Peer Tutoring Orchestration
Streamlined Technology-driven Orchestration for Peer Tutoring

Lighton Phiri[1], Christoph Meinel[2] and Hussein Suleman[1]
[1]*Department of Computer Science, University of Cape Town, Rondebosch 7701, Cape Town, South Africa*
[2]*Hasso Plattner Institute, University of Potsdam, Prof.-Dr.-Helmert-Str. 2-3, D-14482 Potsdam, Germany*

Keywords: Computer Supported Instruction, Orchestration, Peer Tutoring, Technology-enhanced Learning.

Abstract: Peer tutoring models that involve senior students teaching junior students is a well established practice in most large universities. While there are a range of teaching activities performed by tutors, these are often done in an ad hoc manner. We propose to leverage organised orchestration in order to make peer tutoring more effective. A prototype tutoring platform, aimed at facilitating face-to-face tutoring sessions, was implemented in order to facilitate orchestration of activities in peer tutoring sessions. The tool was evaluated by 24 tutors for first year Computer Science courses at a large university. The NASA Task Load Index (NASA-TLX) and Perceived Usefulness and Ease of Use (PUEU) instruments were used to measure the orchestration load and usability of the tool, respectively. The overall workload falls within acceptable limits. This initial result confirms the feasibility of the early stage tools to implement organised orchestration for peer tutoring.

1 INTRODUCTION

Peer tutoring involves students learning with and from one another (Falchikov, 2001). The learning broadly involves individuals from similar social groupings helping one another to learn. The individuals who take on the role of teaching are tutors while those being taught are tutees (Topping, 1996). In higher education, tutors are typically senior students in higher levels with little or no teaching qualification. The advantages of peer tutoring in higher education, such as small group learning and cost savings, are well documented (Bowman-Perrott et al., 2013; Topping, 1996; Beasley, 1997). With the widespread availability of general purpose technology and specialised educational technology, peer tutoring is increasingly becoming more effective (Evans and Moore, 2013).

A technique commonly employed in large undergraduate courses involves forming smaller manageable tutorial groups, which are administered by tutors. However, in the majority of these cases, the tutorial sessions are typically conducted in an informal manner. This is, in part, due to the fact that tutors usually do not have the formal training required to teach. In this work, we investigate the potential of technology-driven organised orchestration on peer-led tutoring with a particular focus on pre-session management of learning activities.

Orchestration involves the management of processes and procedures that are performed by educators in formal learning environments (Dillenbourg, 2013). Roschelle et al. further state that orchestration is a Technology Enhanced Learning approach that focuses on challenges faced by educators when using technology in formal learning environments (Roschelle et al., 2013). Our previous work has highlighted flaws and shortcomings of contemporary orchestration of learning activities, primarily due to its ad hoc nature. We argue that the ad hoc nature of orchestration is as a direct result of a lack of a standardised way of orchestrating learning activities (Phiri et al., 2016a). Furthermore, we propose a more streamlined approach for orchestration of learning activities: organised orchestration (Phiri et al., 2016b).

This work is a further attempt at exploring the potential applicability of our proposed approach in a different educational setting: peer tutoring sessions. We argue that due to its focus on curriculum content and, additionally, the lack of formal teaching training of tutors, peer tutoring could potentially be made more effective by leveraging organised orchestration.

We propose the design and implementation of a peer tutoring teaching platform aimed at facilitating the orchestration of tutor-led learning activities. A proof of concept pre-session management tool was

Phiri, L., Meinel, C. and Suleman, H.
Peer Tutoring Orchestration - Streamlined Technology-driven Orchestration for Peer Tutoring.
DOI: 10.5220/0006339104340441
In *Proceedings of the 9th International Conference on Computer Supported Education (CSEDU 2017) - Volume 1*, pages 434-441
ISBN: 978-989-758-239-4
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developed based on an existing standard: IMS Global Simple Sequencing Specification (IMS Global Learning Consortium, 2003). We also present preliminary results gathered after evaluating the implementation of this tool.

The main contributions of this paper are as follows:

1. A new potentially–viable approach to facilitate technology-driven orchestration of peer-led learning activities.
2. A use of the IMS Global Simple Sequencing Standard to facilitate organised orchestration of learning activities.
3. Experimental results to demonstrate the viability of tools for pre-session management of peer-led tutorial sessions.

