# Re-visioning Curriculum: Towards Communicative Competence

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In this paper I review theory on communicative competence and identify characteristics of competent spoken performance in a Year 12 mathematics class. Key actions of the teacher were that he asked open-ended questions, accepted responses that he did not expect and attended to student interpretation. Key actions by students were that they joined discussion and offered ideas without waiting to be nominated by the teacher. The nature of the teaching can inform teaching practice in all classrooms.

What does communicative competence entail? How can it be fostered in students? Why is it important? I explore these questions in this paper, drawing on the literature and on my observations in an all-girls' Year 12 calculus class over five weeks. In particular, I refer to Young's (1992) account of Habermasian communicative competence; and the characteristics of communicative competence in mathematics identified by Mehan (1979), Jungwirth (1991) and Zevenbergen (2000). The practices in the calculus class that I interrogate are the types of questions asked by the teacher, students' critical responses and the ways the teacher accepted their responses. The questions and responses all relate to exponential growth and vector calculus topics that were subjects of instruction when I attended the class. The locus of the inquiry is whole-class work.

## The Literature

### *What Does Communicative Competence Entail?*

Habermasian communicative competence (Young, 1992) is evidenced in the expression, explanation and negotiation of personal views. It includes justifying personal claims when challenged. It entails openness to and respect for others' ideas, and a critical orientation, so that inconsistencies and unjustified statements are recognised and voiced. Further, communicative competence is the capacity to state a personal point of view in social situations of unequal power relations such as exist between teachers and students.

Mehan (1979) distinguishes social from subject-content related competence in mathematics, viz interactional competence and academic competence. Interactional competence entails responding to the others' actions in timely and appropriate ways, for example, producing an answer (or clarifying question) to a question, providing an explanation when requested, and not interrupting others; or initiating action so others attend to what is said, which requires timing the initiation in accordance with social norms in the class. For academic competence, the content of answers and initiations needs to advance the subjects of discussion.

Zevenbergen (2000), drawing on the work of Bourdieu (e.g, Bourdieu & Wacquant, 1992), describes how participation that is sanctioned by the teacher as acceptable (i.e., competent) requires recognition of power structures and relations in the class. For example, usually it is deemed inappropriate for students to express non-understanding in the early part of the lesson when the teacher is establishing his/her control. It is more appropriate to voice non-understanding in the middle work-part of the lesson.

Communicative competence also has an emotional dimension (Forster, 2000). Confidence to offer personal views and persistence in defending them are salient. Appearing competent can also depend on hearing exactly the teachers' questions, so the focus of a response corresponds to the focus of the question. Competence in the public domain of class work can be underpinned by one-to-one conversations with peers and individual written work.

### *How Can Communicative Competence Be Fostered in Students?*

I subscribe to the view of Cobb, Boufi, McClain and Whitenack (1997), Young (1992) and Mehan (1979) that competencies, including all facets of communicative competence, emerge in social interaction and, as well, are determined by individual thought and action. On the social plane, the emergence could involve a process of collective reflection (Cobb et al., 1997) where the students and teacher, together, reconsider proposed mathematics relationships, and perhaps consider explanation and reflection processes. Individual reflection underpins the collective reflection; and, reflexively, the collective reflection can provoke individual reflection so that students might advance their mathematics understanding and move towards assuming critical and communicative stances, indicative of communicative competence.

Further, Young (1992) identifies that a paradigm of inquiry involving the teacher and students, more than traditional tripartite questioning (where the teacher asks questions, students respond, and the teacher evaluates), allows the demonstration of communicative competence by students and could encourage its development. Inquiry implies shared exploration of a domain, where the teacher and students together decide the direction of the discussion. Moreover, open-ended questions that admit a variety of acceptable answers, rather than closed questions that admit relatively few answers, encourage students to think critically and to be creative. However, questions function as open-ended only if students have not previously rehearsed the multiple answers and so chant them.

Jungwirth (1991) describes situations in teaching that mediate against students' appearing competent. They mainly relate to tripartite questioning and Jungwirth classifies students' responses on the basis of gender. In her observation, girls more frequently than boys don't take hints that their answers don't conform to the answers the teacher expects and consequently their mis-takes and incompetence appear to grow in the interaction. Girls more frequently than boys give 'too complete' (dense) answers that the teacher explains to the class, which can make the responding student appear incompetent; and girls more frequently than boys refrain from answering ambiguous questions.

