COCO: A SYSTEM FOR SUPPORTING COLOCATED COLLABORATIVE LEARNING WITH TABLETS

Mia Čarapina[1] and Klaudio Pap[2]
[1]*Zagreb University of Applied Sciences, Vrbik 8, 10000 Zagreb, Croatia*
[2]*University of Zagreb, Faculty of Graphic Arts, Getaldićeva ul. 2, 10000 Zagreb, Croatia*

ABSTRACT

This paper introduces CoCo, a system designed to support and encourage collaborative learning among colocated students sharing a single mobile device. It provides teachers with the possibility to create digital lessons, configure parameters for collaborative activities such as the number of students and tablets, and monitor students' progress. On the other side, students use the tablet mobile application with an implemented split screen feature which can support up to four colocated users. This approach could be advantageous for organizations with limited technology resources and a restricted budget.

KEYWORDS

Collaborative Learning, Mobile Learning, Multiuser Interaction, Tablet Computers, Split Screen

1. INTRODUCTION

The distribution of devices during the mobile learning activity generally falls into one of two categories: 1) one-per-one (1:1) or one device per student, and 2) one-per-many (1:m) or one device per many students. The literature overview in the mobile learning domain shows the prevalence of educational activities favoring 1:1 distribution (Čarapina & Botički, 2015) and the evident popularity of the numerous 1:1 learning initiatives or bring your own device (BYOD) solutions (Song, 2014; Tamim et al., 2015; Tubplee, 2019). Nevertheless, a significant digital gap persists in terms of global access to information and communication technologies (ICT) in education. For example, this is evident in the findings of a study performed by the European Commission on ICT in education (European Commission, 2019). The causes behind this phenomenon are diverse, with budgetary considerations frequently being the primary cause of restricted technology integration in public schools (Gray & Lewis, 2021; Heinrich et al., 2020; Tamim et al., 2015; Tubplee, 2019). In such circumstances, instructional activities utilizing technology are often organized in a one-per-many distribution, where several students use a single device. However, working on a single device in 1:m distribution is typically facilitated with software support specifically designed for individual use. Moreover, as a result of the cost infeasibility of providing each student with an individual device, equipment like mobile devices is often not purchased at all.

Building upon the existing research that 1:m distribution can be as effective as favored 1:1 distribution (Čarapina & Pap, 2023a; Heinrich et al., 2020; Lin et al., 2012; Wang et al., 2021), this paper presents a system for supporting collaborative learning activities of colocated students who can share a single tablet device. This is achieved by partitioning a tablet's screen into many distinct sections that are visually distinguishable from each other. This study extends prior research exploring the effectiveness of 1:m device distribution among early elementary school students solving a set of mathematical assignments on tablets with implemented split screen feature (Čarapina & Pap, 2023a) as well as the proposed prototype of a tablet split screen application for collaborative learning (Čarapina & Pap, 2023b).

2. THE SYSTEM FOR COLOCATED COLLABORATION ON TABLETS

The system developed for supporting collaboration between colocated students was named CoCo, which is a symbolic name derived from the combination of the words "colocated" and "collaboration". The name reflects

the system's purpose, which is to facilitate and support collaborative activities involving a group of students who are physically located in the same place, next to each other, so they can work around a single mobile device. Up to four students can simultaneously share one device, yet many different groups can participate in the same activity.

The system has three main components (Figure *1*):

- client web application with three different modules for creating the content of educational lessons, defining the settings of the educational activity, and analyzing the data collected during the learning activity,
- client mobile application for displaying the content of the educational lesson, and
- database server.