The remainder of this paper is organised as follows: Section 2 is a synthesis of related work, and Section 2 presents design and implementation details of the prototype Web-based tool. In Section 4, experimental design and results details are outlined, while Section 5 discusses the implication of the results. Finally, Section 6 presents concluding remarks and future directions.

2 RELATED WORK

Peer Assisted Learning (PAL) has historically been employed in higher education, particularly in difficult courses and those with significantly large enrolments. While there exist many different models of PAL, Topping emphasises that Peer Tutoring and Cooperative Learning are the most common models (Topping, 2005). Peer tutoring typically focuses on the curriculum content, with clearly outlined procedures. In addition, participants will generally receive some form of training (Topping, 2005). However, cooperative learning involves collaboration among students in order to achieve a shared goal (Johnson et al., 2000).

2.1 Technology for Peer-led Learning

There is a wide range of tools that have been employed to facilitate peer tutoring. However, most of these tools are aimed at facilitating interaction between peers and, additionally, enabling teachers to monitor interactions between peers.

Classwide Peer Tutoring Learning Management System (CWPT-LMS) provides tools and services required by teachers to implement CWPT (Greenwood et al., 2001). The software enables teachers to plan and measure progress. Unlike CWPT-LMS, our work focuses more on facilitating the activities performed by the tutors.

G-math Peer-Tutoring System is a Web-based application developed as a Massive Multiplayer Online Game, in order to facilitate interactions among connected users (Tsuei, 2009). The system is composed of two modules, which are operated by teachers and students. The core focus of the system is to improve mathematics outcomes of learners by facilitating interactions amongst the learners.

Due to the size of most Massively Open Online Courses (MOOCs), peer feedback has become an integral part of the assessment process. PeerStudio is an assessment platform that was implemented to take advantage of large MOOC enrolment numbers in order to facilitate rapid assessment feedback (Kulkarni et al., 2015).

2.2 Technology for Supporting Orchestration of Learning Activities

There have been numerous studies that have proposed techniques aimed at supporting the orchestration of learning activities. Niramitranona et al. proposed a toolset, consisting of a scenario designer: SceDer, in order to support one-on-one collaborative learning (Niramitranon et al., 2007). GLUEPS-AR is a system aimed at facilitating orchestration of learning scenarios in ubiquitous environments (Muñoz-Cristóbal et al., 2013). Some approaches have been more focused on computer-supported collaborative learning; for instance GLUE!-PS facilitates deployment and management of learning designs in distributed learning environments (Prieto et al., 2014).

This paper is explicitly aimed at exploring the implications of facilitating the orchestration of learning activities by peer tutors during formal face-to-face interaction with learners.

3 A PEER-LED TUTORING ORCHESTRATION TOOL

3.1 Design Goals

The premise of our work is that peer-led tutorial sessions can be made more effective by the use of organised orchestration tools. A proof-of-concept toolkit was developed to serve as the basis for experiments to test this premise, and an initial evaluation was then conducted to assess the usability of the toolkit by tutors in the context of actual tutorial/course content.

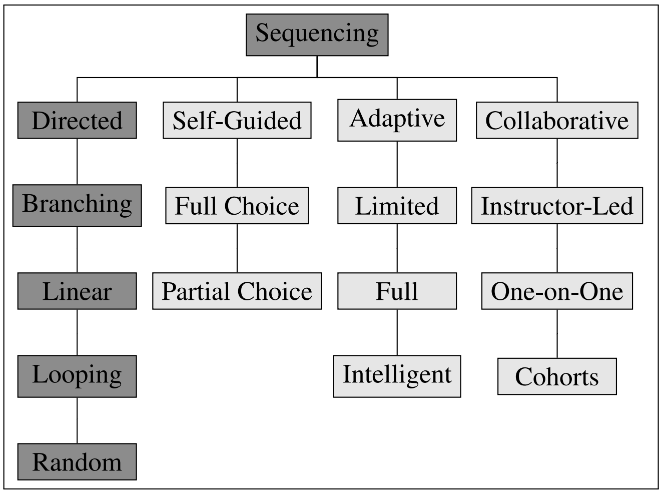

Figure 1: IMS Global Simple Sequencing activity tree.

