Mathematics was taught from 6th century BC from the Greeks, however, the topic of communicating mathematics has only been discussed from the sixteenth century. Mathematical communication is understanding how to engage with a range of audiences to learn and understand mathematics. This could be through engagement activities such as an interactive session, exploration of concepts through physical objects, and the standard teaching and answering questions from a textbook.

However, in modern society, many mathematical concepts may not have been interesting or easy to understand, such as algebra, trigonometry in comparison to geometry. The current curriculum within the UK is standardised to help ensure that students can understand the topics with ease through the meticulous planning of what needs to be included within each year group. In contrast, prior to the sixteenth century, mathematical communication was not thought of as scholars were persuaded to explore, understand, and create to compete against other scholars. It would be a battle of who has new ideas and the first to communicate to the society leading to the foundation of mathematics in today’s age.

Mathematical Communication was not spread easily to teach to others as of the lack of a printer. However, in 1440, as seen in [1], this had revolutionised the opportunity to mass produce mathematical research, theorems, and teachings for others to review and understand. Many new scientific ideas were not shared until scholars encountered each other or through connections, hence this meant research was primarily individual and were not seen by others. However, this did not stop individuals from sharing their knowledge, which due to the invention of the printer press, enabled individuals to publish their own scientific research to permanently record it for others to see.

[1] "[Mathematics, Communication, and Community .](https://www.encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-maps/mathematics-communication-and-community)" Science and Its Times: Understanding the Social Significance of Scientific Discovery. . *Encyclopedia.com.* 28 Dec. 2021 <[https://www.encyclopedia.com](https://www.encyclopedia.com/)>.

Another study was made to show the relationship of communication for students and their understanding of mathematics. As shown by (Kosko et al. [2]), the author has referenced several resources which showed a positive correlation between the level of a students’ understanding of mathematics and communication in the form of verbal and written. To summarise, for students to understand mathematics, it is vital for them to be able to interact with the concepts so that they can piece the puzzle together. Some may describe and think of mathematics as being logical, however, it requires creativity to be able to think outside of the box and potentially discover new concepts.

A series of methods are detailed within the paper, such as the use of manipulatives (using physical materials), verbal communication and/or social interaction (where students engage with other students to deepen the understanding of mathematical concepts), written communication (enabling them to connect and create a formal understanding of the concept). Consequently, combining both manipulatives and different forms of communication, this builds the solid foundation of the theory. As suggested, without the combination of the two sides, it can decrease the confidence of one understanding the concept fully. Hence, the study primarily shows the importance of manipulatives use and it’s benefits of utilising this to build the platform for students to continuously write and discuss mathematics.

Throughout the study, it compares the different types of communication in mathematics, such as – student discussion, writing about mathematics, and connecting mathematical communication and manipulative use. The blend of these variations in effect allows students to improve and deepen their understanding. The main purpose of manipulatives was used to understand abstract concepts. Within the statistics, there was a positive correlation between manipulative use and writing providing a “statistically significant” result of ρ=.32, p<.01. Discussion was also positive, ρ=.32, p<.01. Finally, the best correlation was between writing and discussion ρ=.32, p<.01. This was shown on page 86, detailed in Table 3. As observed, this can create a feedback loop between the different communication methods.

From the conclusion of the article, it was shown that the use of manipulatives had encouraged students to continue writing about mathematics which further improved several skills other than mathematics, these included social skills, being more logical and creative. However, this study only showed how effective the method given would be, provided to the teachers. The study also showed a range of different methods of teaching, which showed that in a face-to-face setting, students are more engaging and likely to ask more questions. In relation to my project, this would mean that to produce the best results of engagement, and to evaluate the effectiveness, it would be best to create an engagement activity in a face-to-face setting and one online to compare the differences. However, since COVID-19, it may be difficult to conduct the former. On the other hand, this could be conducted within the same bubbles, which can still provide results for the experiment.

