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An Exploration of the effect of Bray's Activity Design Heuristics on Students' Learning of Transformation Geometry

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Introduction

The Irish Mathematics Curriculum, Project Maths, which was introduced into all post-primary schools on a phased basis from 2010, aligns with the core principles that underpin the Programme for International Student Assessment (PISA) mathematical framework (Merriman, Shiel, Perkins, & Cosgrove, 2014). However, there is evidence to suggest that teachers have been slow to move to the more constructivist teaching and assessment style required by the new curriculum (Jeffes et al., 2013; Merriman et al., 2014). In particular, in comparison to other participating countries, students in Ireland performed relatively poorly on the transformation geometry items in the PISA tests in 2003 and 2012.

One approach that has been proposed to address this issue is the use of Bray's Heuristics (Bray, 2016); a set of guidelines for designing technology-mediated, cross-curricular, collaborative and contextual mathematics learning activities. The theoretical framework that underpins Bray's Design Heuristics combines Realistic Mathematics Education (RME) and a particular constructivist model of 21st Century teaching and learning – Bridge21 (www.bridge21.ie). Participation in activities of this kind have been shown to have a positive effect on students' conceptual understanding and engagement with mathematics (Bray, 2016; Tangney, Boran, Knox, & Bray, 2018). The research presented in this paper extends previous work by focusing on student attainment in exam-type questions, asking: How might participation in a transformational geometry activity created using Bray's Design Heuristics, help participants to achieve higher levels of attainment in the topic?

The Activity

Following a number of classroom-based, technology-mediated, exploratory activities designed to provide students with a foundation in basic transformational geometry concepts, participants were presented with a laminated orienteering map of the school campus overlaid with a square grid. An orienteering circuit with 5 bases, each labelled as a set of coordinates from A to E, was set up on the school grounds, with QR codes fixed at each base. Scanning each QR code generated the geometrical transformation required to locate the next base.

The class group was divided into five teams of 4/5 students. Each team was given a card with the coordinates of their team's starting point (e.g. A (-3,5)). Teams were timed from the moment they began to discuss the location of their starting base on the map. The teams dispersed in different directions to locate their first QR code. In order to scan the codes and receive the geometrical transformation, students used a built-in feature of the Snapchat app, which they had on their mobile

phones. The geometrical calculations, needed to navigate to the next location, involved Axial Symmetry, Central Symmetry and Translations and were carried out by the students using white board markers on the laminated maps of their school grounds.

Methodology

The results presented in this paper focus on the quantitative aspect of the overarching exploratory study, exploring changes in attainment in written exams pre- and post-intervention. Participants in this research were 63 students, aged 14-15. The treatment group consisted of one class (n = 22) of students and the control group was made up of two classes (n = 41) graded at the same level of mathematical ability. The first author was mathematics teacher to the students in the treatment group, and the control group classes were taught by two other mathematics teachers within the school. The transformation geometry module was presented as outlined above to the treatment group while the control group were taught in a traditional, classroom-based fashion. The module took place in 10 x 40-minute single class periods over two weeks, within the normal school timetable. In an attempt to ascertain the impact of the learning experience on the students' ability to apply their knowledge of transformation geometry, the treatment and control cohorts sat the same written exam at the end of the module. This exam consisted of five exam questions, focused on transformation geometry, drawn from past papers of the state examination that Irish students sit at the end of grade 10.

Results

Average scores of the treatment group were 3% lower than the control groups in a pre-intervention, mid-year exam whereas in the post-intervention exam their results were 9% higher than those of the control group (Treatment: M = 71%, SD = 18; Control: M = 62%, SD = 15). Results of a one-tailed independent samples *t*-test indicated a statistically significant difference in performance between the participants in the treatment group and the control group ($t(61) = 2.021$, $p = .029$, one-tailed).

Conclusion

This paper provides a small sample of the results of a more significant exploratory study into the possible effects of participation in collaborative, technology-mediated, active learning experiences. The quantitative results described here are limited but have furthered the development of the hypothesis that this approach to activity design has the potential to positively impact on student learning in mathematics in general, and in transformation geometry in particular.

References

- Bray, A. (2016). *Collaborative, Contextual, and Technology-Mediated Mathematics Learning Activities: Design Heuristics and Effects on Student Engagement*. (PhD), Trinity College Dublin, the University of Dublin, Dublin.
- Jeffes, J., Jones, E., Wilson, M., Lamont, E., Straw, S., Wheeler, R., & Dawson, A. (2013). *Research into the impact of Project Maths on student achievement, learning and motivation: final report*. Retrieved from Slough:
- Merriman, B., Shiel, G., Perkins, R., & Cosgrove, J. (2014). *Project Maths and PISA: Comparing the coverage of PISA mathematics items by the Project Maths and pre-Project Maths curricula*.

Tangney, B., Boran, I., Knox, T., & Bray, A. (2018). Constructionist STEM Activities Using the Bridge21 Model. *Constructionism 2018 - Constructionism, Computational Thinking and Educational Innovation: conference proceedings*, 438-448.