Helpwithmaths.com: Students' Use of Online Mathematical Resources

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A recent Google search for 'Help with maths' produced 57 600 000 results, indicating that there are literally millions of online resources claiming to provide assistance with mathematics. As mathematics educators, however, we remain largely uninformed about students' use of such resources, particularly when they are self-initiated and often accessed in an out of classroom environment. This paper reports on a study that investigated the resources Grade 8 and 9 students accessed when requiring support with understanding mathematical concepts. The study found that while friends and teachers were often students' preferred options, they did access online sites, particularly in the later years of schooling. The study has implications for students and teachers including the potential for online resources to both complement and challenge the traditional role of the teacher and contemporary classroom practices.

Understanding, explaining and addressing the ways in which inequities in mathematics education continue to be regenerated is a worldwide issue. Much of the research is this area has examined the role of the teacher (e.g., Askew, Brown, Rhodes, Johnson & Wiliam, 1997) or evaluated specially designed intervention programs, (e.g., Bobis, 2009; Graham, Bellert & Pegg, 2007; Wright, 1991). While some of these programs and other classroom practices incorporate online resources, there is a significant gap in the literature of documentation on students' self-initiated use of online resources. Much of the current research in mathematics education and ICT in Australasia at least, has tended to focus on use of digital technologies (e.g., Beatty & Geiger, 2010; Kissane & Kemp, 2008), and teachers' use of technology (e.g., Beswick & Muir, 2010; Goos & Bennison, 2008). While some attempts have been made to document students' use of particular programs or resources (e.g., Fitzallen, 2008), research into students' self-initiated use of mathematics online tutorials is rare (for an exception see Kronholtz, 2012). Anecdotal evidence suggests that the internet is a rich resource for students, particularly adolescents, who may be reluctant about seeking assistance in class, and at a greater risk of disengagement from learning (MCEETYA, 2008). It may be that online tutorials could be used as an additional resource to teachers, parents, personal tutors and teacher aides, particularly for students studying higher order mathematics. This paper addresses the gap in the literature through reporting on data collected about students' choice of resources to assist them with mathematics, their use of online resources and their perceptions of the benefits or otherwise of such resources. The results will inform mathematics teachers and educators of the potential of these resources for enhancing students' mathematical learning and engagement with mathematics.

Theoretical Framework

Research in mathematics education over the last decade has addressed the nature of new technologies, with many reporting that the use of technology has a positive effect on students' attitudes towards mathematics. Some taxonomies of student behaviour in relation to the use of technology to learn mathematics have been cited in the literature with the most relevant to this paper being the four metaphors developed by Galbraith, Goos,

In V. Steinle, L. Ball & C. Bardini (Eds.), Mathematics education: Yesterday, today and tomorrow (Proceedings of the 36th annual conference of the Mathematics Education Research Group of Australasia). Melbourne, VIC: MERGA.

Renshaw and Geiger (2000). In particular, the notion of Technology as Partner', whereby technology is used creatively to increase the power that students have over their learning (e.g., use of graphical calculator) could be applied to students' use of online resources. Such use is also consistent with the goals identified by MCEETYA (2003, p. 4), which recommend that "students will use online curriculum content to expand and deepen their understanding at a pace, in a place and with an educational purpose that suits them".

There is continued concern in Australia and internationally over the lowering levels of engagement with mathematics (Attard, 2010). Engagement in this context occurs when students are procedurally engaged during mathematics lessons and beyond, they enjoy learning and doing mathematics, and they view the learning and doing of mathematics as a valuable, worthwhile task, useful within and beyond the classroom (Attard, 2010). Research has shown that there is a definite decline in school mathematics engagement of many young adolescents compared with their primary school counterparts (NSW Department of Education & Training, 2005). According to Attard, the pedagogical relationship between students and teachers appeared to have a significant effect on students' engagement in mathematics, but she also found that students were highly engaged when working on computers.

