

Using the interactive visualization tool Simreal+ to teach mathematics at university level: an instrumental approach

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This work focuses on mathematics education at the university level using the interactive visualization tool SimReal+. To capture the complexity of teaching and learning processes in a digital environment, this work uses the instrumental approach to explore teachers' orchestrations in classroom. In addition, this study proposes a set of criteria to analyse students' perceptions of teachers' use of SimReal+ to orchestrate the learning process. The findings indicate that SimReal+ is globally a useful tool in mathematics education at the university level.

Keywords: Instrumental orchestration, SimReal+, usefulness, visualization.

THE INTERACTIVE VISUALIZATION TOOL SIMREAL+

SimReal+ is an interactive visualization tool for teaching and learning mathematics. SimReal+ uses a graphic calculator, video lectures, video streaming, and interactive simulations to teach mathematics. The basic idea of SimReal+ is that visualizations are powerful mechanisms for learning mathematics and explaining difficult topics. According to Arcavi (2003), visualization is the ability to use and reflect upon pictures, graphs, animations, images, and diagrams on paper or with digital tools with the purpose of communicating information, thinking about and advancing understandings. There is a huge interest in visualization in mathematics education. However, there is little empirical support for the use of visualizations in mathematics education (Macnab, Phillips, and Norris, 2012).

THEORETICAL FRAMEWORK

This work uses the instrumental approach to analyse teachers' use of SimReal+ to orchestrate the students' learning of mathematics. The instrumental approach to mathematics education is rooted in a number of research studies (Drivjers, 2010; Trouche, 2004; Verillon and Rabardel, 1995). These studies highlight the role of instrumental orchestration as external steering of students' instrumental genesis, that is to say the process by which a tool becomes an instrument while students carry out mathematical tasks. Instrumental orchestration is more than a one-way process directed from the teacher to the students. It includes a socio-cultural aspect as the digital tool serves as a medium between teacher and students in teaching and learning processes. Starting from a set of possible orchestrations as defined by Drivjers (2010), new types of orchestrations may emerge as a consequence of digital tool use. This work also uses technical, mathematical, and pedagogical criteria to analyse the usefulness of SimReal+ in mathematics education at the university level.

RESULTS

A total of 13 different orchestrations have been observed, eight in lectures and five in exercises. The results show that traditional teaching with white board/projector and/without SimReal+ is the most used teacher-orchestration (41.8%), followed by Individual Guide-and-explain (10.60%), Individual technical support (7.55%), Individual Discuss-the-screen (6.97%) and technical-demo (6.31%). Regarding the technical usefulness, the findings show that it is difficult to navigate through the menus of SimReal+. This indicates that the orchestration Technical-demo should play a greater role in teaching. From the mathematical point of view, the majority of the students believed that SimReal+ is useful in learning mathematical topics such as differentiation and integration. Students' responses to interviews also indicate that SimReal+ can provide a deeper understanding of differentiation and integration. From the pedagogical point of view, a majority of the students believed that they are more motivated to use SimReal+ due to the varied methods provided by the tool.

CONCLUSION

The findings indicate that SimReal+ is a potentially useful digital tool for teaching and learning mathematics at the university level. Still, SimReal+ needs to be improved to make the user interface more intuitive and easy to use. The large number of participants ($N=500$) may be sufficient to adequately support the generalization of the results. However, new cycles of experimentations and evaluations of SimReal+ in higher education are needed to ensure more validity and reliability of the results.

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