

Marc SCHÄFER & Dietlinde Nelao NAMAKALU, Grahamstown
(South Africa)

The role of gestures as visualization tools in the teaching of mathematics

Introduction

We take it for granted that gestures are integral to our interpersonal communication repertoire. They are closely linked with language and thought (Bernard, Millman & Mittal, 2015). Some gestures are quite explicit and easy to understand, while others are more cryptic and thus less obvious. The role of gestures when we teach is perhaps less obvious than initially meets the eye. This paper takes a closer look at the role of gestures in the teaching of mathematics by observing the practice of three primary school teachers and then engaging them in analysing their video-recorded lessons. This qualitative case-study was part of a bigger study which interrogated various aspects of the use of visualization processes as epistemological and pedagogical tools in the teaching and learning of mathematics.

Visualisation in mathematics

When writing and theorizing about visualization, many researchers typically define visualization in mathematics by only embracing notions of producing and using imagery, both physical (external) and mental (internal). Others take a broader perspective and view visualization as an intricate construct that involves both process and product. For example, Arcavi (2003) quite eloquently proposes that visualization is “the ability, the process and the product of creation, interpretation, use of and reflection upon pictures, images, diagrams, in our minds, on paper or with technological tools, with the purpose of depicting and communicating information, thinking about and developing previously unknown ideas and advancing understandings” (p. 217). This definition however is still imagery bound. What about visualisation processes that are embodied with our actions and our ways of communicating such as gestures and language?

In particular, Castellon and Enyedy (2006) suggested that when gestures are used in combination with speech, they can form important visual tools. This resonates strongly with this paper which argues that gestures, which are ubiquitous and readily available to all teachers, can be used to support meaningful conversations and thus mediate learning. This of course begs the question as to the extent to which teachers use, or should use gestures more strategically and consciously? We all use hand gestures, to illustrate physical

objects and even abstract concepts (McNeill, 1992) – but do we make optimum use of these gestures to support learners to visualise mathematical ideas and concepts? From anecdotal observations we can argue that gestures are often used spontaneously, in and for the moment, and often rather inconsistently and not very precisely. The aim of this small-scale study was thus to observe more critically what gestures selected primary school teachers used and for what purpose? The specific research questions that the study sought to answer were:

1. What is the nature of gestures that selected junior primary teachers use in the teaching of mathematics?
2. What are the views and perceptions of selected teachers of the visualisation roles of these gestures as visualisation tools in the teaching of mathematics?

Gestures

In broad terms, gestures are bodily movements, usually with our fingers, hands and arms that accompany a verbal explanation or statement. Gestures often coincide with speech and follow a similar rhythmic pattern. They are used to support, exemplify or illustrate what is said. Goldin-Meadow (2004, p. 314) make the observation that gestures, often in the form of “hand movements ... are directly tied to speech”. Kendon (1996) includes movements in posture, touching of oneself such as stroking one’s hair, various nervous ticks and other fiddling movements as gestures. Although researchers such as Efron (1972) and McNeill (1992) distinguish between everyday conversational gestures and more formal communication gestures, this study specifically focussed on teaching gestures that are used in conjunction with communicating mathematical ideas.

Castellon and Enyedy (2006) argued that gestures are important visual resources that can play a valuable role in the teaching-learning process of mathematics. Very pertinently they can be used as an important bridge between imagery and speech. They may be seen as a nexus bringing together action, memory, speech, imagery and mathematical problem solving (Alibali & Nathan, 2012).

For the purpose of this study we seek to understand how gestures are being used to accompany mathematical instruction with a specific focus on their role as visualisation tools.

