspective concentrates on transformative reform of educational theory and practice at a macro level (Taylor, 1996)

Consideration of the extensive learning environments research literature highlights two well established instruments based on constructivist perspectives (Fraser, 1998) which allow insights into student teachers' perceptions of lecturer practice One is the *Questionnaire on Teacher Interactions* (QTI) (Wubbels, Creton & Holvast, 1988) with eight categories which looks at the nature of interactions (interpersonal behaviour) between teacher and learners from a socio-cultural constructivist perspective The other is the *Constructivist Learning Environment Survey* (CLES) (Taylor, Fraser & Fisher, 1997) with five categories which focuses on the overall nature of the learning environment from a critical constructivist perspective These instruments can be used to establish how the student teachers perceived the nature of aspects of their classroom environments at a whole class and individual level respectively They are structured to do this by comparing an 'Ideal' response to a 'Reality' response on parallel items which are grouped into categories

The Study

The quantitative data considered here was drawn from a larger study on the nature of mathematics teacher educators' beliefs, how they were evidenced in their practice and what aspects impacted on student teachers' beliefs and potentially their practices The participants considered in this paper were pre-service student teachers in the three compulsory primary mathematics education classes taught by four lecturers at a New Zealand teacher education provider of long standing The samples of student teachers surveyed were generally representative of a typical primary student teacher cohort

The prevalent teaching approach was in tune with the mathematics education lecturers' espoused constructivist beliefs and their perception of the requirements of the New Zealand mathematics curriculum and its constructivist underpinnings This approach consisted of teaching primarily through lecturer modelling and workshop techniques emphasising cooperative and group work Thus, teaching took place in small classroom environments (20-25 students) that were conducive to such approaches The nature of the overall teacher education programme in which this occurred was (in theory) predicated on promoting constructivist approaches and constructivist-aligned teaching approaches and the promotion of a reform or transformative approach to education (Auckland College of Education, 1995) Thus, the programme, and the mathematics education lecturers, sought to empower student teachers to negotiate against traditional models of pedagogy in schools

Two quantitative instruments based on constructivist perspectives were used to collect data from student teachers about how they perceived the classroom learning environment (CLES) and lecturer / student teacher interactions (QTI) These data reflected views underpinned by the theoretical constructs of the instruments but not necessarily by those of the respondents The two instruments were modified to better reflect the environment of a teacher education institution that differs in many respects from schools This occurred in two ways, firstly with changes in terminology to reflect the changed nature of the subject – now learning to teach mathematics rather than learning mathematics – and the change in the nature of the learning institution – tertiary rather than primary or secondary These type of change were made in the CLES, while the QTI, which focuses on general teacher /

student classroom interactions, was subject free and did not require modification in this way Secondly, minor adjustments to wording were made on the basis of trialling the instruments with student teachers and staff

A longitudinal approach was taken with surveys being conducted over a three year period which is the length of time a particular cohort of students would normally take to complete their primary teacher education degree Each semester the student teachers in a selection of classes taught by any one of the four lecturers involved were surveyed using both instruments The surveys were conducted in the later part of each semester long course about a week apart Thus the students involved were a subset of any year group in each semester and their involvement was determined by their attendance, the vagaries of lecturers' timetables and the practicalities of timing and carrying out any data collection

Following a general examination of the data they were analysed statistically In considering the alignment of the responses with constructivist perspectives a framework of five sub ranges was established for both instruments – for the QTI (and CLES respectively); 0 to 5 (0 to 4) indicates a weak alignment; 5 to 10 (4 to 8) a weak to moderate alignment; 10 to 15 (8 to 12) a moderate alignment; 15 to 20 (12 to 16) a moderate to strong alignment, and 20 to 24 (16 to 20) a strong alignment Statistical significance was taken at the 1% ($p < 0\ 01$) rather than a 5% level to compensate for the non-random sampling procedure used and the potential for the Ideal and Reality instrument category responses failing to be independent of each other As category data had either normal or exponential distributions parametric and non-parametric analysis was carried out as appropriate for each category