The toolkit has two major functions: pre-session management and in-session orchestration of activities. The pre-session management involved three specifics tasks:

- Activity management, which is the specification of metadata associated with the activity;
- Resource management, which is the uploading and organising of resources; and
- Activity sequencing, which is the ordering of resources within the activity.

After an activity has been designed, using the tool, it can be viewed or played back by a tutor in a tutorial session. There are two viewers for this purpose: a built-in viewer that uses HTML; and a PowerPoint export feature.

3.2 Key Components

As described above, there are four key components that implement the major function of pre-session and in-session management of the tool. These are described further in the following sections.

3.2.1 Activity Manager

The Activity Manager module makes it possible for session activities to be properly structured and organised. A two-level hierarchical node structuring technique allows for courses or modules to act as top-level container structures and for session activities to be presented as level two node structures. Teaching resources are then associated to the level two nodes, as described in Section 3.2.2. Figure 2 shows a screenshot of the structuring.

3.2.2 Resource Manager

The Resource Manager module allows for resources such as PDF documents, video and audio files to be uploaded and associated with level two nodes. As shown in Figure 2, this is accomplished by selecting a specific level two node and subsequently uploading the desired resources. In addition associated resources can later be downloaded.

3.2.3 Activity Sequencer

The Activity Sequencer module enables the user to construct a sequence chain that explicitly specifies the order in which the associated resources should be orchestrated.

3.2.4 Activity Viewers

A basic HTML viewer can then be used to play back the sequence chain, as shown in Figure 4. In addition, another proof of concept viewer allows for the sequence chain to be downloaded as a PowerPoint document with the specified order. Furthermore, the sequence chain is accessible through the RESTful API, described in Section 3.3.3.

3.3 Implementation

3.3.1 Data Storage Standard

The IMS Global Simple Sequencing Specification (IMS Global Learning Consortium, 2003) was used as the underlying standard representation for data storage. The standard can be used to represent many different types of sequenced activities, as shown in Figure 1. In this proof-of-concept implementation, only

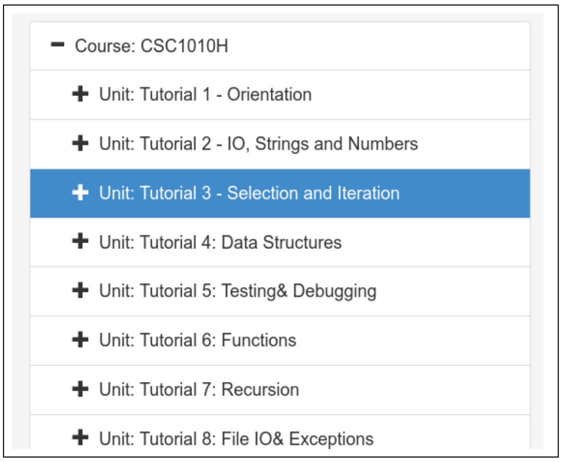

Figure 2: Activity management.

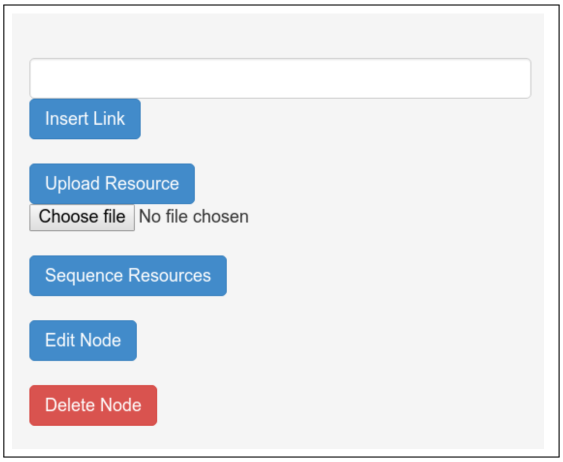

Figure 3: Resource management.

Figure 4: Activity sequencer.

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the Directed path was used, as tutorial sessions are typically linear-structured directed activities.

3.3.2 Scripting Platform

The scripting platform was implemented as a Web-based system[1]. The front-end was implemented using HTML/CSS and JavaScript, together with Twitter Bootstrap[2]. Node.js[3] was used to implement core backend module services, as described below.

