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Pre-service Primary Teachers' Perceptions of Mathematics Education Lecturers' Practice: Identifying Issues for Curriculum Development

Gregor Lomas
The University of Auckland

Teacher educators' work with pre-service teachers plays a part in trying to shape the nature of classroom teaching. Their teaching usually follows an established curriculum and delivery that is underpinned by particular theoretical, philosophical or political agendas. In an institution where the teacher education programme is predicated on constructivism and a transformative agenda, a study was conducted on how primary student teacher perceived the 'lived' mathematics education curriculum. This paper reports on the student teachers' views of their mathematics education lecturers' practice as explored through their perceptions of the mathematics education classroom interactions and learning environments they experienced. The questionnaires used showed differences in the student teachers' views of socio-cultural and critical focussed aspects of the classroom environments, both within and between the two instruments. Some initial 'in-house' approaches to addressing issues identified, along with approaches from the literature that could enhance the transformative aspects of the mathematics education courses, are presented.

Teacher educators generally have strong ideas about their practice and what they intend it to convey to pre-service student teachers. How this practice is perceived and what student teachers understand and adopt from it, however, may be quite different (e.g., Aldridge & Bobis, 2001). In light of this, teacher educator practice is worth examining from the perspective of student teachers to determine how they perceive their teacher education experience as opposed to the 'intended' curriculum.

In teacher education (and education generally) constructivist learning theory has become the norm (e.g., Treagust, Duit & Fraser, 1996). It provides a useful theoretical framework for examination of, and reflection on, teaching/learning situations, and can be used to determine the degree of congruence between theory-aligned approaches and lecturers'/teachers' practice.

In the last few decades, constructivism has developed from a primarily individual and cognitive focus (radical constructivism) to incorporate a number of viewpoints including socio-cultural (e.g., Confrey & Kazak, 2006; Ernest, 1995) and critical (transformative) factors (Taylor, 1996, 1998). It is not surprising that consideration of constructivist learning theory has had a significant impact on debate in mathematics education, and, in one form or another, has become the learning theory of choice among many mathematics teacher educators (e.g., Confrey & Kazak, 2006; Taylor, 1998). Despite this apparent widespread adoption, constructivist-aligned pedagogy has had a lesser effect on the system-wide pedagogical practices of classroom teachers (e.g., Airasian & Walsh, 1997; Clements, 2003).

An early cognitive focussed model was the "learning as conceptual change"

model (Hewson, 1996; Posner, Stike, Hewson & Gertzog, 1982) that described learning in terms of individuals changing conceptions. This involved a change in the status of 'alternative' conceptions: the conception that developed the higher status being adopted and replacing an existing one. Congruent teaching approaches emphasise the eliciting and sharing of students' conceptions, and learning experiences that create cognitive conflict to promote change processes. The expectation was that exposure to alternative conceptions, in situations that value the teachers' preferred conceptions more highly, would automatically lead to the desired change. Cognitive models largely ignore the influence of social and cultural factors that impact within the classroom even in considering the discussion necessary to share and make explicit individuals' conceptions.

The incorporation of socio-cultural factors into constructivist learning theory sought to address this by moving from a view of mathematics learning simply as a "cognitive activity constrained by social and cultural processes" to also be "social and cultural phenomena" (Wood, Cobb & Yackel, 1995, p. 402). The focus, however, remained within the classroom with the exploration of new socio-cultural norms reflecting the change in roles and expectations required by constructivist-aligned teaching approaches (Confrey & Kazak, 2006). The critical model draws upon the work of Habermas (1972, 1987) focussing on making "explicit the interwoven epistemological and ethical strands of teachers' and students' communicative actions" (Taylor, 1996) and directly considers aspects outside the classroom. It provided a framework for exposing and deconstructing repressive cultural myths that disempowered the individual. Thus, the critical model 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 potentially develop (Taylor, 1996, 1998).