In his seminal work, Skemp (1978) distinguished between two kinds of understanding in mathematics: instrumental and relational. Relational understanding is concerned with the underlying principles of a particular mathematical idea whereas instrumental understanding involves following rote learnt rules and procedures, that is "rules without reason" (Skemp, 1978, p. 9). Whilst instrumental understanding may afford students the opportunity to get the correct answers to certain mathematical items in a very specific context, relational understanding involves the learner building a conceptual structure to solve mathematical problems in a range of contexts. Online tutorials, such as Khan Academy, have a strong focus on demonstrating mathematical procedures, thereby facilitating instrumental understanding, but according to its supporters, Khan has the "uncanny ability to inhabit the mind of someone who doesn't already understand something" (Thompson, 2011, p. 4). Critics, however, argue that the videos and software encourage uncreative, repetitive drilling and lack the interaction that a teacher can provide.

Methodology

The main aims of the study were to investigate students' sources for assistance in mathematics, including online resources, and then to further investigate how, why and what online resources students were accessing across a range of grades and contexts. The study was undertaken with Grades 5-9, but only the data collected for Grades 8 and 9 are presented in this paper. The participants were 47 Grade 8 students from two different classes and teachers, and 28 Grade 9 students from two different classes with the same teacher. The Grade 8 classes were of mixed ability while the Grade 9 classes were streamed and represented 'middle' achievement. All classes were from the same large metropolitan non-government school. The teachers volunteered their classes' participation and parental consent was obtained for all student participants. The procedure involved the completion of an online survey using Qualtrics and for some students, participation in a follow-up interview. The researcher visited each class, provided students with the link to the survey and was present while students completed the survey online. The survey contained 28 questions, of which 17 were Likert scale items (see Table 1 for example statements). There were two questions which required students to rank items, and 3

questions that provided for open-ended responses. The survey took approximately 20 minutes to complete.

A total of eight Grade 8 students and 12 Grade 9 students participated in the interviews. Students were given the choice to be interviewed individually or in pairs and all opted to be interviewed in pairs. Interviews were typically fifteen minutes duration, with questions related to elaboration of the survey responses. In the first part of the interview, students were asked who they accessed first for assistance in mathematics and why, and whether or not they had used the internet and any online resources to help them with their mathematics. In the second part of the interview, they were asked to select a clip from Khan Academy, watch the clip (limited to 5 minutes duration) and then respond to questions about it. Khan Academy was selected as it houses a variety of different topics, is free and easily accessible, and was identified by the Grade 9 teacher as a site students would be familiar with.

Quantitative data from the survey were analysed using Qualtrics, with responses to the Likert scale items expressed in percentages for ease of comparison. Qualitative data from the surveys and interviews were transcribed and analysed using reflexive iteration (Srivastava, 2009) whereby each sentence in the transcripts was coded using both pre-determined and emerging themes, progressively leading to increased focus and understandings.

Results and Discussion

Students' choice of assistance in mathematics

Survey question 5 contained seven Likert items that were used to gather data on this aspect. In addition, question 18 required students to rank where they went for help and to explain why in question 19. Students who were interviewed were also asked to elaborate on their responses to these questions.

Table 1
Grade 8 responses to Likert scale items

Statement	SA/A	Undecided	D/SD
If I don't understand something in maths I ask my teacher	85%	4%	11%
If I don't understand something in maths I ask my parents	60%	10%	30%
If I don't understand something in maths I'll go to the internet for help	36%	13%	51%
If I don't understand something in maths I'll ask my friends	64%	11%	25%
If I don't understand something in maths I'll go to text books and study guides and try to work it out myself	45%	23%	32%
I feel uncomfortable asking for help in mathematics	32%	6%	62%
I have used the internet to help with mathematics	55%	11%	34%

Tables 1 and 2 show, that for both grades, there was a high level of agreement in relation to asking the teacher for help in mathematics. For both grades there was a similar percentage of disagreement for the statement 'I feel uncomfortable asking for help in mathematics', indicating that generally students felt they could ask for help. There was a noticeable increase in agreement to the statement about using the internet for Grade 9

students, and a decrease in agreement in relation to asking parents. This could be attributable to the more difficult nature of the mathematical content studied in Year 9, a factor which was later elaborated on in the interviews and open survey responses. Asking friends for help was a more popular response for Year 9 students and the interviews and open responses also showed that friends were often the first or second choice for both year groups.

