

TALKING ABOUT MATHEMATICS PROBLEMS ON THE WEB

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This paper outlines an initial investigation into the nature of communication about a mathematical problem on the AskNRICH discussion board on the NRICH website (www.nrich.maths.org.uk). It involves elements of collaborative problem solving but also shows some conventions adopted from other settings including those associated with classroom talk and text messaging. The webboard offer young people the opportunity to engage in dialogue about mathematics without teacher intervention or instigation and the purpose of the analysis is to gain some ideas about the nature of that communication and its value.

This paper arises from a consideration of an exchange between three teenagers related to a mathematical problem posed by one of them on the NRICH website (www.nrich.maths.org) on its discussion board, AskNRICH. My interest in analysing this exchange arises from an interest in talk about mathematics in classrooms and my focus here is on considering the similarities and differences between this webboard discussion and ‘ordinary’ talk in mathematics classrooms. The paper constitutes an initial attempt to analyse data from a source that I have not previously considered and I am interested in developing ways of analysing the data that might throw light on the nature and purposes of the mathematical communication that is taking place. I am interested in trying to ascertain whether the webboard is a helpful facility to offer pupils through which to communicate their mathematics as well as their difficulties with it and responses to it. I am also interested in whether the webboard offers the opportunity to engage in collaborative problem solving. Specific questions might be: What is the mathematical communication that is going on here? What are the differences between this and face-to-face communication? Are there any constraints or advantages?

The NRICH website is free, well used and offers mathematical problems, games and interactivities as well as the opportunity to engage with other users in webboard discussions. The subjects of these discussions might be mathematics and the teaching and learning of mathematics. The NRICH website as a whole receives over five million hits a month from users throughout the world. This paper focuses on data taken from the webboard. This facility is available to anybody who registers to use it and is a free service. When joining in for the first time a participant is required to register and to agree to abide by the rules and conventions of the website. The webboard discussions are monitored by undergraduate mathematics students and one of the participants, Matthew, in the discussion analysed is such a monitor. They are also overseen by a member of the NRICH staff. The relative status of different participants is apparent from the discussion board as the undergraduate student mentors and the moderator post in different colours from the general public.

In analysing the data I have used a grounded theory approach referring constantly

back from the coding to the text and using strategies developed in the process of undertaking my earlier research into classroom talk (Back, 2004). This paper constitutes an initial enquiry into the genre of webboard communication about mathematics and considers in detail a short exchange.

The discussion involved three participants: Helen, Matthew and Jeff and was predominantly a dialogue between Helen and Matthew with Matthew in the role of the teacher or at least mentor. Jeff makes a brief intervention. The discussion is opened by Helen who poses the problem and starts the thread of the discussion:

Helen: help!!! pls can u help solve this problem? king john is given 9 identical coins however 1 is an underweighted fake. Using a balance how can you find the fake with just 2 weighings??

There are conventions here from the genre of text messaging in the use of 'pls' for please and 'u' for you as well as the lack of capital letters. Matthew responds by offering a hint:

Matthew: Well here's a hint to start you off: If on the first weighing you put a certain number of coins and they happen to balance it means the fake is in the ones you didn't weigh, so you have to be able to find the fake from the left-over pile in just one weighing. Consequently, what will your first weighing be?

In doing this Matthew takes on the role of a teacher especially in offering a hint that does not give away the solution. These two exchanges took place ten minutes apart and Helen then responds after 12 minutes. At this point Helen uses Matthew's name in her response and seems to be staking out the discussion as a place for a private conversation. She starts with a social opener and ends with a social appeal to continue the conversation:

Helen: hi matthew what happens if you have the fake in the piles you weigh i have already considered these possibiliteies (sic)?? pls reply helen!

Helen uses her social skills to approach Matthew and then she is free to ask her mathematical question. Unfortunately her question shows Matthew that she has not followed his reasoning so he has another go at an explanation for her:

Matthew: My hint was basically to explain why we can't leave more than 2 coins out on the first weighing. So we leave as many as possible, and weigh the other 6 in groups of 3. If they balance it's one of the other two. If they don't then we take the lighter triple. Well, in our last weighing if we put more than 2 coins we won't be able to decide for sure which coin it is. Can you now see how to finish this off?