The usefulness of constructivism as a referent for examining practice by analysing "the learning potential of any situation", was stressed by Tobin and Tippens (1993, p. 8). This view is also inherent in the work of Taylor (1996). He argued, however, that the use of a cognitive-based "learning as conceptual change" model as a referent limits the possibility of reform to a narrow range of pedagogical approaches and techniques. Although the socio-cultural model has similar limitations, it does address additional factors, however, only the critical constructivist perspective focuses directly on the potential for transformative reform of educational theory and practice at a macro level. In examining practice for evidence of 'shifts' from a weak (cognitive) toward a strong (critical) view of constructivism, the use of a socio-cultural or critical constructivist model as a referent is an advantage.

The various forms of constructivism and the extent to which they promoted a transformative agenda informed this study which sought to identify: the nature of lecturer practice from the perspective of student teachers; how it aligned with some particular forms of constructivism; and hence the extent to which it might promote transformative practices among student teachers. A related aspect of the study was the identification of issues in specific areas of non-alignment. The intention was to explore possible ways to address the issues and then prioritise

the implementation of those focussed on critical perspectives. The aim of such curriculum development was the enhancement of the mathematics education courses to prepare student teachers better for transformative action.

The Study

The quantitative data considered here were drawn from a larger study on the nature of primary student teachers' beliefs, and their potential practices, and how these were related to the beliefs and classroom practices of their mathematics education lecturers. The participants were pre-service student teachers in three compulsory primary mathematics education courses (see Table 1) taught (1 in each year of their 3 year degree programme) by four lecturers, including the researcher, at a New Zealand teacher education institution.

Table 1
The three compulsory mathematics education courses

Year of Delivery	NZ curriculum content focus	Other focii
1	Year 0 to 3	– curriculum structure – children's knowledge of mathematics – positive mathematical experiences
2	Year 3 to 6	– problem solving – investigative approaches – children's learning of mathematics – session planning
3	Year 6 to 8	– number sense – constructive assessment – sequence planning

The nature of the overall teacher education programme was (in theory) predicated on the promotion of: constructivism as the most appropriate theory of learning; the use of constructivist-aligned teaching approaches, and a reform or transformative approach to education (Auckland College of Education, 1995). The teaching approaches within the degree programme reflect the requirements of the New Zealand mathematics curriculum and its constructivist underpinnings. Teaching was in small classroom environments (20-25 students) and comprised lecturer modelling and workshop techniques emphasising small group work, student collaboration and discussion opportunities, formative feedback and reflection, and assessment/reassessment of personal learning (Davis, Maher & Noddings, 1990).

Thus, the lecturers across all courses in the programme (including mathematics education) sought to empower student teachers with the purpose being to provide student teachers with the knowledge, skills, attitudes and resources to challenge existing classroom practices and to implement constructivist-aligned practices. That is, to enable student teachers to negotiate against more traditional models of pedagogy, primarily based on behaviourist transmission models, which remain prevalent in schools (Gallagher, 1996; Jaworski & Gellert, 2003).

Two well-established quantitative instruments, drawn from the extensive learning environments research literature (Fraser, 1998), were used to collect data from student teachers about how they perceived lecturer practice in terms of lecturer/student teacher interactions and classroom learning environment. The instruments were modified slightly to better reflect the environment of a teacher education institution, which differs in some respects from schools. For example, terminology was modified to reflect the change from teacher to lecturer and the changed nature of the subject: learning to *teach* mathematics rather than learning mathematics. Both instruments use parallel items to compare an 'Ideal' response, recording the optimum environment as perceived by the participant, to a 'Reality' response, recording the experienced environment as perceived by the participant. The instruments use Likert scales with five response levels (0 - strongly disagree, to 4 - strongly agree).

The *Questionnaire on Teacher Interactions* (QTI) (Wubbels, Creton & Holvast, 1988) focuses on the nature of interactions (interpersonal behaviour) between teacher and learners at a classroom level. It has eight categories (see Table 2), each with 6 items, indicating the extent to which teaching approaches congruent with social constructivist ideas are present in the learning environment.

Table 2
QTI behaviour categories, the category behaviours and sample items

Behaviour categories	**Category behaviours**	**Sample items**
Leadership	Notice what's happening, lead, organise, give orders, set task, determine procedures, structure the classroom situation, explain, hold attention	1. This lecturer talks enthusiastically about his/her subject.
Understanding	Listen with interest, empathise, show confidence & understanding, accept apologies, look for ways to settle disputes, be patient, be open to students	6. If we don't agree with this lecturer, we can talk about it.