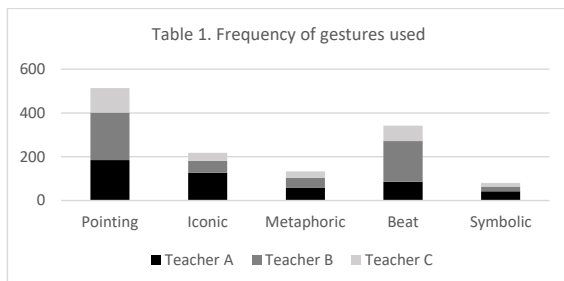
As an analytical starting point we used McNeill’s (1992) taxonomy of gestures. In this taxonomy McNeill identifies five types of gestures. These are:

Pointing gestures are those that indicate or point to persons, objects, directions, inscriptions or locations in the physical environment (Alibi & Nathan, 2012). **Iconic** gestures refer to gestures that imagistically represent object attributes, actions and spatial relationships (McNeill, 1992). **Metaphoric** gestures are those that use shape or actions to symbolically show the complexity of what is explained or expressed (McNeill, 1992). **Beat** gestures are repetitive hand movement that keep the rhythm of the speech (Kendon, 1997). **Symbolic** gestures are those that substitute the speech. In a mathematics class the following respective examples could apply:

- Pointing to an object in- or outside the classroom that looks similar to what the teachers is talking about, for example triangular roof trusses.
- Iconic are imaginative gestures that illustrate a mathematical concept, such as placing your index fingers parallel to each other to illustrate parallelism.
- Metaphorical gestures create a physical representation of an abstract mathematical idea, such as cyclical actions with the hands to illustrate iterative algorithmic processes.
- Beat gestures are used in a “rhythmical pulse” (Leonard & Cummins, 2011) to, for example illustrate repetitive mathematical iterations.
- Symbolic gestures are physical representations of shapes such as triangles by forming a triangle with the two index fingers and thumbs or tracing a triangle in the air without speaking.

Research methodology and some initial findings

Three foundation phase teachers in Namibia agreed to participate in this study. Their mathematics classes were observed for the first trimester of 2018. Ten lessons for each teacher were video recorded and analysed. After each lesson the selected teachers engaged in a 1-1 stimulus recall interview where they were asked to reflect on their lessons and elaborate on the gestures that they used and were evident in the lessons. Prior to the observations the selected teachers participated in a series of awareness and orientation workshops where the issue of using gestures as a visualisation tool were discussed and deliberated upon. The analysis of the lessons was two-pronged. Firstly, the frequency of the five types of gestures were calculated to provide an overview of the occurrence of the gestures, and secondly a qualitative analysis was done with the participating teachers for a more in-depth and comprehensive understanding of the use of the gestures. Table 1 below illustrates the frequency of the five types of gestures that were evident in the 30 lessons that were observed.



Some very few examples of what the teachers identified as the roles of their gestures included communication, illustration, conceptual support, grab attention, emphasising, motivating and giving instructions.

Conclusion

In this study we provided evidence that indicate that the use of gestures provides for a visually rich learning environment. Gestures facilitate and strengthen instructional communication and conceptual communication. It is thus important that the appropriate use of gestures is recognised as a legitimate teaching strategy that supports good teaching, and we argue that for gestures to be meaningful they should be used strategically.

References

- Alibali, M. W., & Nathan, M. J. (2012). Embodiment in Mathematics teaching and learning: Evidence from learners' and teachers' gestures. *Journal of the learning sciences, 21*(2), 247-286.
- Arcavi, A. (2003). The role of visual representations in the learning of mathematics. *Educational Studies in Mathematics, 52*(3), 215-241.
- Bernard, J.A., Millman, Z.B. & Mittal, V.A. (2015). Beat and metaphoric gestures are differentially associated with regional cerebellar and cortical volumes. *Hum Brain Mapp. 36*(10). 4016-4030.
- Castellon, V. & Enyedy, N. (2006). Teacher's speech and gesture as communicative and strategic tool to convey and discuss mathematical concepts in a bilingual Algebra classroom. *American Educational Research Association, San Francisco*.
- Efron, D. (1972). *Gesture, race and culture*. The Hague: Mouton.
- Goldin-Meadow, S. (2004). Gesture's role in the learning process. *Theory into practice, 43* (4), 314-321.
- Kendon, A. (1996). An agenda for gestures. *Semiotic Review of Books, 7*, 8-12
- McNeill, D. (1992). *Hand and mind: What gestures reveal about thought*. University of Chicago press.
- Leonard, T. & Cummins, F. (2011). The temporal relation between beat gestures and speech. *Lang. Cogn. Process. 26*:1457 – 1471.