Results

The frequency data for the QTI categories presented two distinct patterns: a normal type distribution for both the Idea and Reality responses for *Student Responsibility* and *Strict*; an exponential type distribution for both the Idea and Reality responses for *Leadership*, *Understanding*, *Admonishing*, *Helping*, and *Dissatisfied*, plus a change in distribution for *Uncertain* from a normal type for the Ideal to a more exponential type distribution for the Reality The mean and standard deviations for the categories (see Table 1) reflect these divisions with the two normal distributions deviating most from a strongly constructivist alignment and having the largest standard deviations, while *Uncertain* has the next largest standard deviations

Table 1
The Means and Standard Deviations for the QTI Ideal and Reality Category Data (N=266)

	Leadership	Understanding	Uncertain	Admonishing	Helping	Student Responsibility	Dissatisfied	Strict
Mean Ideal	21 71	22 27	19 83	22 56	22 46	12 71	22 62	16 90
Mean Reality	20 89	21 61	22 05	23 21	22 38	11 65	23 55	17 98
SD Ideal	2 04	1 95	3 38	2 45	2 07	3 67	2 78	3 60
SD Reality	2 61	2 76	3 18	2 59	2 66	3 73	2 31	3 42

The five exponential categories had smaller standard deviations and were aligned with a strongly constructivist stance (see Figure 1) The *Student Responsibility* category with the largest standard deviations was also the least aligned with constructivism being only moderately so and the *Strict* category with the next largest was moderately to strongly

aligned Overall, six of the eight categories indicated a strong socio-cultural constructivist alignment

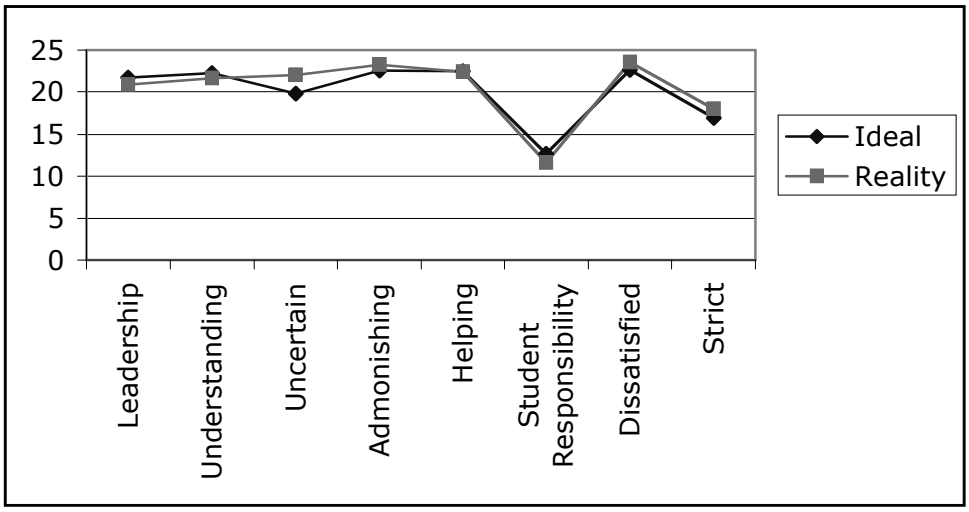

Figure 1 Graph of means for the QTI Ideal and Reality category data

For the within category QTI comparison (Ideal to Reality) a paired samples t-test was carried out for the normal categories and a Wilcoxon Signed test for the exponential (and *Uncertain*) categories There was a statistically significant shift away from a constructivist alignment in the *Leadership* and *Understanding* categories between the Ideal and Reality mean responses with Z(265) = 4 813, p<0 0005 and 3 395, p<0 005 respectively There was also, however, a statistically significant shift toward a constructivist alignment in the *Uncertain, Admonishing* and *Dissatisfied* categories between the Ideal and Reality mean responses with Z(265) = -8 926, -4 661 and -5 597 respectively (p<0 0005), and in the *Strict* category, with t(265) = -23 572, p<0 0005 Although these were statistically significant differences, the changes in means were very small and there was little educational difference with all category means remaining in the same sub range except *Uncertain* which had the largest change in means and became more closely aligned shifting into the strongly aligned sub range (see Figure 1)