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Behaviour categories	Category behaviours	Sample items
Uncertain	Keep a low profile, apologise, wait & see how the wind blows, admit one is in the wrong	19.This lecturer is not sure what to do when we fool around.
Admonishing	Get angry, take students to task, express irritation & anger, forbid, correct, punish	24. This lecturer is sarcastic.
Helping/friendly	Assist, show interest, join, behave in a friendly manner, be able to make a joke, inspire confidence & trust	25. This lecturer helps us with our work.
Student Responsibility/ Freedom	Give opportunity for independent work, wait for class to let off steam, give freedom & responsibility to class	42. This lecturer gives us a lot of free time in class.
Dissatisfied	Wait for silence, consider pros & cons, keep quiet, show dissatisfaction, look glum, question, criticise	39. This lecturer thinks that we can't do things well.
Strict	Keep reins tight, check, judge, gets class silent, maintain silence, be strict, exact norms and set rules	28. This lecturer is strict.

(Wubbels, Creton & Holvast, 1988)

For example, *Student Responsibility*, which measures the degree to which students are given opportunities to take responsibility for their own work, is aligned with 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.

The *Constructivist Learning Environment Survey* (CLES) (Taylor, Fraser & Fisher, 1997) has five distinct categories, each containing five items, which focus on the overall nature of the learning environment from a critical constructivist perspective (see Table 3). The CLES determines, at an individual level, the consistency of a classroom environment with one predicated on a critical constructivist perspective.

Table 3
CLES categories, the category focus and sample items

Category (and 'user friendly' form)	**Category focus**	**Sample items**
Personal Relevance (Learning about the world)	The connectedness of the learning situation to the learner's external world and its use as a starting point for learning experiences.	2. My new learning starts with problems about the school world outside college
Uncertainty (Learning about maths)	The degree to which subject matter is presented as evolving hypotheses, dependent on the human experience and thus culturally, socially and value laden.	7. I learn how maths is influenced by people's values and opinions
Critical Voice (Learning to speak out)	The social climate in terms of the extent and non-judgmental nature of interaction between teacher and student as students question the teacher's agenda and express concerns about barriers to their learning.	12. Its OK for me to question the way I'm being taught
Shared Control (Learning to learn)	The degree to which students are invited to have input into shaping and controlling the learning environment, including goals, activities and assessment criteria.	17. I help the lecturer to decide how well I am learning
Student Negotiation (Learning to communicate)	The extent to which student-student interactions about their developing understandings and their viability is seen as a legitimate and integral part of the learning environment along with time and space for personal reflection on the same.	22. I talk with other students about how to solve problems

(Taylor, Fraser & Fisher, 1997)

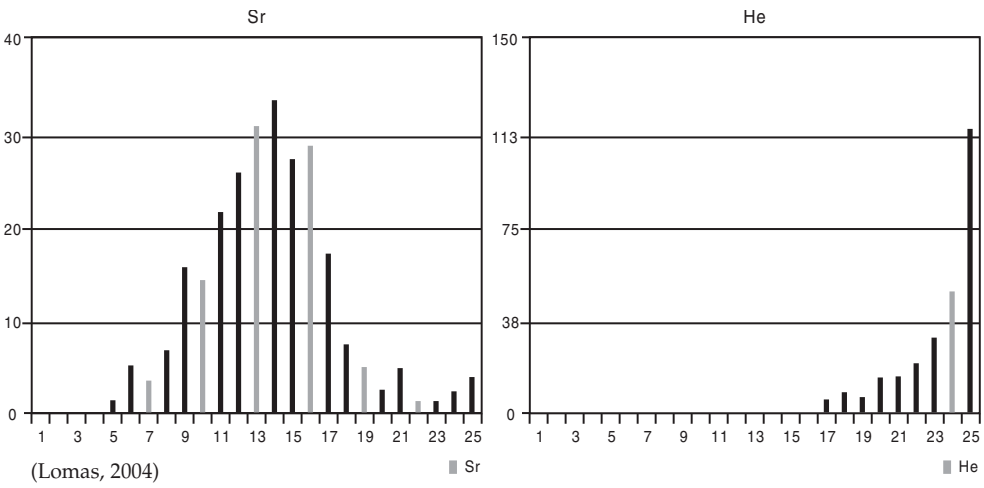
To indicate the alignment of the item responses with the particular constructivist perspective of each instrument a framework of five sub-ranges was established for both the QTI (and CLES, respectively): 0 to 5 (0 to 4) indicates a weak alignment; 5 to 10 (4 to 8) a weak-to-moderate alignment; 10 to 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. It was anticipated that categories with an alignment different from the others and/or where there was a significant difference between their Ideal and Reality responses would identify issues as a focus for curriculum development.