Differences in response are also seen in students from 'middle-class' and 'working-class' families (Zevenbergen, 2000). For example, students from middle-class families are more likely to conform to the expectations of tripartite questioning and, hence, constitute their own competence in relation to teachers, who generally come from the middle-class. Familiarity with this style at home in middle-class families, and the absence of it at home in working-class families, explains the difference in response. Hence, a challenge is to offer curricula that are inclusive of all students, which requires an awareness of their different social experiences. How to cater for the differences is not so clear. However, it is relevant to my analysis that the setting for my inquiry was a private school for girls and a major goal for the class was preparation for tertiary entrance examinations which were two months away.

### *Why is Communicative Competence Important?*

Personal ability to participate in critical dialogue can support mathematics learning, by the individual and the group (Cobb et al., 1997; Cobb, 1998). Inability to participate because of social inexperience or limited knowledge of subject-content effects marginalisation and can result in students' feeling alienated from the class. Further, communicative competence is a requirement of full participation in democratic society. Without appropriate communication skills and academic knowledge, groups can be marginalised and feel alienated from political processes (Cobb, 1998). Hence, the choices of communication style and subjects for instruction are crucial decisions in all classrooms, including mathematics classrooms, and have political implications.

## Research Method

I attended 21 50-minute lessons in the Year 12 class of 13 students, observing whole-class work and acting as an assistant teacher during individual work. The assistant-teacher role allowed me to query students about their mathematics understanding and problem-solving approaches. I set up a video-recorder to record continuously for entire lessons, with the whiteboard in the field of view. I audio-recorded the conversations of the 13 students in the class, who generally sat in four groups. The recordings captured whole-class dialogue and one-to-one interactions. I transcribed at least some of the audio-recordings immediately after the lessons and informally followed up points of issue with the teacher and students during or after subsequent lessons. In addition, I held more formal interviews with the teacher on classroom practices.

At the analysis stage, I coded the audio-transcripts for types of calculator use and interpersonal interaction, and the video-recordings offered corroborating data. Then I proposed in writing to the teacher the scope of the analyses for publication and we discussed and agreed to the proposal. A criterion for the research is that the teacher does not object to publication of an analysis and I seek critical feedback from at least one colleague before submitting for publication.

In the analysis below, I present six episodes of class discussion. My selection of them was purposive. I chose them to illustrate repeated interaction patterns that I saw were conducive to the exhibition and development of communicative competence. Thus, a limitation of the analysis is that it does not portray the variety in the classroom practice, for example, direct instruction and dictation, and length limitations of the paper meant that some types of action consistent with communicative competence are not included. Further, I do not claim that the analysis reflects participants' perceptions of their own or others' competence. It is written from my point of view. This approach is informed by the methods and assumptions of ethnomethodology (e.g., Jungwirth, 1991).

## Analysis: Communicative Competence in the Year 12 Class

The transcripts show that the teacher, Mr D, repeatedly used open-ended questions in whole-class work. The questions functioned to bring properties and relationships that had been discussed previously and known methods of solution into the conversation, and they provoked the prediction of new mathematical relationships. An example of an open-ended question that Mr D asked on previous work was: 'Describe the motion given by $\mathbf{r}(t) = 3\sin(\pi\, t/4)\mathbf{i} + 3\cos(\pi\, t/4)\mathbf{j}$ '. After each property was offered and relevant methods of calculation discussed, he asked "What do you think would be another good piece of information in your description?", or similar. Altogether, nine properties of the motion were offered (it was circular, the anticlockwise rotation, the starting point, radius and period, the cartesian form of the equation, the speed, and distance travelled in one rotation). Further, the properties hadn't been drilled, so the question was open-ended according to Young's (1992) definition: in previous lessons students had identified the centre, radius and constant speed of the circular motion given by $\mathbf{r}(t) = \cos t\,\mathbf{i} + \sin t\mathbf{j}$ , and had identified the period and other properties for non-circular motion. However, the question relating to $\mathbf{r}(t) = 3\sin(\pi\, t/4)\mathbf{i} + 3\cos(\pi\, t/4)\mathbf{j}$ was the means for the class to bring together, for the first time, the array of vector motion properties and associated methods for circular motion.