Table 2
Grade 9 responses to Likert scale items

Statement	SA/A	Undecided	D/SD
If I don't understand something in maths I ask my teacher	86%	11%	3%
If I don't understand something in maths I ask my parents	46%	11%	43%
If I don't understand something in maths I'll go to the internet for help	82%	18%	0%
If I don't understand something in maths I'll ask my friends	89%	4%	7%
If I don't understand something in maths I'll go to text books and study guides and try to work it out myself	18%	25%	57%
I feel uncomfortable asking for help in mathematics	21%	14%	65%
I have used the internet to help with mathematics	93%	4%	3%

The tables show that students used a variety of sources to ask for help, and Question 18 complemented this through requiring students to rank in order where they would go to for help. Table 3 shows the results for first and second preferences for both year groups.

Consistent with responses received for the Likert scale items, students indicated a strong preference for asking the teacher for help first. Friends received a similar ranking for both year groups, while the use of internet again increased for Grade 9 students, with the use of parents declining. As the survey question did not differentiate between home and classroom context for seeking help, the explanatory sentences given in response to Question 19 provided clarity around this. In terms of teacher selection, responses typically included reference to the teacher's knowledge and/or ability to explain:

> I go to my teacher because he is most likely to know how to help me the best (Grade 9 student)

> I would ask my maths teacher first because they are going to know how to work it out properly and get the answer right (Grade 8 student)

Table 3
Results of first and second preferences for Year 8 and 9 students

First or Second Preference	Grade 8	Grade 9
Teacher	43%	42%
Friends	21%	18%
Parents	23%	12%
Internet	7%	20%
Textbook	6%	8%

In contrast, some students preferred to ask their friends, with common reasons being availability and ability to explain:

> I would ask my friends first before asking for help from teachers as I feel they can explain it easier *(Grade 8 student)*

I would go to my friends because they are at, and explain at, my level *(Grade 8 student)*

I would firstly ask my friends because they are the closest to me *(Grade 9 student)*

Students mainly mentioned the internet and parents in relation to homework, with reasons given generally related to convenience and expertise. There was a general perception that the internet "is a good provider of information" (Grade 9 student), with one student writing that "I would go to the internet because parents and teachers are not always right and the internet is more reliable" (Grade 8 student).

While the interviews were generally structured to focus on students' use of online resources, students were asked about where they would go to first to assist them with mathematics. Again teachers and friends featured strongly with convenience and good explanations being common reasons. The interview situation did provide for more opportunity to expand on reasons as the following response indicates:

My friends [because] my friends know how I think better than anyone and they're like higher up in maths and they can like explain things to me and I get it a lot easier than a teacher or a computer or anything like that *(Carol[1], Grade 9 student)*

When students did mention the internet, it was often with reference to convenience and as a knowledgeable source, particularly when at home. While some students mentioned parents, many of these had parents who were "good at maths" while others felt that they could not ask their parents for help as "a lot of the new methods they're teaching us in the book, my parents don't use those" (Tim, Grade 8).

Students' use of online resources

In the survey, 64% of Grade 8 students and 96% of Grade 9 students agreed that they used online resources to help with their learning. 79% of Grade 8 students and 64% of Grade 9 students, however, indicated that this usually occurred in other subjects, rather than mathematics. 76% of the Grade 8 students indicated that they had never used Youtube as a mathematical resource, with 51% being unaware that such resources were available. Of those who did use online mathematical resources, the most common response from both groups was to use 'Google' to search for mathematical topics, with Mathletics being the next most cited resource for Grade 8 students and Khan Academy for Grade 9 students. This was probably due to the different class contexts in which Grade 8 students were given access to Mathletics while the Grade 9 teacher exposed students to Khan Academy. The survey also had provision for students to describe a situation in which they used the internet to find out more about a mathematics concept. Responses typically revealed that "if I am confused about a maths problem I will look on various websites to see if I can find the solution" (Grade 9 student), while others were more specific: "I looked at a video on Khan Academy on trigonometry showing sin, cos and tan" (Grade 9 student).

Students' evaluation of online tutorials

In the interviews students were asked to select a video clip from a Khan Academy online tutorial and to provide feedback on the clip in terms of maintaining their interest, helping them with understanding a concept and then comparing it to explanations given by other people. While all of the Grade 9 students who were interviewed were familiar with Khan Academy, many had only used it once or twice and the majority of Grade 8 students had not heard of the site or accessed it before. When making the selection, students (in

[1] Pseudonyms used throughout

pairs) were asked to choose a clip whose topic was one that they were either not confident with or wanted to find out more about. Topics selected varied among students and included mean, median and mode, algebra, sin rules, ratios and trigonometry.