A longitudinal approach was taken with surveys being conducted over the six semesters of a three-year period; that is, the length of time a particular cohort of students would normally take to complete a primary teacher education degree. Each semester, the student teachers in a selection of classes taught by each 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: the QTI on the first occasion and the CLES on the second. Thus the students sampled were a subset of any year group in each semester (giving rise to a different number of responses for each year group), with their involvement being determined by their attendance at class on the day of the survey (giving rise to a different number of responses for each instrument), the vagaries of lecturers' timetables and the practicalities of timing and carrying out data collection. Some student teachers may have been included more than once over the three years, but in a different year level course. The demographic composition of the two sample sets of student teachers surveyed is, therefore, representative of a typical primary student teacher cohort at the College (Lomas, 2004).

The general examination of the data set for each category, and for each instrument, showed either normal distribution characteristics, with the responses spread over the range of the category scale with lower maximum frequencies, or exponential distribution characteristics, with the responses clustering around one end of the category scale and higher maximum frequencies. (See Table 4 for examples drawn from the QTI data). Parametric or

Table 4
Graphs of frequency versus QTI Ideal category response scores (out of 24) for Student responsibility (Sr) and Helping (He)



(Lomas, 2004)

non-parametric analysis was carried out as appropriate for each category. The level for statistical significance was set at 1% ($p < 0.01$) rather than 5% to allow for the 'opportunistic' nature of the sampling procedure and, to a lesser extent, the potential for the Ideal and Reality instrument item responses failing to be independent of each other, which can be an issue with such instruments (Fraser, 1998). The analysis on the basis of year group which showed only minor variation between year groups across all categories (Lomas, 2004) is not reported.

Findings

The frequency data for the QTI categories presented two distinct patterns: a normal type distribution for both the Ideal and Reality responses for *Student Responsibility* and *Strict*; an exponential type distribution for both the Ideal and Reality responses for *Leadership, Understanding, Admonishing, Helping* and *Dissatisfied*. In addition, there was a change in distribution type for the Uncertain category 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 5) reflect these divisions, with the two normal distributions having the lowest mean values and deviating most from a strongly socio-cultural constructivist alignment. They also have the largest standard deviations, reflecting the greater spread in student responses. *Uncertain* has the next largest standard deviation, which is consistent with the change of distribution type evident for this category.

Table 5
The means and standard deviations (SD) for the QTI Ideal and Reality category data (N=266) for a total score out of 24 for each category for each student

	Leader-ship	**Under-standing**	**Un-certain**	**Admon-ishing**	**Helping**	**Student Re-sponsibility**	**Dissat-isfied**	**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*

Note: Italicised Means and SDs indicate normal type distributions

The five categories with exponential type distributions had smaller standard deviations, reflecting the responses clustering around one end of the scale, and were aligned with a strongly socio-cultural constructivist stance (see Figure 1). The *Student Responsibility* category with the largest standard deviations was also the least aligned, being only moderately so; the *Strict* category, with the next largest, was moderately-to-strongly aligned.

For the QTI within category 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 socio-cultural constructivist alignment in two categories—*Leadership* and *Understanding*—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 socio-cultural constructivist alignment between the Ideal and Reality mean responses in four categories: *Uncertain*, *Admonishing* and *Dissatisfied* 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 minimal change in alignment with all category means except *Uncertain* remaining in the same sub-range. *Uncertain*, which had the largest change in means, became more closely aligned shifting into the strongly aligned sub-range (see Figure 1). Overall there was a significant shift to a more strongly aligned perspective where aspects of the lived classroom environment exceeded student teacher's Ideal.