On another occasion, Mr D asked: 'What questions can be asked and what calculation is involved for projectile motion given by $\mathbf{r}(t) = 2t\mathbf{i} + (10 + 12t - 4.9t^2)\mathbf{j}$ '? A student suggested: "How long to hit the ground". After the students individually worked the time out, the methods they suggested in fast succession were all graphics calculator based. They were to isolate the **j** component of **r**($t$) and (a) solve $10 + 12t - 4.9t^2 = 0$ in the numeric equation solve facility (SOLVE), (b) use the POLYROOT function (which produces all real and non-real roots for polynomials), and (c) plot the graph of $y = 10 + 12t - 4.9t^2$ . The teacher asked the class what problems could occur with SOLVE and a student identified it gives only one answer at a time. Then, another student argued for the POLYROOT method, and the teacher agreed on the basis that "With POLYROOT we get the answer straight away. It's quicker". Next, the maximum height and methods for the motion were discussed and debated. Students favoured obtaining the maximum value from a calculator graph. Mr D claimed that differentiation was quicker. Students argued it was easier to plot a graph, there was more chance of error with the manual method, and that you still had to evaluate the maximum height, which makes the manual method longer.

Hence, the class responded to the open-ended questions by giving some of the multiple responses that the questions allowed. Students' competence was evidenced in the discernment of different possibilities, in voicing their views and in successfully having them heard. The action that followed the open-ended questions involved (a) Mr D taking turns with students in speaking, when he confirmed their suggestions (as with the circular motion properties), or (b) consecutive student turns (for the projectile motion). Generally, confirmation/negation can shut off critique by students and the consequent display of competence (Young, 1992). On the other hand, when students take control and speak consecutively, they shut off confirmation/negation by the teacher. So, one aspect of communicative competence is being the first student to usurp the teacher from his traditional right to take alternate turns in speaking. Mehan (1979) observed usurpation is often followed by a cascade of student replies (i.e., others are encouraged to contribute), which happened in the projectile motion task.

Voicing the claim that the POLYROOT method was preferable, the challenges to the teacher's differentiation method and the accompanying justification were other evidence of students' communicative competence, where the critique by students followed critique by the teacher. Individual calculation on the calculator and written solutions underpinned the public performance. Further, the pattern of claim and counterclaim was repeated in other episodes and often related to limitations/benefits of different analytic and calculator methods of calculation (see other examples in Forster, 2003).

As well, open-ended questions were sometimes followed by extended student-teacher turn taking, where students offered responses and Mr D called for explanation. The pattern was a means to the development of new concepts and fitted Young 's (1992) definition of learning through inquiry. The determination of the properties of acceleration for $\mathbf{r}(t) = 10\sin t\,\mathbf{i} + 5\sin 2t\,\mathbf{j}$ was a case in point. The class had drawn velocity vectors on the circuit for $t$ = 0, π/8, π/4, 3π/8 …(see Figure 1), and had discussed the changes in speed and the direction of velocity on the circuit.

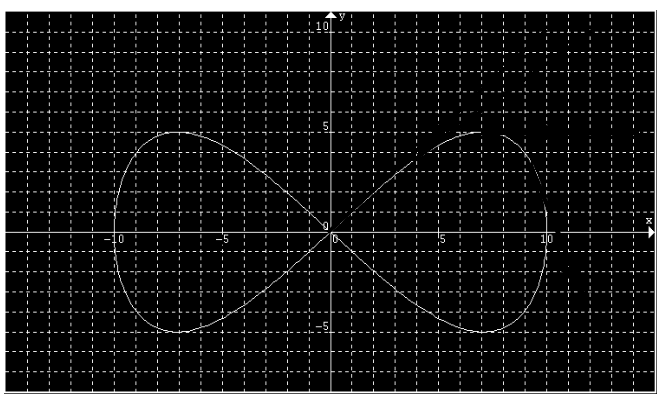


*Figure 1.* The $\mathbf{r}(t) = 10\sin t\,\mathbf{i} + 5\sin 2t\,\mathbf{j}$ path with velocity vectors $\mathbf{v}(0)$, $\mathbf{v}(\pi/8)$, $\mathbf{v}(\pi/4)$ and $\mathbf{v}(3\pi/8)$, drawn to start at $\mathbf{r}(0) = 0\mathbf{i} + 0\mathbf{j}$, $\mathbf{r}(\pi/8)$, $\mathbf{r}(\pi/4)$ and $\mathbf{r}(3\pi/8)$.