Just as for the QTI the CLES data for its five categories fell into two apparent patterns: a normal type distribution for both the Ideal and Reality responses for *Personal Relevance*, *Uncertainty* and *Shared Control*, and an exponential type distribution for both the Ideal and Reality responses for *Critical Voice* and *Student Negotiation* The mean values for the categories (see Table 2) reflected the division of the categories into normal and exponential type distributions with the exponential categories (as for the QTI) being more closely aligned with constructivism *Student Negotiation* strongly so, but only just, and *Critical Voice* moderately to strongly so (see Figure 2)

Similarly, the categories with normal distributions deviated most from a strong constructivist alignment The standard deviations for the CLES categories are all greater than 3 67 (see Table 2) and larger than those for the QTI categories which are generally less than 3 67 with only one over at 3 73 (see Table 1) This indicates a greater degree of variability / spread in student teacher responses to all categories of the CLES instrument

Table 2
The Means and Standard Deviations for CLES Ideal and Reality Category Data (N=297)

	Personal Relevance	Uncertainty	Critical Voice	Shared Control	Student Negotiation
Mean Ideal	13 94	11 77	15 39	11 65	16 19
Mean Reality	12 27	9 68	15 48	6 63	16 05
SD Ideal	3 77	3 91	4 54	4 05	4 02
SD Reality	4 02	3 88	4 41	4 29	3 67

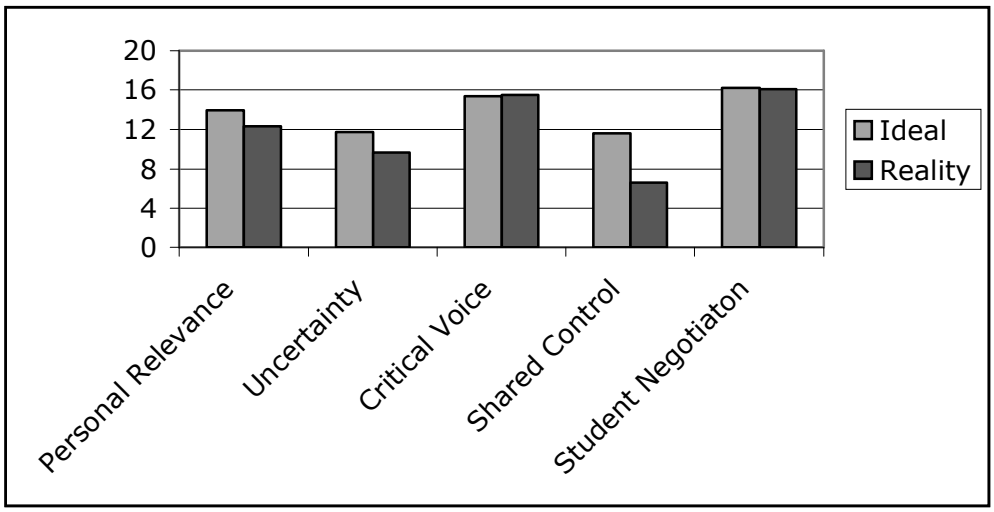

Figure 2 Graph of means for the CLES Ideal and Reality category data

For the CLES within category comparisons (Ideal to Reality), appropriate tests were conducted as for the QTI There was a statistically significant shift away from a constructivist alignment in the *Personal Relevance*, *Uncertainty* and *Shared Control* categories between the Ideal and Reality responses with t(296) = 6 181, 8 171 and 15 343 respectively (p<0 01) with *Shared Control* being the only category in which the mean shifted into another sub range – from moderate to weak to moderate These indicate a shift to a less constructivist view of the perceived reality overall but the differences in means were relatively small except for *Shared Control*