3.3.3 Scripting API

A RESTful Web service API (Fielding, 2000) enables access to specific activities and resources. This would effectively make it possible for tailored viewing user interfaces to be implemented. The API is currently implemented to facilitate access to sequenced activities and resources and, as such, only GET requests are allowed.

[1]http://simba.cs.uct.ac.za/indefero/index.php/p/simplescripting
[2]http://getbootstrap.com
[3]https://nodejs.org/en

4 EVALUATION

A user study was performed to better understand the orchestration load imposed by the described tool, during scripting of learning activities and, additionally, to assess its potential usefulness to tutors. The emphasis of this initial study was on the reaction of tutors to the tool in a controlled environment, rather than an assessment of the tool in tutorial sessions.

4.1 Context Selection

The experiment was conducted in a Computer Science department at a large university. The context provides for an ideal environment in which peer-led learning is essential. In order to complement the formal traditional lectures, the department hires senior undergraduate students to act as peer tutors.

Students enrolled for a typical course are split into smaller, more manageable tutorial groups that are administered by tutors, as shown in Table 1. In some of the courses, the tutors' role involves facilitating tutorial sessions aimed at revising lecture material and responding to ad hoc student queries. Tutorial sessions are held once a week and topics addressed are those from the previous week.

Table 1: Tutorial groups in study environment.

Course	Students	Tutors	Tutorial Groups
CSC1015F	754	38	12
CSC1017F	165	9	3
CSC1010H	80	6	5
CSC1011H	26	2	2

4.2 Experimental Design

4.2.1 Instrumentation

The orchestration load was measured to determine the amount of effort needed to use the tool, or the degree of complexity of the tool. If the load is low, this indicates that the tutors are able to use the tool effectively to achieve the necessary orchestration of activities.

Measuring the orchestration load was accomplished through the use of the NASA Task Load Index (NASA-TLX) (Hart and Staveland, 1988) pencil and paper version [4]. The NASA-TLX measurement instrument measures the subjective workload score using a weighted average rating of six subscales, outlined below.

Mental Demand. How much mental and perceptual activity was required (e.g. thinking, deciding, calculating, remembering, looking, searching, etc)? Was the task easy or demanding, simple or complex, exacting or forgiving?

Physical Demand. How much physical activity was required (e.g. pushing, pulling, turning, controlling, activating, etc)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?

Temporal Demand. How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?

Performance. How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?

Effort. How hard did you have to work (mentally and physically) to accomplish your level of performance?

Frustration. How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

[4] https://humansystems.arc.nasa.gov/groups/tlx/tlxpaperpencil.php

Measuring the subjective workload is a two-step process, outlined in Section 4.2.4, that involves pair-wise comparisons among the six subscales and individual ratings on each of the subscales.

In order to measure the usability and usefulness of the tool, the technology acceptance model (TAM) was used to evaluate the Perceived Usefulness (PU) and Perceived Ease of Use (PEU) (Davis, 1989). TAM facilitates the prediction of user attitudes and actual usage by using participants' subjective perceptions of usefulness and ease of use of a system. The TAM questionnaire was used in its entirety. Table 2 outlines the PUEU questions used in the questionnaire.

4.2.2 Selection of Subjects

The study participants were chosen based on convenience, from a sample pool of all tutors who had tutored first year courses. A total of 24 participants were recruited, via email, after ethical clearance was granted. Each participant received ZAR 50.00 as compensation for their time.

4.2.3 Experimental Tasks

The experiment used official teaching materials for CSC1010H—outlined in Table 1—normally used and/or referenced by tutors during tutorial sessions in order to respond to student queries and concerns. The description of the teaching materials that were used during the experiment sessions are detailed below.

Lecture Slides. Archived lecture slide notes used by lecturers in formal lecture sessions.

Laboratory Exercises. Practical laboratory exercise questions used in practical programming sessions.

Pre-practical Tutorials. Assessment questions, similar to assignment questions, meant to orient students to the assignment questions.

Assignment Tutorials. Assignments questions that are required to be handed in by students.

The list of the three experiment tasks performed by the participants are outlined below. For each of the three tasks, participants repeated the procedures for two tutorial session scenarios: ”Tutorial 6: Python Functions“ and ”Tutorial 7: Recursion“.

Task 1: Activity Management. This task involved activity management by creating two-level hierarchically structured orchestration activity nodes.