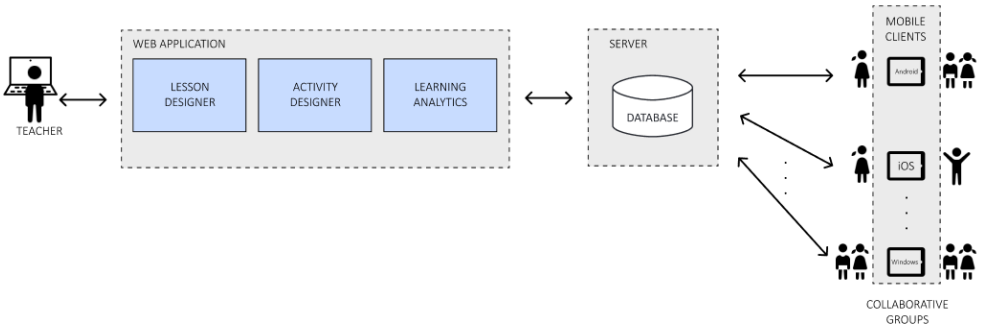


Figure 1. CoCo system architecture

Each component of the system is designed as an independent subsystem that functions relatively independently from other components of the system. The server acts as an intermediary between the web and mobile application and is accountable for retrieving and storing essential information necessary for the overall operation of the system. The educational content is created through the web application and stored on the server. There is no direct communication between the web application and the mobile application. The mobile application only communicates with the server during specific events such as when it is launched and when working settings are downloaded, and after the completion of collaborative activities when information collected on tablets, which is necessary for learning analytics, gets uploaded to the server. Thus, the system's architecture allows for the client mobile application to be developed using different technologies, such as native development for Android and iOS or one of the multiplatform development technologies, and easily integrated into the system. In other words, the client mobile application can run on different types of devices with different operating systems. Furthermore, the system design facilitates the connection of several client mobile applications, allowing for their concurrent usage during the carrying out of educational activity. The first functioning prototype of the client mobile application was developed employing native development for Android OS tablets. The web application was developed using the Angular framework and Google Firebase[1] Firestore was used as a database.

2.1 Web Application for Teachers

The web application is organized into three different modules: the lesson designer, the activity designer, and the analytics module. The web application enables teachers to create educational lessons, define the settings for the educational activity they wish to carry, and afterward they can analyze the data collected from tablets during the learning activity.

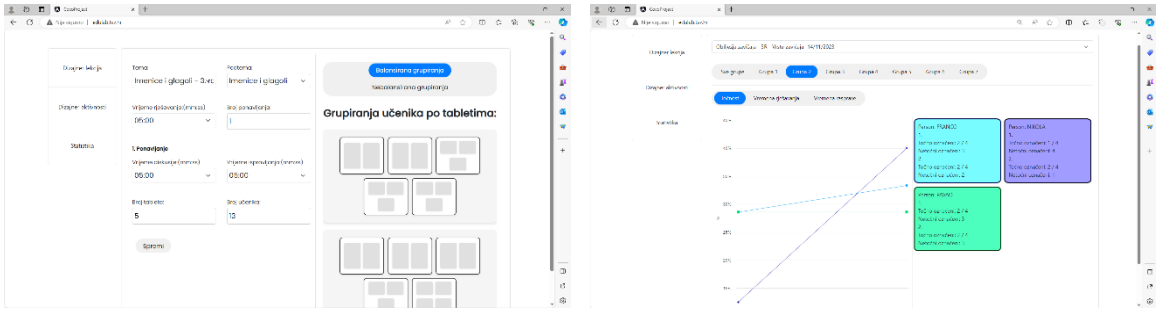
Interacting with the lesson designer teachers can create educational content that will be displayed in the mobile application. The technology allows for the production of instructional materials for any subject as long as students sharing a mobile device are presented with mutually exclusive questions as described in more detail in a paper by Čarapina & Pap (2023b). For example, if two students work in pairs one should get a question "*Select all animals that can fly.*" and the other student should get a question "*Select all animals that can't fly.*".

[1] https://firebase.google.com/

To complete the assignment, each student must choose answers from the same set of available answers and engage in discussion if any discrepancies arise. The answers can be presented as text or as images. The collaborative process is in more detail described in section 2.2.

Through the activity designer module (Figure 2(a)), teachers can configure the settings for the activity planned to be carried out in the classroom, such as the number of students per device and the duration of the activity. One notable characteristic of the system is its ability to adapt the execution of activities depending on the number of devices and pupils present in the classroom when the instructor intends to use digital lessons. In other words, a teacher can set up the activity to be carried out in any combination of 1:2, 1:3, or 1:4 distributions with a desired number of students and available mobile devices.

Furthermore, in the analytics module (Figure 2(b)) teachers can analyze the data gathered from the mobile application. The purpose of this module is to display the performance of individuals within a specific group and showcase the outcomes of all groups that participated in the classroom activity.



