SYNCHRONOUS COLLABORATIVE MATHEMATICS LEARNING IN EARLY PRIMARY SCHOOL GRADES: CHALLENGES AND OPPORTUNITIES

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Abstract

This paper presents the results of a mobile learning research project in Croatia, Europe with a special focus on synchronous collaborative in-class learning. As part of the project, technology for learning mathematics in pairs and triplets was developed and used in first, second and third primary school grades in a neighborhood primary school in Croatia. Students were learning through digital lessons by engaging in group work in different roles: editors and checkers when learning in pairs; and authors, editors and checkers when learning in triplets. Digital lessons were co-designed with the help of primary school teachers so that the contents were aligned with the lesson plans and the curriculum. The collected software logs and classroom observation data was then triangulated with the student background information consisting of their academic success and engagement. On a macro level, the analysis shows that students, even first-graders, are able to successfully engage in synchronous collaborative math learning. Results indicate the need for a more adaptive group and role assignment mechanisms to better support learners in different tasks and stages of their learning.

Introduction

Mobile technologies bring great potential into everyday life and especially look promising for the use in educational settings. Although mobile devices, tablet computers, smart boards and other tools are seen as great innovative drivers of educational processes, they might not always be easily implemented into the existing classrooms environments and they might not be suitable tools to replace all of the existing tools and school practices. Therefore, not every technology use actually leads to wanted educational benefits.

This study deals with one specific avenue of technology supported learning, so called computer supported collaborative learning (CSCL). Although teachers already use collaborative learning for implementing some lessons, the use of technology for collaboration in classroom remains relatively new area of research and school practice. The variety of existing tools available on the market is available for teachers to use, but most of them remain very generic and do not come with specific guidelines for educational use. What is more, when it comes to group work processes and organization, teachers still feel the area of CSCL is relatively new and that support for such scenarios is lacking.

The aim of this study is explore the usage of roles in a synchronous CSCL environment for learning mathematics in a design-based research (DBR) fashion, thereby giving teachers more insight into the benefits and drawbacks of using roles as a group work assignment mechanism. The study does so in a synchronous CSCL learning scenario where students work in groups and in roles in real-time, meaning they interact with their classroom peers while in classroom. The activities presented in this study are integrated with the existing lesson plans and the curriculum, and aim at elaborating how roles can be used in teaching mathematics to young learners in a primary school settings.

Synchronous Computer Supported Collaborative Learning

The area of computer supported collaborative learning (CSCL) has been developing through last decades bringing new tools, methods and ideas that could be used in classrooms environments. Researchers have been exploring two different modes of using technology for CSCL: asynchronous and synchronous modes. Asynchronous CSCL utilizes tools such as the online forums and message boards that can be accessed at any location and time of convenience. On the other side, synchronous CSCL happens when learners engage in learning in a specific time-frame, but can, depending on the technology, be positioned at various locations (Bower, Dalgarno, Kennedy, Lee, & Kenney, 2015). Synchronous CSCL can facilitate peer discussion even when used at distance leading to metacognitive, co-regulation and social emotional activities occurring to enhance learning (Lajoie et al., 2015).

Although desirable, interactions in asynchronous CSCL environments bring complexity to learning processes and there is more guidance needed to promote better conceptual understanding (Sun, Looi, & Xie, 2014). A study in Pakistan involving 1025 respondents points out that asynchronous CSCL can be beneficial for some learning scenarios but does come with limitation which could be scaffolded by synchronous learning sessions (Perveen, 2016). The study concludes that a blend of asynchronous and synchronous CSCL might be a solution to the problems identified in the study. Some researchers even emphasise that the asynchronous nature of CSCL prevents an efficient interaction which may even hamper the learning process (Fita, Monserrat, Moltó, Mestre, & Rodriguez-Burruezo, 2016) proposing a more synchronous approach to CSCL.

Synchronous CSCL can provide intellectually stimulating contexts in which all students can learn to reason by interacting with one another, as long as it had well-established procedures and effective moves (Kim, 2014). A study of microblogging-based professional development community report on uneven levels of participation when using synchronous CSCL but emphasizes a variety of topics and multitude of types of interactions (Gao & Li, 2017). When exploring the dynamic of synchronous fixed group CSCL, substantial differences in knowledge distribution between fixed groups was found, where the students who actively participate and contributed high-level ideas were the students with higher level domain knowledge.

Research Contexts and Tools

This 1st DBR cycle of the project, which will be presented in this paper, is designed to explore how roles can be used to structure synchronous CSCL activities in a mobile CSCL equipped classroom. The study consists of an experiment where students get fixed roles throughout the learning activity and get different tasks depending on the assigned role.

Participants were primary grade 1-4 students of a neighbourhood school in Croatia. They participated in a series of synchronous CSCL lessons with roles throughout a period of 4 months. A proprietary tool named “The Number Adder” was constructed and used to support both synchronous CSCL scenarios using roles (Figure 1). The left-had side picture depicts the author role in which students are to assemble the formula after reading the textual assignment. The middle picture illustrates the editor role in which students need to solve the proposed formula, while the right-hand picture illustrates the checker role in which students need to check (or evaluate) the overall solution proposed by the author and editor.