This is an interesting contribution from a number of points of view. Firstly Matthew switches to the use of 'we' instead of you. This is a ploy often used by teachers to involve their pupils in an action: it suggests complicity of the other person in something in which they may not necessarily be complicit and is similar to the nurse's use of 'we' when talking to patients. (Pimm 1987) Matthew's adoption of this behaviour suggests that he takes on the teacher's role in this exchange. In this

intervention Matthew explains the method that he is suggesting but unfortunately makes a mistake in the first sentence by saying '2' instead of '3'. This leads to a follow up question from Helen and Matthew corrects himself in his next contribution as well as asking Helen another question:

Matthew: Yep sorry I meant "we can't leave more than 3 coins out on the first weighing".
Well, if you weigh just two of them, what could be the outcome?

In this contribution he reverts back to using 'you' and the next few exchanges follow on very quickly after one another as Helen reaches a solution and suddenly 'gets' it. Once again Matthew treads the difficult line of leading Helen's reasoning whilst at the same time not giving away the answer.

Helen: if it is one of the three that you didn't weigh to begin with how do you find the fake in just one weighing?? h xxx

Matthew: Okay, I don't think I'm explaining myself clearly enough. Suppose you're left with 3 coins and only one weighing. Now consider just weighing two of three coins you've boiled it down to. Can you see how you can tell from this one weighing which coin is the fake?

Helen: yes if they are equal it is the one that is left over! if they aren't it is the lighter one !
i feel really silly!! thank-you matthew!!!

Matthew: No problem

Helen: your a star!!!! (smiley face)

The time lapses here are very short at ten minutes or under making this much more like a 'normal' conversation in real time. Matthew's contribution amounts to an elaboration of his previous statements and he 'unpacks' the meanings which this time enables Helen to make sense of the solution. Her response, which is full of exclamation marks, looks spontaneous and she seems really pleased with herself but annoyed at the same time that she did not understand it sooner. From Helen's annoyance with herself, it seems likely that she has re-read the earlier exchange by this point. This is obviously possible with the webboard discussion and is a significant difference from 'normal discussion'. In face to face conversations the only opportunities for revisiting prior exchanges are to run through them in one's memory. This might be considered to be a significant advantage of the webboard discussion. Once again the conventions of text messaging and internet chatting are apparent with the use of the 'smiley' and the abbreviations. Helen is once again engaging Matthew in social chat as well as mathematical discussion. Matthew's 'no problem' is his first solely social contribution to the discussion and he even adds a smiley face to emphasise it.

Helen now raises another mathematical question:

Helen: can u help again!!!! i think i no the answer but i'm not sure?? between midnight and midnight in a 24 hr day how many times are the minute hands at right angles to each other?? got sixteen but that s only in 5's e.g 5 to 6 10 past 4 e.t.c do think i

need to do the minutes?? Helenxxx

Once again the conventions of emailing and text messaging are apparent and Helen adopts the same chatty informal style although this time she seems to have more idea about how to solve the problem. This time Matthew responds by asking for clarification and raising a mathematical question and a new mathematical concept:

Matthew: I'm not sure I get the question. Are we looking for times where the minute hand is perpendicular to the hour hand? Because you mention times like 5 to 6, and I see no right angle there (?) Also, how does the clock work. Do the minute hand and hour hand change continuously?

In doing this he makes his mathematical expertise clear and seems to assert his position as Helen's mentor. The concept 'continuously' is quite advanced mathematically so Matthew raises the mathematical level of the discussion by introducing it. Helen's response clarifies the question and explains that continuous is not mentioned in the question.

Now there is a change with the intervention of a new participant, Jeff, after a time delay of only eleven minutes. Of course with the webboard discussion it is impossible to judge how long Jeff has been 'lurking' and watching the conversation or whether he has just noticed it. However, he doesn't enter into the spirit of the exchange at all and contributes by just giving an answer. This is not the same as talking about the problem. His intervention suggests that he has failed to interpret the culture of the exchange which is about supporting one another's mathematical thinking rather than telling answers.

