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TEACHING ALGEBRA WITH DIGITAL TECHNOLOGY: FACTORS INFLUENCING SECONDARY MATHEMATICS TEACHERS' TASK DEVELOPMENT AND IMPLEMENTATION

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Research suggests using digital technology (DT) has the potential to support students' mathematical understanding and that rich tasks enhance the effectiveness of using such technology in the classroom. Tasks, carefully designed by educators, inevitably need adapting during teacher implementation. Thus, this research considered it important to support teachers in designing rich DT tasks for their students. To do this, the benefits of collaborative work in small teacher communities in the same school or educational zone were investigated. The aim of the study was to identify what teacher factors influence secondary mathematics teachers in designing and implementing DT tasks and how. Design-based research methodology was adopted within a sociocultural constructivist paradigm to identify these teacher factors.

Four groups of three Sri Lankan teachers teaching Advanced Level mathematics collaboratively designed a preliminary task before participating in the professional development (PD) researcher intervention. The PD intervention was based on theoretical principles of rich DT tasks taken from the literature with the intention of using these principles as factors to construct a task-richness framework that could be used to examine the richness of the tasks produced. In addition, the PD also considered how teachers may be supported in planning a lesson to implement a DT task. This included what decisions teachers may need to make and the role of resources, orientations and goals in making those decisions based on Schoenfeld's [6] ROG theory based on resources, orientations and goals. Teachers were also provided with an understanding of the three-point FOCUS framework [1] for planning, delivering

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and reviewing a lesson. Then, in the next step the groups modified their tasks based on the points discussed at the PD and participated in a semi-structured group interview explaining how they designed and modified the task. This interview was followed by a task-implementation lesson that was taught by a teacher from each group, while the other two teachers observed with the researcher. Each group had an opportunity to reflect on their lesson and do a further modification of the task. Finally, they answered a questionnaire including a Likert-style attitude scale.

Data were collected using a questionnaire comprising open and closed questions and Likert-style attitude scales, semi-structured interviews, task-development video and audio recordings and observations. Both pre- and post-intervention tasks were analysed using the Task Richness Framework developed for the research. The observations and data recordings were translated into English and transcribed before being coded. The theories of Mathematical Knowledge for Teaching, instrumental genesis (IG), resources, orientations and goals, group dynamics and the FOCUS framework were used to develop codes for the qualitative data.

The findings suggest that the task richness after the PD intervention had significantly increased for all groups confirming that this is one way to design a suitable PD intervention to support teacher task design. Further, the PD programme's supportive nature improved teacher attitudes towards using technology in teaching and encouraged confidence in developing tasks. The findings of the study give evidence that there is value in supporting teachers' confidence in three areas—teaching, using DT and task design—since each is linked with a positive influence on task development and implementation. Teachers having higher instrumental genesis, positive attitudes and confidence are more likely to design quality tasks. The study showed that conducting similar DT PD programmes may be effective in supporting teachers to produce quality tasks.

This study was designed in such a way as to give opportunities for teachers to design tasks in small communities of inquiry. The teachers formed co-learning groups where they engaged in task design, inquired into the pedagogical use of DT and classroom implementation (action) and reflected on their activity as a group. Among the four groups, members of groups homogeneous in age and experience showed more willingness to share ideas, with greater flexibility in approaching DT. The evidence suggested there would be increased success of PD programmes with communities of inquiry where age and experience are homogenous. The greater collaboration and equal contribution of these groups supported their development of documents including DT tasks, lesson plans and a list of areas for potential student difficulties and possible teacher courses of actions. Further, the communities homogeneous in age showed increased flexibility in developing their personal and professional instrumental geneses and documentational genesis, which assisted with improving the quality of the task through incorporating appropriate DT techniques [4]. The groups either having a leader with positive attitudes or having no lead teacher in a group were more likely to develop flexibility in using DT and members were more confident in sharing ideas, which was beneficial in the process of task development and implementation.

Finally, as previously reported in Ratnayake *et al.* [5], although the tasks those teachers developed after the PD were richer than their preliminary tasks they still primarily employed DT as a partner among the four roles of teacher use of DT, as described by Goos *et al.* [2]. Used in this way, DT provides access to new ways of approaching existing tasks to develop understanding and mediate mathematical discussion, but the teachers had not reached DT as an extension of self, where it is seamlessly integrated into the teacher's mathematical and pedagogical activity [5]. Further, during the PD the teachers were supported to place their pedagogical focus on mathematical concepts rather than technology and to use DT to teach mathematics. This approach helped them to focus on developing mathematical concepts rather than simply teaching how to use GeoGebra [3].

The thesis is available at https://researchspace.auckland.ac.nz/handle/2292/37388.

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