Task 2: Resource Management. This task involved resource management of all teaching materials required to orchestrate a typical learning session. This involved uploading teaching materials and subsequently associating them to their respective nodes.

Task 3: Sequencing Activities. This task involved the creation of a learning session sequence chain using specified teaching resources.

4.2.4 Procedure

One-on-one hour-long sessions were held with each of the 24 participants. Participants were briefed about the study; they were then requested to read and sign an informed consent form, explaining the purpose and procedures of the experiment.

Thereafter, participants performed experiment tasks outlined in Section 4.2.3, using the tool described in Section 3.3.2. After completing each of the three tasks described in Section 4.2.3, participants were asked to fill out a NASA-TLX questionnaire in order to assess their subjective workload for each of the individual tasks. Specifically, this process was conducted as follows for each of the three tasks:

1. Participants executed the experiment task
2. Participants then filled out a NASA-TLX questionnaire
   (a) Participants performed pair-wise comparisons for the six NASA-TLX subscales
   (b) Participants provided raw ratings for the six NASA-TLX subscales

Finally, after performing the activities specific to each of the three tasks, participants filled out a PUEU questionnaire.

4.3 Results

4.3.1 NASA-TLX Ratings

The Shapiro-Wilk test was used to test the normality of each of the three task participant results; a One Sample median test was performed on Task 1 ($p < 0.001$) and One sample t-tests Task 2 ($p > 0.05$) and Task 3 ($p < 0.01$); Task 1 and Task 3 scores were significantly lower than the 50% mark, however Task 2 scores were not significantly lower than 50%.

Figure 5 shows the weighted workload scores for all the three tasks. The overall weighted scores for all the three tasks are below the 50 mark, with Task 1 (Activity Management) requiring the least workload and Task 2 (Resource Management) requiring the most workload.

Figures 6 to 8 show subscale ratings for each of the three tasks. The width of the subscale bars indicate the importance of each factor, while the length represents the raw rating scores for the subscales.

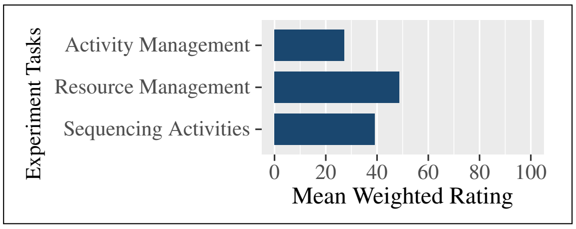

Figure 5: Overall weighted workload score.

In Task 1, the Performance subscale contributed the most towards the overall workload, while the Physical Demand subscale was the least contributor. For Task 2, the Effort subscale was the highest contributor to the overall workload, while the Mental Demand subscale contributed the least. Then, for Task 3, the Performance subscale contributed the most to the workload and the Frustration subscale was the least contributor.

In terms of the raw ratings, all subscale ratings were rated below the 50 mark, however, the Frustration subscale for Task 2 and Effort subscale for Task 3 were closer to the 50 mark.

4.3.2 PUEU Scores

Table 2 shows the PU and EU mean scores and their associated standard deviations. The Shapiro-Wilk test was used to test the normality of the individual question scores and aggregate PU and EU scores. One-sample t-test† and Wilcoxon signed rank test‡ were conducted as shown in Table 2, with p-value results represented with the asterisk.

The aggregate PU and PEU scores were all significantly greater than 4, where 4 is the mid-point of the scale of responses. In addition, all the individual 12 questions were also significantly greater than 4. The implication of this is that all results were statistically better than average.

The results indicate the potential usefulness and ease of use of the tool.

5 DISCUSSION

The purpose of this paper was to investigate the effect of technology-driven organised orchestration when applied to a specific educational setting: peer tutoring sessions. The NASA-TLX workload and PUEU scores provided an avenue for measuring the orchestration load and usability of the tool, respectively.

As shown in Figure 5, the results indicate that Resource Management requires the most workload. The high workload is as a result of four subscales—Physical Demand, Temporal Demand, Effort and

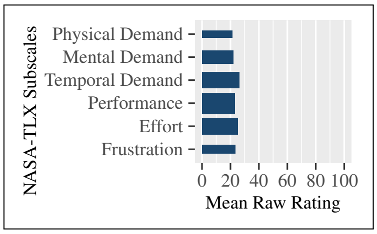

Figure 6: Activity management.