Matthew's next comment is added only a minute after Jeff's and it seems likely that he did not see it until he had made his own contribution. He elaborates a solution to the problem as follows explaining how many occurrences there will be each hour and discounting 4 out of the 48 which would have been counted twice. It is possible too that Matthew has seen Jeff's solution and chosen to ignore it. He does however reach the same conclusion of an answer of 44 although it is a little unclear why he chooses to discount 1:50, 2:55, 22:05 and 23:10. He then adds 'Ah good!' and a smiley although it is rather unclear to what this contribution refers although it may be an expression of satisfaction that Jeff's solution agrees with his. Jeff now elaborates on his contribution with a mathematical explanation that is intimidating in its use of algebra:

Jeff: Ok, well theres several ways to do this. The first is to systematically go through each hour and count, which isnt particularly mathematical, nor imaginative. The other way to do this is to find the length of time between each right angle occurence. We can write an equation where t is the number of minutes elapsed and θ is the bearing of the hour hand, and α is the bearing of the minute hand. ... Solve the equation to find the length of time between each right angle.

It is interesting to note that Jeff's contribution here effectively rubbishes Matthew's method of solving the problem. It seems that he has taken on the role of arbiter of

what counts as mathematical. Note that he does not try to solve these equations and it is questionable whether using them is at all helpful. Matthew makes another contribution that more or less ignores Jeff and considers a different approach to a solution:

Matthew: Interestingly, if the clock works like my watch where the minute hands and hour hands are updated only once per minute, then the only solutions are 03:00, 09:00, 15:00, 21:00.

This offers another valid solution but with different constraints. It is a highly mathematical contribution working with the idea that mathematical problems have different contexts and that these contexts need to be well defined for the solutions to be clear. The following contribution from Helen revives the conversation with Matthew and asks why the values he listed should be ignored. It seems that she has re-read the earlier conversation and asks:

Helen: hi matthew it's helen again why do u take away these times :01:50, 02:55, 22:05, 23:10 ? helen xxxx

Once again Helen's approach is very friendly and it seems rather as though she would like to get back to her one-to-one conversation with Matthew. She makes two more increasingly frustrated appeals for help even commenting on the football result while she is writing:

Helen: pls help somebody do you know why we had 2 subtract the times mentioned above?????? helen ps we rule 2-1 england croatia

And then another in a similar vein in a different colour with lots of sad faces. However Jeff is waiting in the wings and gives Helen an explanation of the times that need to be discounted. This time he seems to have picked up the genre of contributions and offers a fully argued mathematical account of why there are four times in the 24 hour period that might feasibly be considered to have been counted twice in giving an answer of 48. He seems to have become enculturated into the setting of this webboard discussion and his contribution now fits in perfectly with those of the others. He has also taken over Matthew's role here of mentor to Helen. After this the discussion dries up.

SUMMARY AND CONCLUSIONS

The discussion involves three participants: Helen, Matthew and Jeff. It is predominantly a dialogue between Helen and Matthew with Matthew in the role of teacher or mentor. Jeff also takes on something of a mentor role but his intervention is brief. It is initiated by Helen by asking for help on a problem which she states clearly. In the webboard discussions a specific question is often the starting point for thread and after an initial statement of a problem by a user a mentor commonly offers some hints about how to tackle it as Matthew does here.

There are similarities with classroom talk in the exchange. The levels of mathematical reasoning here are varied with some demanding concepts being

discussed such as continuity. Matthew and Jeff both use strategies that are used by teachers in class room talk such as shifting in the use of personal pronouns and re-voicing Helen's contributions. Matthew makes a metacognitive comment and this is also something that teachers use. He also gives a hint then asks a question which is a ploy often used in classrooms (Back 2004).

The main difference between these exchanges and those found in face to face discussion in classrooms is the way in which webboard discussion is open to breaks and gaps. This offers both advantages and disadvantages. One advantage is that the participants have plenty of time to think before responding and can re-read other contributions. The webboard environment may appeal to those who like more time to mull ideas over and for whom the 'quick fire' setting of many classrooms fails to allow space for deep thinking. The main disadvantage is that not being face to face means there is less sense of ideas sparking off one another as the conversation proceeds although the text messaging conventions that these young people use do speed things up a little. To gain further insights a larger sample of discussions will need to be considered but there is some evidence here of meaningful mathematical discussion between these young people.

The exchange displays some of the characteristics of transcripts of classroom talk in its informality but also some of the characteristics of a written communication: it is actually written but displays the informality of a spoken communication. This throws up questions about what appropriate analytic tools and framework for its analysis might be. Schreiber (2003) suggests that internet chats have an intermediate status between speech and written texts and this webboard discussion seems to be similar. It might be worthwhile exploring further the similarities to and differences from other written and spoken communication in mathematics. Starting points might be some definition of 'typical' classroom discourse or it might be necessary to elaborate some more precise descriptors of mathematical communication.

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