(a) (b)

Figure 2. Web application with (a) activity designer module and (b) analytics module

2.2 Mobile Application for Students

The primary role of the client mobile application is to deliver educational content to students. The content is displayed by employing the split screen feature and supports up to four colocated users. In other words, educational content can be displayed to a pair of students sharing a mobile device (Figure 3(a)), a group of three students (Figure 3(b)), and a group of four students (Figure 3(c)). The split screen functionality was implemented under the notion that it could help the organization and implementation of collaborative learning activities in early grades of elementary education. This was based on the premise that sharing a device would encourage them to exchange knowledge as indicated in the research on the effectiveness of the 1:m split screen approach applied for supporting independent activities on a shared tablet by Čarapina & Pap (2023a).

(a) (b) (c)

Figure 3. Representation of screen partitioning on a mobile device with the split screen feature into (a) two independent segments, (b) three independent segments, and (c) four independent segments

The designed activity for supporting colocated collaboration is broken down into three distinct phases: an initial phase that promotes individual effort, followed by a variable number of rounds of discussion and a correction phase. With the designed process (Figure 4), it was attempted to encourage the active participation of all students in the group while at the same time nurturing a sense of personal accountability in each individual through an individual task that is integrated into the overall activity. That is, the student is encouraged to think independently about the assigned task and work on a separate segment of the device's screen during the first

phase. To encourage student engagement and knowledge sharing, the discussion phase follows the initial phase of answers submission. During this phase, students are presented with visually distinguished correct answers and potentially erroneous answers that can then be debated among the group of students sharing a device. If there are discrepancies in the answers within a set of tasks, the answers will be highlighted as possibly incorrect on every instance they appear on the device screen, for both students (Figure 5). To promote a focused discussion on questionable responses corrections are not allowed during the discussion phase. During the correction phase, students are given a chance to correct their responses, but without any visible highlighting of potentially erroneous answers.

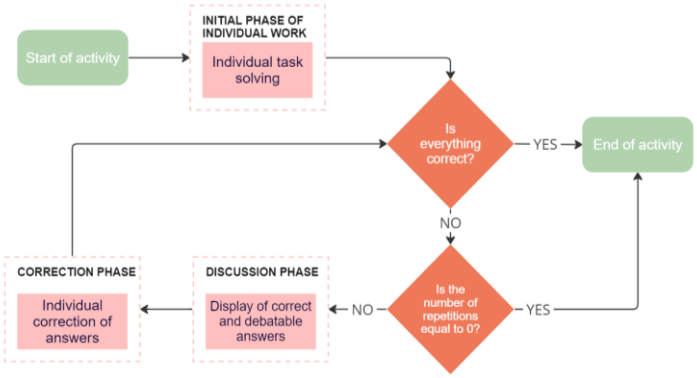


Figure 4. Collaborative process diagram

Upon launching the mobile application, all necessary data for the activity's execution is downloaded from the server. The content of the educational lesson is obtained together with a set of questions and answers, the configuration in which the application should be started on the device, that is, the number of segments that must be instantiated, and other data such as the duration of each phase of the activity. The collaborative learning activity is then carried out in the split screen mode (Figure 3). The process also allows for the early ending of each phase, but all students must agree that each phase stops before the time limit expires. On top of that, the application has a feature that allows students to rotate their segment, enabling them to move and position themselves relative to the device. In October and September 2023, the system was tested on a variety of topics (e.g. mathematics, Croatian language, etc.) among students of the first four grades (6 to 10 years old) of elementary education in Croatia (Figure 6) and the preliminary results indicate this approach could be beneficial for supporting and encouraging collaborative activities.