Then, with the graph in Figure 1 in view on the whiteboard, Mr D asked the class to guess what the acceleration vectors would look like. A student (Kim) offered: "For the first bit, they will be going backwards, because it is slowing down". Mr D asked her "What do you mean backwards"? Her subsequent responses, upon repeated requests for explanation by Mr D and assisted by consultation with a friend, yielded a more precise definition for acceleration: " …it's slowing down, so it's going the opposite way to the velocity", "…it will be going backwards as it goes to the next one…", "[It] will be going backwards as it goes to the next point round". The sequence finished when Mr D drew a vector on the graph, starting at the origin and pointing into the third quadrant. He asked of it: “Say, like that maybe?”, to which Kim responded “Yes”, then “I don’t know”. Two other students offered other possibilities.

While calls for explanation are widely documented as a strategy for eliciting students’ ideas (e.g., Cobb et al., 1997), a request for confirmation/negation by a student, (Say, like that maybe?), according to Young (1992) is unusual and potentially empowering for the student. In fact, Kim’s doubt about the diagram was warranted. Homework was to calculate and draw the acceleration vectors, which revealed the true relationship. The 44-line episode that I have summarised here and the insightful discussion the next day based on the homework are reported in full in Forster and Taylor (in press).

### *Other Teaching Actions That Fostered Communicative Competence*

Mr D also regularly used closed questions and a tripartite style. However, repeated actions that distinguished the practice were: Mr D accepted and valued responses that he didn’t appear to have planned or expected; suspended his own interpretation in favour of student interpretation; and returned to recognise students and their contributions after their ideas had been subject to discussion in the class. Examples follow.

Unplanned/unexpected responses. Mr D was intending to revise the conversion of vectors in magnitude direction form to component form and had in mind the use of sine and cosine ratios (which I confirmed in an interview). He specified a projectile set up and asked the class how to do the conversion. Students answered: “Cosine and sine” and “Use the little symbolly thing”. Mr D responded, “Now we have two answers here”, and proceeded to hand the second student the lead to connect her calculator to the overhead projection panel and she demonstrated what she meant. He returned to the traditional method later and there was heated debate on the efficiency and limitations of the two approaches. Mr D kept to his rationale that you could understand “exactly what's happening” by using a diagram and the trigonometric ratios. Students who spoke preferred the calculator method because it was quicker and they showed him that exact values were possible with it. The interaction contrasted with the common practice whereby teachers only accept the answers that suit their intentions and prescribe the methods to be used, and where students passively follow the instruction (see Jungwirth, 1991; Mehan, 1979).

Suspending interpretation. Mr D asked the class for the points where a particle on the path given by $\mathbf{r}(t) = 10 \sin t\, \mathbf{i} + 5 \sin 2t\, \mathbf{j}$ (see Figure 1) would be moving in a positive $x$ direction. Students suggested the turning points in the first and third quadrants, to which Mr D agreed. Then, he asked:

| | |
|---|---|
| Mr D | When you say it has no **j** component what is it referring to? |
| Tanya | The velocity. |
| Mr D | When the velocity has no **j** component. |
| Tanya | Yes, and when **i** is positive. |
| Anna | No, **i** is positive above the line, and you are above the line. |
| Kate | No, because with velocity you have a new axis. |
| Rebecca | Like up the top. |
| Anna | No. It s still going [pause], it’s still moving to the right |

Mr D Okay, I have been ambiguous in my question, as Anna has correctly said. Shall we add that to the question, shall we say when it is travelling parallel to the $x$ axis, in the positive $x$ direction.

The issue was the particle was moving to the right at every point in the first quadrant and not just the turning point. Anna discerned the ambiguity and had the confidence to voice it, even though other students and the teacher had agreed just two positions were involved. The dissention attracted the participation of other students, who disputed Anna's claim, but she restated it succinctly. Mr D engaged with Anna's objection and addressed the discrepancy.