After viewing the clips, which were typically between 3-5 minutes duration, students were asked to rate the footage on a scale of 1-10 in terms of maintaining interest and 1-10 in terms of helping with understanding. 60% of all students rated the clip they viewed as 7 or more in terms of maintaining interest, while 75% of all students rated the clip 7 or more in terms of helping them understand. When asked about the features of the clip which made it interesting or easy to understand, most students identified that the style of the presenter and the combination of drawings and verbal explanation were beneficial. For example, one student after viewing a clip on mean, median and mode, noted that "it was a lot more interesting than reading out of a book really because it was nice to see visually, but it was also nice to see how he explained it as well with a different tone for different things so he used different tones to get you more involved" (Zoe, Grade 8). Many commented on the voice being "human" and made reference to the use of different colours used in the diagrams as being particularly helpful. Students also believed the information to be credible, and portrayed in a way that helped them understand. For example, one student stated that "some teachers will tell you something and you won't have any clue what they're talking about, but with him you know what he's talking about" (Bill, Grade 9).

Not all students, however, agreed that the clips were interesting and helpful. Some found the footage to be "too repetitive", while others found that he "talked really quickly and that he didn't explain how to do it very well". While students' evaluations were likely influenced by the subject matter that they chose and whether or not they were familiar with the topic, their responses did provide general feedback about the strategies used by the presenter and their relative effectiveness.

Students were also asked to comment on how the online tutorial compared to the explanations that they received from others. Feedback was mixed, with students providing some insightful comments about the use of such resources:

> [he has] probably got more time to like describe everything … and the teacher might not have time to explain it *(Declan, Grade 8)*

> This is probably more detailed … our maths teacher sort of runs through things a bit quick [but] this helps you do it at your own pace … and you can pause it *(William, Grade 8)*

> It'd be easier with the teacher because if he was explaining something and you didn't understand, then you could ask him something … and also the teacher would know the student so they would be able to explain it in a way that they would understand *(Carol, Grade 9)*

A common theme that emerged was the recognition that the teacher has responsibility for teaching a whole class and was not always available to provide assistance when it was required. One student, Damon (Grade 9) thought that "with a regular teacher you can't ask them to repeat – well you can, but it would be disrupting the rest of the class, but you can just play back the video if you don't understand what is happening", while another student, Josh (Grade 9) would access online tutorials if "I didn't want to disrupt the teacher if he was helping another student".

While many of the students indicated in the survey that friends were a popular source of information for assistance with mathematics, most students rated the online tutorial clip as more helpful and more accurate than a friend's explanation. For example, Damon (Grade 9) stated that:

> [the online tutorial] is more in depth so it helps you understand more – and when friends help you, they're helping you with one question maybe and if they have time, they'll help you with how the actual thing works, but that is what this does, it's helping you with how the whole actual question or thing works

Other typical student comments included "I'd probably go to that because a friend's explanation isn't always right" (Nigel, Grade 8). Reference to accuracy was a common theme, as the following transcript from an exchange with a Grade 8 student shows:

> Hannah: I would trust the computer a lot more – their explanation more than a friend's
>
> Researcher: OK, so are you pretty convinced that the information he gave you was correct?
>
> Hannah: Yes

Overall, students' responses indicated that they could see the usefulness of such tutorials and many said that they would use them in future when they required assistance. The benefits included the accessibility of the resource, the simple explanations and the facility to pause and view it multiple times. In this respect, students were demonstrating the notion of 'Technology as a servant' (Galbraith, et al., 2000) and operating at a pace and with a purpose that suited them (MCEETYA, 2003). On the other hand, some limitations identified included the generic explanations that were not tailored to individuals and no opportunity to interact and ask questions.