Discussion

The overall situation for the QTI is clearly strongly aligned with a socio-cultural perspective for six of the eight categories and in that the Ideal and Reality mean values are very close for all categories This indicates that the lecturers' practice is largely congruent with student teacher expectations and has a strong alignment with a socio-cultural constructivist perspective

For the two categories where alignment with a socio-cultural perspective is less the initial trials had indicated that some items were ambiguous and open to interpretation and that this may have influenced responses In the *Strict* category items two of the six were seen as contradictory by both student teachers (and staff), where strictness and high standards were discussed as positive aspects (rather than negative as intended by the instrument design), particularly by some mature students while others saw them as

negative The likely overall response was seen as being less aligned with constructivism due to this Similar issues were addressed with respect to *Student Responsibility* category which considers underlying constructivist ideas on the importance of the socio-cultural perspective in enhancing learning, by empowering learners to take greater personal responsibility for their learning Here three of the six items were seen ambivalently within a context of group work For some individuals, direction and control was perceived positively while for others the opposite was the case, leading to an expectation of the overall response being less aligned with constructivism However, despite these considerations the disparity in alignment with a socio-cultural perspective suggests that lecturer practice, particularly as it impacts in these two areas, also needs careful examination to find ways to enhance the alignment further

The overall situation is not as clear for the CLES responses with the Reality means being significantly less congruent than the Ideal in three of the five categories and being less aligned with a constructivist perspective than the QTI This difference in overall alignment between the instruments could reflect a standard feature of learning environment research, which sees less aligned responses for individual focused questions – the CLES – as opposed to class orientated ones – the QTI (Fraser, 1998) This is, however, confounded to some extent by the different constructivist perspectives of the instruments Indeed, the critical nature of the instrument in line with transformative / reform agenda is unlikely to be sit comfortably with many student teachers reflecting attitudes in the community at large

For the three categories where alignment with a critical perspective was less other factors may have had an influence The *Shared Control* category focuses on the degree to which students are invited to have input into shaping and controlling the learning environment including goals, activities and assessment criteria Here responses could be less aligned as the courses were compulsory parts of a credentialing programme whose content had been closely defined, thus limiting opportunities for student input in determining goals Similarly, the further constraints of assessment requirements and time available in semester long courses meant that there was possibly limited scope for lecturers to allow student teachers to have input, other then at a micro level and to a minor extent The *Uncertainty* category measures the degree to which mathematical knowledge is presented as evolving hypotheses, dependent on the human experience and thus culturally, socially and value laden Thus, primary student teacher mathematics experiences, their negative attitudes toward mathematics itself and their lack of confidence in mathematics may explain in part the lack of alignment with a critical constructivist perspective A similar lack of alignment for the *Personal Relevance* category, which focuses on the connectedness of the learning situation to the learner's external world and its use as a starting point for learning experiences, may be partly due to the tension between experiences in the academic world of college and in the practical reality of schools, where the relevance of proposed practice may well not have matched school realities (Wideen, Mayer-Smith & Moon, 1998)

Of note with the CLES responses is the shift to a less aligned view of the Reality of the teacher education experience indicating that lecturers' practice was not even congruent with the more limited Ideal expectations of the student teachers with regard to a critical constructivist perspective This raises questions as to the nature of lecturers' constructivist ideas and the degree to which they are aligned with a critical constructivist perspective as compared to a socio-cultural one

Concluding Remarks

The evidence on how the student teachers view their mathematics teacher education experience suggests a shift on a continuum from weak view of constructivism as a cognitive endeavour to a stronger socio-cultural view but falls short of a shift to a strong critical view In failing to achieve reaching this strong view the probability of generating reform in teaching is reduced (Taylor, 1996) It represents a lack of success in promoting critical (transformative) constructivist views among student teachers which might better empower them to negotiate against traditional models of pedagogy in schools

As the degree programme in the study is predicated on a transformative philosophy, the less effective promotion of a critical constructivist perspective within the mathematics education courses is of concern It would indicate that student teachers are not being taught as the programme, and presumably the mathematics education lecturers would want them to teach

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