Recognising students. When revising compound interest prior to commencing a unit of work on continuous growth and decay, a student (Alex) upset the order in the closed questioning. The task was the calculation of the amount after one year, for a principal of \$100 at 100% p. a. interest compounded daily, that is $100(1+1/365)^{365}$. Alex began her answer with $100 \times 366/365$, whereas if she had followed the pattern established by Mr D and other students in previous questions she would have started with $100(1+1/365)$. A student objected with "What?" and Mr D's response was "Ohh. Hang on. So, here…". He elicited the $(1+1/365)$ from Alex then said: "Yes. So, you are one step ahead of me. So, $1/365$ [saying it as he wrote it on the board]. Okay. So, you are correct in what you are saying here…". The interaction fits the pattern of the 'too complete description' or 'too dense answer' that Jungwirth (1991) identified. The teacher typically assumes ownership of the answer in the explanation of it and leaves the responding student looking inept. Instead, Mr D had Alex expand her answer and, then, turned to recognise explicitly the validity of the original form.

## Concluding Discussion: Towards Communicative Competence

The open-ended questions certainly functioned to stimulate students to contribute their ideas in whole-class work. Mr D's calls for explanation were also effective and constituted a type of shared inquiry. Otherwise, he confirmed and negated students' responses, or they disrupted this pattern. Importantly, the inquiry and disruptions indicated that students, as well as Mr D, determined how interaction in the class unfolded. It was normal for students to interject and factors were that Mr D allowed the interjections (i.e., breaks with turn taking) and sometimes provoked them by stating his preferences for methods of solution, yet he didn't enforce his preferences.

A close look at both the closed and open-ended questioning yielded other explanations for the voicing by students of their ideas. Namely, there were multiple instances when Mr D accepted student responses that he did not seem to have anticipated, and he valued student interpretation, rather than prioritising his own. Examples were when he sought confirmation from a student about a diagram, restated a question upon a student identifying it allowed a wider range of answers than he assumed, and commended a dense interpretation as being one step ahead of his.

The environment was such that some students freely offered their ideas on mathematics properties or methods of solution without waiting for Mr D to choose them to speak, and this attracted the participation of others, so there were cascades of responses. In addition, students sometimes disputed Mr D's claims in conversation, and supported each other when impasses were met in public performance.

Furthermore, in conducting the analysis it seemed to me that the Year 12 students' interjections and challenges to Mr D's authority resembled some of the actions of students from 'working class' families that Zevenbergen (2000) describes. However, when students of Zevenbergen's inquiry did not adhere to turn taking, the teacher reprimanded or ignored them. Further, the teacher attempted to keep control over the mathematics that was discussed and made no attempt to elicit student explanation. So, while Mr D usually valued the Year 12 students' proactive behaviour (when it was constructive and did not amount to speaking over others), the 'working class' students' non-adherence to traditional norms was treated as misdemeanour.

However, when interjections and challenges are allowed and encouraged, disorder can escalate and mediate against learning for the class. In fact, Mr D exerted control when dissent/debate was not productive, for example, by shifting the class to a new task: and perhaps he enjoyed a higher level of control than the teacher in Zevenbergen's study, so that he could afford to appear to relinquish it.

Furthermore, I suggest Mr D's actions, in part, evolved because of the Year 12 students' communication skills, and were not necessary or sufficient for the development of those skills. The school-program in performing arts and experience in humanities subjects could have been influential. In accordance with Cobb et al. (1997), Young (1992) and Mehan (1979), I also suggest that participating in mathematical discussion and debate might have enhanced students' capacity to discuss and debate; and voicing insight, discrepancies and alternative methods of solution might have increased students' capacity to be discriminating. Moreover, in my observation, classroom conversation was inclusive in that 10 of the 13 students voluntarily contributed to it and Mr D nominated the others to answer occasionally. It is also possible that students in listening mode learnt from the interaction However, any progress would have been dependant on personal reflection: it is not sufficient to participate or be exposed to dialogue, the individual must reflect on action in order bring it to conscious realisation and to advance.

During the month of my inquiry, advancement did seem to occur, for the class in general, in the discernment of graphics calculator use (see Forster, 2003). As well, the verbal responses and written work of most students' indicated good to strong advancement in their subject-content knowledge. Only one student seemed out of her depth mathematically.

In conclusion, I suggest the development of communicative competence, with its interactional and academic facets, is a useful notion to guide teaching. Furthermore, I recommend that the different types of open-ended questions reported in the paper seemed to serve mathematics learning well; and the ways through which Mr D respected students' ideas could inform teaching in all classrooms.

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