**Can interactive visualization tools engage and support pre-university students in exploring non-trivial mathematical concepts?**

( Hai-Ning Liang & Kamran Sedig)

The authors make the observation that many students have difficulty engaging with mathematical concepts and that a new class of learning tools, namely visualisation tools may have a role in promoting higher levels of engagement with mathematical comprehensions. The paper makes the argument that a lot of the evidence about the effectiveness of these tools appears to be suggestive rather than based on empirical evaluations, the authors make the assertion that they will attempt to fill this gap and provide empirical evidence that all students, regardless of their grade level and other differences (e.g., cognitive and language skills), can benefit from interacting with the visualization tool.

My interest in this article was prompted by the nature of the study, as it has strong similarities to part of my own research project, “namely can a study assess if a visualization tool designed by research from information visualization and human–computer interaction, help pre-university students in their exploration and learning mathematical concepts”.

The results of this study show that visualization tools can “effectively engage students and support their investigation of mathematical concepts, only if the tool is designed such that it can satisfy the diverse needs of these students”; this result bound me to take this article seriously as it could help in the justification of my own research position.

 This paper investigates how a wide a range of students with varying language and learning abilities, and with diverse attitudes and preferences towards mathematics can become engaged with maths by employing a well-designed visualization tool. The authors make the point that prior to this study, that there was a lack of empirical research about the usefulness and effectiveness of visualization tools in engaging students in their exploration of non-trivial mathematical concepts, by employing rigorous research techniques throughout this paper the authors hope to overcome this.

The paper provides a good definition of Interactive visualization tools, “external artefacts whose primary aim is to support and enhance users’ exploratory, interpretational, and sense-making processes involving visually-represented information (Card, Mackinlay, & Shneiderman, 1999), these primarily adhere to a constructivist epistemology and their main features; “ (1) they maintain and display information in the form of visual representations or visualizations; and (2) they allow students to operate upon or interact with these visualizations via a human–computer interface”.

This article explains comprehensively, how tools such as Interactive visualization tools help students learn, especially abstract subjects like Geometry. Section 1.2.2, explains that by permitting the student to visually step inside a three dimensional shape this allows for the formation of a stronger ability to visualize abstract structures and relationships. Many students had difficulty forming an understanding of these abstract structures when dealing with 2-dimensional objects, the observation is made that “younger students might particularly face greater challenges because their visualization and cognitive capabilities are still largely in an early formative stage”. The authors build on this advantage of Interactive visualization tools (IVT’s), by explaining that “for learning to take place, students need to be actively engaged with the explored concepts or objects—whether abstract or concrete. The more engaged students are with these objects, the better the learning outcome one can expect. Visualizations are intended to be concrete means which allow students to explore more difficult mathematical concepts.”

The article explains the concept of metamorphosing; this hypothesis has great significance in the teaching of abstract mathematical concepts the following example is given;



 In Fig. 11. Interactive morphing (L-R): the cube transformed into the cuboctahedron through interactive morphing of the solids. Another technique that can help the student conceptualise 3-d objects is the introduction of rocking, to compensate for the lack of depth when displaying a 3-d object on a 2-d screen, by continuously tilting the object back and forth slightly a ‘rocking’ movement emphasizes the 3-dimensionality of the object.

The use of colour to reinforce visualization and cognitive capabilities is described, “Colour plays an important role in visual communication (Keller & Keller, 1993; Tufte, 1990; Wilkinson, 1999). Colour operates at both perceptual and subconscious levels; hence, its judicious use can enhance the communicative power of visual images. This is another point I will have to be cognizant off in the design of my own artefact.

To back up their findings the authors carried out a pre and post-test analysis on the participants, participants from both groups achieved a higher score on the post-test than on the pre-test. The advantage of using a pre- and post-test design is that it affords the researcher a method to compare participants’ performance before and after using IVT’s. A mean increase of 22% was recorded, this result emphasised that the overall performance of all participants improved after interacting with IVT. The inference made from statistical analysis was that IVT had a positive effect on all participants. The results indicated that that an IVT tool if properly designed, can have positive impacts on improving young children’s exploratory and learning experiences. The attitudes of the children was very positive to the use of the IVT tool with a distillation of their comments being that, “ IVT seems to have been able to assist in the exploration and learning of participants with different language skills, psycho-cognitive abilities and challenges, as well as preferences for mathematics”.

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| **Reference:**Card, S. Mackinlay, J, D. & Shneiderman, B. (1999). Readings in information visualization: Using vision to think. San Francisco, CA: Morgan Kaufman.Keller, P. R. & Keller, M, M. (1993). Visual cues: *Practical data visualization*. Silver Spring, MD: IEEE Computer Society Press.Liang, H, N. & Sedig, K. (2010). *Can interactive visualization tools engage and support pre-university students in exploring non-trivial mathematical concepts?* Journal of Computers & Education*:* Journal Article 54  |
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