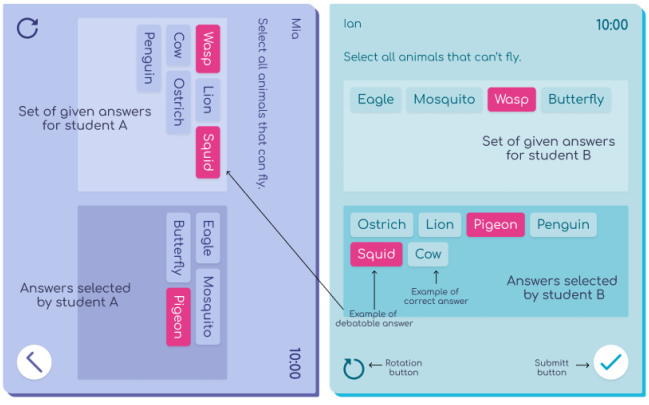
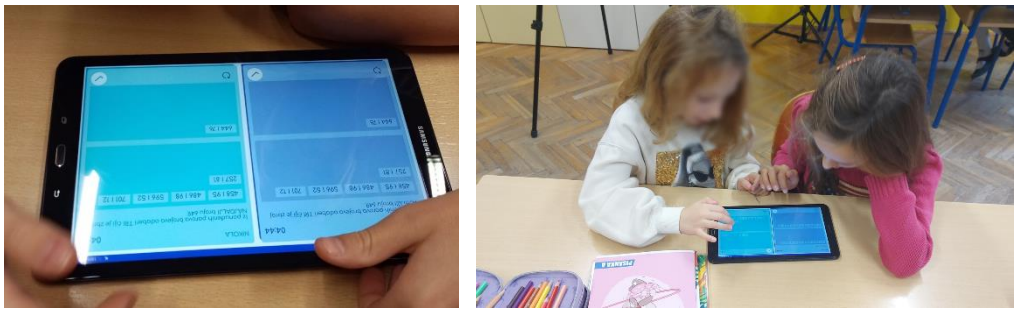


Figure 5. An example of the discussion phase with the display of highlighted debatable answers for a pair of students



(a) (b)

Figure 6. An example of (a) educational content displayed on Android tablet for pairs and (b) pair of first grade students sharing tablet

3. CONCLUSION

The CoCo system was developed to support and encourage collaboration between colocated students sharing a single mobile device. Throughout web modules teachers can create content, organize activities and track students' progress when working on tablets with implemented split screen functionality. The utilization of a split screen approach for device sharing offers a novel alternative for organizing educational activities. Initial trials undertaken with first-grade children suggest that this method has the potential to facilitate and encourage collaborative learning, thus creating new opportunities for organizations operating on tight budgets or with limited equipment.

REFERENCES

Čarapina, M., & Botički, I. (2015). Technology trends in mobile computer supported collaborative learning in elementary education from 2009 to 2014. *Proceedings of the 11th International Conference on Mobile Learning 2015*, 139–143.

Čarapina, M., & Pap, K. (2023a). Exploring colocated synchronous use of tablets based on split screen feature. *IEEE Access*, 11, 123418–123432. https://doi.org/10.1109/ACCESS.2023.3329478

Čarapina, M., & Pap, K. (2023b). The prototype of a tablet split-screen application for collaborative learning. *17th International Technology, Education and Development Conference*, 1437–1444. https://doi.org/10.21125/inted.2023.0415

European Commission. (2019). *2nd Survey of Schools*: *ICT in Education*. https://data.europa.eu/euodp/data/storage/f/2019-03-19T084831/FinalreportObjective1-BenchmarkprogressinICTinschools.pdf

Gray, C., & Lewis, L. (2021). *Use of educational technology for instruction in public schools: 2019–20*. https://nces.ed.gov/pubs2021/2021017.pdf

Heinrich, C. J., Darling-Aduana, J., & Martin, C. (2020). The potential and prerequisites of effective tablet integration in rural Kenya. *British Journal of Educational Technology*, *51*(2), 498–514. https://doi.org/https://doi.org/10.1111/bjet.12870

Lin, C.-P., Wong, L.-H., & Shao, Y.-J. (2012). Comparison of 1:1 and 1:m CSCL environment for collaborative concept mapping. *Journal of Computer Assisted Learning*, *28*(2), 99–113. https://doi.org/https://doi.org/10.1111/j.1365-2729.2011.00421.x

Song, Y. (2014). "Bring Your Own Device (BYOD)" for seamless science inquiry in a primary school. *Computers & Education*, *74*, 50–60. https://doi.org/https://doi.org/10.1016/j.compedu.2014.01.005

Tamim, R. M., Borokhovski, E., Pickup, D., & Bernard, R. M. (2015). *Large-Scale, Government-Supported Educational Tablet Initiatives*. https://oasis.col.org/server/api/core/bitstreams/3348c70b-eee3-47d9-ac29-83d595520b3a/content

Tubplee, E. (2019). One Tablet per Child Policy in Thailand. *Academic Journal Bangkokthonburi University*.

Wang, C., Wang, J., Shi, Z., & Wu, F. (2021). Comparison of the effects of 1:1 and 1:m CSCL environments with virtual manipulatives for scientific inquiry-based learning: a counterbalanced quasi-experimental study. *Interactive Learning Environments*, 1–18. https://doi.org/10.1080/10494820.2021.1948431