Comparison of QTI Responses in this Study with Secondary School Studies

A comparison of studies in secondary schools (Wubbels, 1993) shows a very similar overall pattern, with the *Student Responsibility* and *Strict* categories

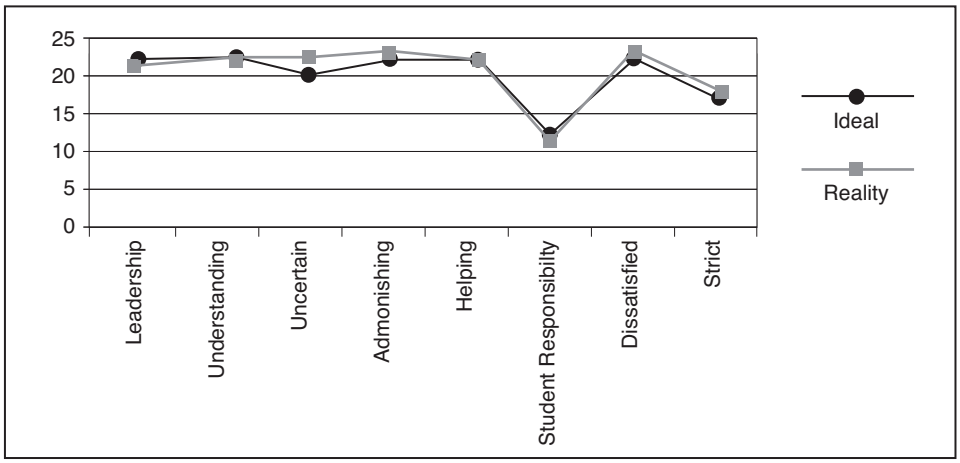


Figure 1. Graph of means for the QTI Ideal and Reality category data

having much lower responses than the other categories. The secondary students' Reality responses are, however generally lower than the student teachers' responses although their Ideal responses are similar. The mean variation between the Ideal and Reality for student teachers is much smaller (<1 or around 1) than for the secondary students (>2) for all categories. The variation for secondary students revealed a shift from a strongly aligned Ideal to moderate-to-strongly aligned Reality response for all but the *Student Responsibility* and *Strict* categories, which stayed in the moderate-to-strong sub-range. This shift to a less aligned state is different from the student teachers' data where the only change in alignment was for Uncertain where the alignment increased. The difference may be a result of the nature of the teacher education programme, with an emphasis on constructivism and lecturers' congruent teaching practices, along with its focus on the nature and practice of teaching, as compared to a secondary school focus on the learning of subject material.

The lower responses for the *Strict* and *Student Responsibility* categories are explained by Wubbels (1993) in terms of two types of students: some students preferring "a strict teacher" while others "prefer to have a lot of responsibility and freedom" (p. 5). This typology was evident in the initial trial and focus group discussions with student teachers, where some items were seen as ambiguous and open to interpretation. For example, in the Strict category, two of the six items (e.g., Item 28. This lecturer is strict) were seen as ambiguous by student teachers, and strictness was discussed as both a positive and negative aspect (rather than simply negative, as intended by the instrument design). The larger standard deviations for these categories may well be evidence of this ambiguity influencing responses (as for secondary students). A similar situation was evident with respect to the *Student Responsibility* category where for some individuals, direction and control were perceived positively while for others the opposite was the case. An added factor here was that three of the six items (e.g., Item 30. This lecturer is lenient) were seen ambivalently within the particular context of assessment related group work by one or two members of the focus groups. Comments on their experiences with such group work in courses across the degree programme referred to occasions when small numbers of students were apparently 'coasting' on the efforts of others.

For the eight categories five Ideal and six Reality perspectives indicated a strong socio-cultural constructivist alignment and taking into account Wubbels (1993) position on the Strict and Student Responsibility categories, the overall situation is one of strong socio-cultural alignment for both perspectives.

The CLES Response Data

The CLES data for its five categories fell into two apparent patterns, as for the QTI: normal type distributions for both the Ideal and Reality responses for *Personal Relevance, Uncertainty* and *Shared Control*, and exponential type distributions for both the Ideal and Reality responses for *Critical Voice* and *Student Negotiation*. The mean values for the categories (see Table 6) 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 a critical constructivist stance: Student Negotiation strongly and Critical Voice moderately-to-strongly (See Figure 2).