DBR Cycle 1: Synchronous Collaborative Mathematics Learning with Predefined Roles in Fixed Groups

In the 1st DBR cycle the students were randomly assigned into fixed groups by the system every time the activity was started (beginning of the lesson). The group size was predefined by the teacher and the group formation algorithms were used for *ad hoc* formation according to the pre-set parameters.

The purpose of 1st DBR cycle was to answer the following research questions: (1) What are the differences in *time* needed to complete the synchronous CSCL mathematics lessons for early primary school students in different roles (authors, editors or checkers)? (2) What are the differences in *process* exhibited in the synchronous CSCL mathematics lessons for early primary school students in different roles (authors, editors or checkers)? and (3) How does student background (academic performance and engagement) data relate to the time students needed to complete the synchronous CSCL mathematics lessons for early primary school students in different roles (authors, editors or checkers)?

Table 1 shows an analysis for the three different roles (authors, editors, checkers) over two example tasks and all tasks that were attempted by the students. The results clearly depict that students in the author role spent most of the time on completing the assigned tasks, followed by the editor and checker role.

To get more insight into the process of solving mathematics tasks in different roles, the time spent on solving a task was correlated with the academic success of students and the engagement of students. Table 2 shows that the time spent in author and the editor roles statistically significantly negatively correlated with the student’ academic performance. Time spent in the checker role statistically significantly negatively correlated with the engagement of students.

Discussion and Conclusions

Structured interviews with both students and teachers show group work does come with a lot of benefits, such as high student motivation, the ability to compete and better efficiency in solving tasks (Table 3). Students feel group work is useful and feel good learning from each other and engaging in help with the other students. Students do find group work in roles useful in solving some types of problems.

From the data analysis it could be noted that different roles come with differing complexity primarily reflected in the times needed for students in each role to complete the assigned tasks. Although this conclusion might seem trivial it holds important implications in the design of synchronous CSCL activities that take place in groups as it my significantly affect group dynamics, with some students getting bored and disengaged while some are struggling to provide a correct solution.

The data shows that students with higher academic success require less time in the author and editor roles, the roles with most work. More engaged students require less time in the Checker role, being more effective with tedious and repetitive assignments. Different nature of roles and the fact that certain types of students manage better in certain roles calls for adapting role assignment to students. However the questions remain on whether such an approach is feasible and whether the constant change of roles could lead to non-desired consequences, such as confusion and the loss of focus of students. Furthermore, there is a need for adapting contents to the students participating in the activity, especially in the case of highly academically inclined students and the academically not well versed.

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Tables and Figures

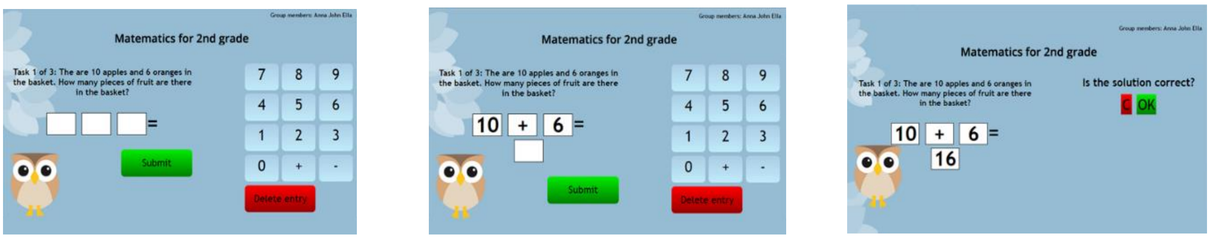

Figure 1. A tool to support synchronous CSCL using roles. Left: the Author roles where students need to construct a formula. Middle: the Editor roles where students need to provide a calculation answer. Right: the Checker role where students need to check the overall solution.

Table 1. Mean time needed for solving tasks across all three main roles.

Task	Author	Editor	Checker
35+7	M=81s	M=27s	M=5s
43-6	M=88s	M=17s	M=4s
All tasks	M=115s (SD=97s)	M=23s (SD=8s)	M=6s (SD=5s)

Table 2. Mean time for all roles across two representative exercises correlated with the Academic performance and Engagement (*p<0.05)

Mean time for role	Academic performance	Engagement
Author (exercise 1)	-0.483	0.019
Editor (exercise 1)	-0.706*	-0.08
Checker (exercise 1)	0.06	-0.314
Author (exercise 2)	-0.62*	-0.425
Editor (exercise 2)	0.134	-0.149
Checker (exercise 2)	0.152	-0.728*

Table 3. Teacher and student reported experience from the 1st Cylcle of DBR

Teacher reported experiences	**Student reported experience**
• „Solving tasks in pairs or triplets is for some students very motivating, they want to show their good at it." • „During group work more successful students show off so the less successful feel bad." • „Solving mathematics tasks presented in textual form is percieved as more fun for students when they do it on tablets. In a small amount of time they manage to solve more tasks than there are available in their workbooks."	• „Working in pair is useful because if you do not understand something, the other in pair can explain it to you." • „When you help other people, you feel well!" • „It is fun to solve math assignments with friends from the class and every time I want to be in group with someone else." • „I like working in pair because if the other one solves the task out loud, I hear it and I can just key in the solution." • „I like working in pair when one student needs to solve the task and the other check if the solution is correct."

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