Conclusion

The results from the study indicate that for these groups of students, asking for help in mathematics was an accepted practice, with the preferred options being teachers and friends. The students also identified that online resources were useful particularly when teachers and friends were not readily available. The students could also identify aspects of online tutorials that were helpful and rated them quite highly in terms of maintaining their interest and adding to their understanding. In terms of engagement, observations and interview data indicated that the students did engage with watching the clips and some benefits were identified over traditional teacher instruction. The video clips viewed, however, could be described as facilitating instrumental understanding (Skemp, 1978) and the study was not able to determine whether or not students' relational understanding would be enhanced through watching the clips. In terms of implications, the study has showed that online resources have the potential to be part of students' learning experiences. Teachers and friends are not always available to provide assistance and parents find it more challenging to offer support as their children move into senior grades. Further research is required to determine extent of use with a larger sample size and whether or not student outcomes can be improved through the use of such resources.

References

Askew, M., Brown, M., Rhodes, V., Johnson, D., & Wiliam, D. (1997). *Effective teachers of numeracy*. London: School of Education, King's College.

Attard, C. (2010). Students' experiences of mathematics during the transition from primary to secondary school. In L. Sparrow, B. Kissane & C. Hurst (Eds.), *Shaping the future of mathematics education* (Proceedings of the 33rd annual conference of the Mathematics Education Research Group of Australasia, pp. 53-60). Fremantle, WA: MERGA.

Beatty, R. & Geiger, V. (2010). Technology, communication and collaboration: Rethinking communities of inquiry, learning and practice. In C. Hoyles, & J.B. Lagrange (Eds.), *Mathematics education and technology – Rethinking the terrain* (pp. 251-284). New York, NY: Springer.

Beswick, K., & Muir, T. (2011). Interactive whiteboards as potential catalysts of pedagogic change in secondary mathematics teaching. In J. Clark, B. Kissane, J. Mousley, T. Spencer, & S. Thornton (Eds.), *Mathematics: Traditions and [new] practices* (Proceedings of the 34th annual conference of the Mathematics Education Research Group of Australasia & the 23rd biennial conference of the Australian Association of Mathematics Teachers, pp. 115-123). Adelaide, SA: MERGA.

Bobis, J. (2009). *Count me in too: The learning framework in number and its impact on teacher knowledge and pedagogy*. Sydney: NSW Department of Education and Training.

Fitzallen, N. (2008). Validation of an assessment instrument developed for eliciting student prior learning in graphing and data analysis. In M. Goos, R. Brown, & K. Makar (Eds.), Navigating currents and charting directions (Proceedings of the 31st annual conference of the Mathematics Education Research Group of Australasia, pp. 203-209). Brisbane, Qld: MERGA.

Galbraith, P., Goos, M., Renshaw, P., & Geiger, V. (2000). Emergent properties of teaching-learning in technology-enriched classrooms. (Short communication). In J. Bana & A. Chapman (Eds.), Mathematics education beyond 2000 (p.690). Sydney: MERGA.

Goos, M., & Bennison, A. (2008). Surveying the technology landscape: Teachers' use of technology in secondary mathematics classrooms. Mathematics Education Research Journal, 20(3), 102-130.

Graham, L., Bellert, A., & Pegg, J. (2007). Supporting students in the middle school years with learning difficulties in mathematics: Research into classroom practice. *Australasian Journal of Special Education, 31*(2), 171-182.

Kissane, B. & Kemp, M. (2008). Some calculus affordances of a graphics calculator. *Australian Senior Mathematics Journal, 22*(2), 15-27.

Kronholtz, J. (2012). Bell curve to the right. *Education Next* (Spring 2012),17-22.

MCEETYA. (2008). Melbourne declaration of the educational goals for young Australians.

MCEETYA. (2003). Learning in an online world. Available: http://www.mceecdya.edu.au/verve/_resources/ICT_LearningOnlineWorld-Content_Strategy.pdf

NSW Department of Education and Training. (2005). Students - middle years. Retrieved from http://www.dec.nsw.gov.au/about-us/statistics-and-research/public-reviews-and-enquiries/

Skemp, R. (1978). Relational understanding and instrumental understanding. *Arithmetic Teacher, 26*(3), 9-15.

Thompson, C. (2011). How Khan Academy is changing the rules of education. Retrieved from: http://www.wired.com/magazine/2011/07/ff_khan/

Srivastava, P. (2009). A practical iterative framework for qualitative data analysis. *International Journal of Qualitative Methods 8* (1), 76-84.

Wright, R. J. (1991). The role of counting in children's numerical development. *The Australian Journal of Early Childhood, 16*(2), 43-48.