Table 6
The means and standard deviations for CLES Ideal and Reality category data (N=297) for a total score out of 20 for each category for each student

	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

Note: Italicised Means and SDs indicate normal type distributions

As for the QTI, the three CLES categories with normal distributions deviated most from a strong critical constructivist alignment being mainly only moderately aligned except for the weak-to-moderate alignment for the *Shared Control* Reality response. The standard deviations for the CLES categories are all greater than or equal to 3.67 (see Table 6) and larger than those for the QTI categories, for which all but one are less than 3.67 (see Table 5). This indicates a greater degree of variability/spread in student teacher responses to all categories of the CLES instrument. There is no clear pattern of smaller standard deviations being associated with the more aligned categories and larger standard deviations with the less aligned categories, as there is for the QTI.

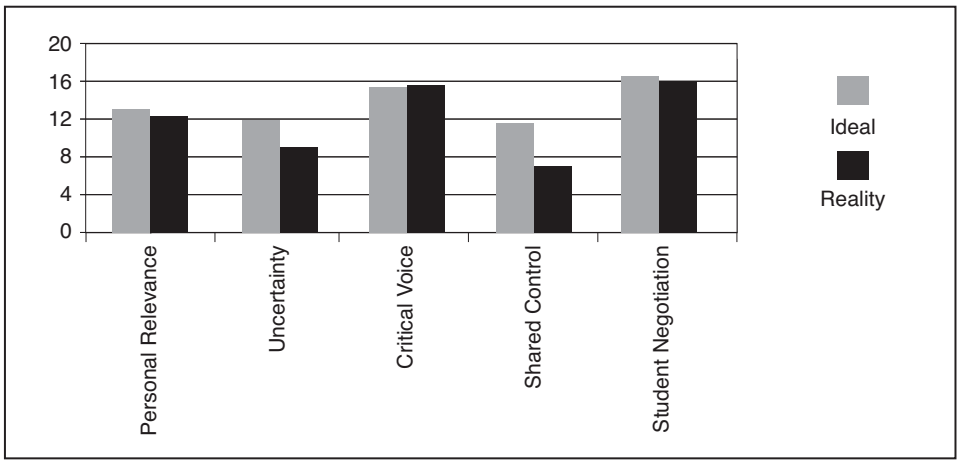


Figure 2. Graph of means for the CLES Ideal and Reality category data

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 ($p<0.01$). *Shared Control* was the only category in which the mean shifted into another sub-range: from moderate to weak-to-moderate. These data indicate a significant shift to a less critical constructivist view of the perceived reality in three of the five categories, and thus overall. However, the differences in means were relatively small. Thus, both the Ideal and Reality responses indicate a moderate to moderate-to-strong perspective overall.

Comparison of CLES Responses in this Study with Secondary School Studies

The low Reality value for *Shared Control* is also evident in Aldridge, Fraser, Taylor and Chen's (2000) validation study of the Reality form of the CLES questionnaire conducted in Australian and Taiwanese secondary schools. *Shared Control* had a much lower response value (around six) than the other categories which were all around 11 to 12 for the Australian data. Similarly, Simpson's (2000) study of students in an Australian classroom environment predicated on constructivist-aligned teaching approaches had a lower response value for *Shared Control* (around eight for Ideal and six for Reality) but a higher value for *Student Negotiation* (around 15 for both Ideal and Reality) and values around 12.5 (for both Ideal and Reality) for the other three categories.

The higher values for *Student Negotiation* in both Simpson (2000) and this study may reflect the consistent focus on group work and discussion as an integral part of teaching practice: a feature of both environments. Such a focus could have been perceived by students as legitimating student-student interactions. The lower value in Aldridge et al. (2000) probably reflects a sample of students from class environments where teaching approaches are based on a variety of theories. The Critical Voice values are higher in this study than in the other two. This indicates both the expectation and provision of a more positive social climate toward questioning and discussion of the learning agenda.