[2] Kosko, Karl & Wilkins, Jesse. (2010). Mathematical Communication and Its Relation to the Frequency of Manipulative Use. International Electronic Journal of Mathematics Education. 5. 79-90. 10.29333/iejme/251.

From the previous journal [2] the author had referenced Borasi et al [3], in which I have included a summary following. As mentioned, [3], the article discussed the “educational value of engaging mathematics students in a specific form of writing to learn – the keeping of a journal throughout a mathematics course.”. It details the positive benefits of keeping a journal which allows students to reflect on the mathematics taught whilst giving teachers an insight on how students feel about the mathematical concepts and the course itself. Similarly, the utilisation of a journal builds a relationship between the teacher and student that is tailored to support each individuals’ learning path.

A general journal has provided many uses of the user confiding in themselves, detailing their feelings and thoughts, as well as acting like a progress log. In this case, if students were open enough to trust their teachers reading this journal, it could provide an insightful view to how each of their students feel about each topic, content, lesson and overall, their progress in relation to the materials covered. However, this is a significant step for students to be able to open up for their teachers to have a look at this journal. Journals are generally private and to create a mathematical journal is a different perspective. Although, if a journal is an extension to the exercise book that they use to complete and answer questions, then this may not be as difficult for students to engage with.

As explained, the education of mathematics was primarily seen to be memorising formulas and equations in order to answer them in exams. However, as students study mathematics to a higher level, it can be seen that this is an inappropriate way of learning as it does not provide understanding but only the application. Furthermore, to fully absorb and engage with mathematics, it is crucial to interact with the content in order to fully understand the meaning of why specific formulas and steps are used. Through memorisation, students may be able to answer specific questions easily as of a similar method used for different types of the same topic. For example, addition with likewise terms (x, y, z, etc). However, if applied the same way for calculus, either differentiation or integration, there are multiple methods in which can solve the statement, more so when using trigonometric functions (cos, sin, tan, arcsin, arctan, etc). Proper understanding allows students to know the why and utilise the methods given to solve the statement efficiently.

If we were taught that Mathematics is a science where there is more solving and logic in contrast to English which uses creativity and writing, it would be seen as surprising to be told to write in maths. However, [3] defends that by “writing mathematics intensively, this can create powerful connections between writing and learning”. The concept of writing to learn is a form of active learning as long as the learner is trying to make meaning of the steps involved for each of their topics. As suggested by Mayher et al [5], the concept of active learning is also evidenced by (Oakley 2014, pg, ) [7].

[3] Borasi, Raffaella, and Barbara J. Rose. “Journal Writing and Mathematics Instruction.” *Educational Studies in Mathematics*, vol. 20, no. 4, 1989, pp. 347–365., <https://doi.org/10.1007/bf00315606>

[5] Mayher, J. S., Lester, N. B. and Pradl, G. M.: 1983, Learning to Write/Writing to Learn, Boynton/Cook Publishers, Inc., Upper Montclair, NJ.

[6] Zhou, Jiayu. (2020). A Critical Discussion of Vygotsky and Bruner’s Theory and Their Contribution to Understanding of the Way Students Learn. Review of Educational Theory. 3. 82. 10.30564/ret.v3i4.2444.

[7] Oakley, B., 2014: *A mind for numbers*. J.P. Tarcher, New York,.

[4] Trisnawati, T., R. Pratiwi, and W. Waziana, 2018: The effect of realistic mathematics education on student's mathematical communication ability. *Malikussaleh Journal of Mathematics Learning (MJML)*, 1, 31, doi:10.29103/mjml.v1i1.741. https://ojs.unimal.ac.id/index.php/mjml/article/view/741

Cite in AMS

Thoughts on teaching mathematics:

* Using a journal to communicate with students, individual and unique
* Being able to do a colour code so that for each topic, they can say use a colour to say whether they need more help, and if majority of class needs help, to recap over specific topics

Aim to have 8 – 12 references for every 1000 words

5 – 20 depending on level. Honours dissertation: 20+ titles

Think about books for your dissertation since you seem to only have journals right now

36 hours