Interestingly, the Reality is perceived significantly less positively than the Ideal in three categories: *Personal Relevance, Uncertainty* and *Shared Control*. In Simpson (2000) there was little difference evident in any category except for *Shared Control*. These differences may arise partly from the nature of the teacher education programme and the mathematics education courses. Both investigate the nature of teaching and learning and promote constructivism as a preferred learning theory along with a transformative view of education. This can lead to the development of expectations among student teachers about courses and the way they should be taught and assessed which may not have been met. This may be particularly so for *Shared Control*, where the courses were compulsory parts of a credentialing programme, with closely defined content, thus limiting

opportunities for student input in determining goals. Similarly, the further constraints of institutional assessment requirements and time available in semester-long courses meant that there was limited scope for student teachers to have input, other than at a micro level and to a minor extent.

For *Uncertainty*, the difference may arise from primary student teachers' prior mathematics experiences, their generally negative attitudes toward mathematics itself and their lack of confidence in their knowledge and understanding of mathematics (Thomas, 1998), which would also generate tensions between expectations and course experiences. For *Personal Relevance*, the difference may arise from student teachers' prior mathematics learning experiences being different from those in the courses, creating a sense of disconnectedness and/or the tension between experiences in the academic world of college and in the practical reality of schools, where the practices advocated may well not have matched school realities (Wideen, Mayer-Smith, & Moon, 1998).

Discussion

The QTI Ideal responses are strongly aligned with a socio-cultural constructivist perspective overall, with five of the categories strongly aligned, two (*Uncertain* and *Strict*) moderate-to-strongly aligned and one (*Student Responsibility*) only moderately aligned. The variation from a strong alignment in two of the categories (*Strict* and *Student Responsibility*) lies within the expected response range for the instrument (Wubbels, 1993) and supports the position of a strong alignment overall. Thus the student teachers' perception of Ideal practice is strongly aligned to a socio-cultural constructivist perspective. Similarly, the QTI Reality responses are also strongly aligned overall, with six of the categories being strongly aligned: the *Uncertain* category having become strongly aligned, while the *Strict* and *Student Responsibility* categories remain unchanged. The high level of congruence between the Ideal and Reality mean responses for all categories indicates that the lecturers' practice closely matches student teachers' perceptions of Ideal practice. Thus, lecturer practice is perceived as strongly aligned with a socio-cultural constructivist perspective.

Although lower response means were expected for the *Strict* and *Student Responsibility* categories, the disparity in alignment with a socio-cultural perspective suggested that lecturer practice should be examined in order to find ways to enhance the alignment further. One approach undertaken was to raise the issues of 'strictness' in relation to acceptable standards of behaviour and 'levels of direction and control' (for both students and teachers), in particular teaching contexts that student teachers might find themselves in. This was done in class sessions as appropriate with discussion of concerns expressed and exploration of the different views underpinning them. A specific step taken early in the study was in regard to a piece of assessed group work where the nature of the task was altered so that an initial group work part was not directly assessed for the final mark. Instead, the processes involved (e.g., problem solving and

communication) in the group work was identified and discussed by each student individually, and it was only this focus on the group work that was assessed. This appeared to resolve student concerns about some students 'coasting' on the work of others. However, the data collected in the latter part of the study showed no discernable change resulting from these actions.

The situation for the five CLES category responses was not as clear-cut as the QTI with the Ideal and Reality means having more variability in alignment (three and four sub-ranges respectively and with no more than two means in any sub-range). However, the overall responses indicate a moderate to moderate-to-strong alignment, although with lower Reality responses. This was due to the CLES Reality being significantly less strongly aligned than the Ideal in three categories: *Shared Control, Uncertainty*, and *Personal Relevance*. These shifts to a less aligned view of the Reality of the teacher education experience indicates that lecturers' practice was not even congruent with the more limited Ideal expectations of the student teachers with regard to these three aspects of a critical constructivist perspective. However, the lecturers' practice met the student teachers' expectations in two categories, one of which, *Critical Voice*, had a higher level of alignment than in studies by Aldridge et al. (2000) and Simpson (2000).

The three categories where alignment with a critical perspective was less, and the Ideal Reality difference was a significant decrease, were particular ones where ways to enhance lecturer practice needed examining. In terms of *Shared Control*, where institutional factors outside lecturer control impact on the capacity to involve student teachers in shaping and controlling the learning environment, one approach undertaken was to ensure that such limitations were made explicit. Then, opportunities were provided for explicit and meaningful student input into the learning environment within the imposed limitations. However, the data collected in the latter part of the study showed no discernible change due to this action. With the other two categories no changes were made during the study but various approaches from the literature were under consideration and are presented below.

The *Uncertainty* category measures individuals' mathematical knowledge and understanding of the nature of mathematics, which are both shaped by their mathematical experiences. One way to address associated issues is to develop a more explicit and reflective focus on exploring student teachers' personal beliefs about mathematics and mathematics teaching and how one set of beliefs may impact on the other (Stuart & Thurlow, 2000). Such approaches are supported by Jaworski and Gellert (2003) who stated that "one of the main challenges to initial mathematics educators [is] to make [student teachers'] preconceptions and tacit knowledge explicit" (p. 843). Llinares (2002) also discussed the interplay of student teachers' existing beliefs, which "often run counter" to those being developed through teacher education programmes, and argued that "reflecting on student teachers' beliefs … is a key issue" (p. 197).

When promoting or attempting to promote change, reflection also holds a central place in confronting the tensions that arise between sets of beliefs and aligned practices (Wilson & Cooney, 2002). Wideen, Mayer-Smith and Moon

(1998) and Zeichner (1999) emphasised the importance of student teachers examining (reflecting upon) their beliefs as a starting point in their development as teachers. Possible techniques that may assist in making student teachers' beliefs explicit and allow for reflection and the negotiation of new understanding are, for example, exploring personal histories of mathematics via bibliotherapy (Wilson & Thornton, 2006), examining the realities and tensions of classroom teaching through case studies (Averill & Harvey, 2005), and developing personal metaphors for mathematics and its teaching (Grootenboer, 2003; Wolodko, Wilson & Johnson, 2003).

The *Personal Relevance* category focuses on the connectedness of the learning situation to the learner's external world and its use as a starting point for learning experiences. One approach that may help to create greater congruence is to have student teachers take their observations of the mathematics teaching practices of teachers and reflect on the beliefs that might underpin them, using constructivism as a referent. This would assist in explicating the role of beliefs in determining practice and in focusing the student teachers on their own beliefs and how they might impact on their practice (Stuart & Thurlow, 2000).

"Well-remembered events" from student teachers' own teaching experiences provide similar opportunities for analysis and discussion. These incidents act as a focus to help make sense of events significant to the student teachers in terms of personal knowledge (based on individual beliefs and professional folklore, possibly "informed" by formal theories) and theoretical frameworks (Piagetian theory, constructivist ideas, etc). Over time, the discussion and negotiation of meanings leads to increased levels of understanding of formal theories, their increased use as frames of reference and their use at a deeper level, accompanied by a decrease in the use of personal idiosyncratic theories (Valdez, Young & Hicks, 2000).

The predominance of strongly aligned QTI categories and the uniformly high levels of congruence, indicating a strong socio-cultural alignment overall, is in contrast to the variable alignments of the (critical) CLES categories and variable levels of congruence within the categories. This raises questions about the nature of the lecturers' constructivist practices (and underlying beliefs) and the extent to which they are aligned with a socio-cultural perspective as opposed to a more explicitly transformative critical constructivist one.

Concluding Remarks

The evidence on how the student teachers view their mathematics teacher education experience indicates a strong socio-cultural view but a more moderate critical view. The high level of congruence in the QTI categories indicates that lecturer practice is strongly aligned with socio-cultural constructivist perspectives, reflecting a *stronger* (socio-cultural) view of constructivism rather than just a *weak* (cognitive) view. Only two of the CLES categories exhibit high levels of congruence indicating aligned lecturer practices. In contrast, the other three exhibit a significant lack of congruence indicating that lecturer practice

does not meet student teacher expectations. This suggests that lecturers' practice is not promoting a strong (critical) view of constructivism.

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 both at a programme and course level. However, the opportunities to address identified issues using approaches from the literature may offer a way forward.

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Author

Gregor Lomas, School of Science, Mathematics and Technology Education, Faculty of Education, The University of Auckland, Private Bag 92601, Symonds St, Auckland 1035, New Zealand. Email: <g.lomas@auckland.ac.nz>