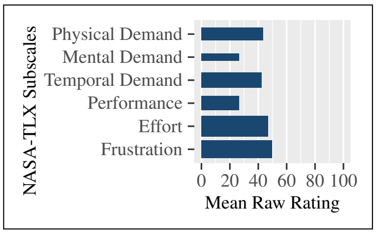

Figure 7: Resource management.

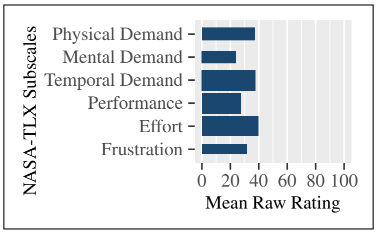

Figure 8: Sequencing activities.

Table 2: Descriptive statistics for PUEU responses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

	Perceived Usefulness and Ease of Use (n=24)	Mean (sd)
A.	**Perceived Usefulness**	5.12 (1.14)*** ‡
1.	Using the system in my job would enable me to accomplish tasks more quickly	4.50 (1.67)* ‡
2.	Using the system would improve my job performance	5.42 (1.18)*** ‡
3.	Using the system in my job would increase my productivity	5.25 (1.15)*** ‡
4.	Using the system would enhance my effectiveness on the job	5.38 (1.41)*** ‡
5.	Using the system would make it easier to do my job	4.71 (1.63)* ‡
6.	I would find the system useful	5.46 (1.41)*** ‡
B.	**Perceived Ease of Use**	5.80 (0.85)*** ‡
7.	Learning to operate the system would be easy for me	6.25 (1.15)*** ‡
8.	I would find it easy to get the system to do what I want it to do	5.46 (1.69)*** ‡
9.	My interaction with the system would be clear and understandable	5.79 (1.10)*** ‡
10.	I would find the system to be flexible to interact with	4.83 (1.40)*** ‡
11.	It would be easy for me to become skillful at using the system	6.33 (0.82)*** ‡
12.	I would find the system easy to use	6.13 (1.12)*** ‡

Frustration—with raw rating scores above 40 and also because both these scales contributed significantly to the weighted score. This can be attributed to the fact that this is the most involving of the three tasks as all teaching resources have to be individually associated to specific activity nodes. Incidentally, some participants expressed a desire for there to be a bulk upload feature in order to cut down on the amount of time required to associate resources to activity nodes. Another potential workaround would be to create templates that would only require a user to edit important fields.

Activity Management required the least workload due to the simplistic nature of the task. All the subscales scored below 25, with the subscales contributing the most to the workload having the lowest raw ratings. The task only requires a user to specify metadata necessary to uniquely identify nodes. Furthermore, the experimental task only required participants to create one level-one node and two level-two nodes.

As with Activity Management, the sequencing of learning activities did not require much workload. In fact, the reason why the score is significantly higher than Activity Management could be attributed to it having been the last task to be performed.

The results for the usability were very revealing. Most notably, the aggregate scores for both the Perceived Usefulness and Perceived Ease of Use were significantly greater than 4, therefore better than average. Furthermore, the individual question scores were also greater than 4, therefore better than average.

6 CONCLUSIONS

This paper proposes to facilitate the formalisation of the face-to-face peer-led tutoring process by leveraging organised orchestration. It is argued that a tool can be developed to help tutors to more effectively organise both their pre-session and in-session activities. A proof-of-concept tool was designed and developed to meet this objective. The various functions of this tool were then assessed by tutors, with an emphasis on the pre-session management of activities. Initial results indicate that the tool, and therefore the approach, are viable as a means of organising tutor-led activities in tutorial sessions.

While the tool has been demonstrated to be usable and potentially useful from the tutor's perspective, with an emphasis on the initial three pre-session activities, it has not been tested during tutorial sessions. This assessment of the final of four activities supported by the tool is the next planned experiment, to complement these initial results with further evidence of the viability of the tool, but with an emphasis on the in-session activities. It is expected that in-session use will confirm the effectiveness of organised orchestration in the classroom, as applied to the specific case of tutor-led small group teaching.

ACKNOWLEDGEMENTS

This work is funded, in part, by the Hasso Plattner Institute. Any opinions, findings, and conclusions or recommendations expressed in this work are those of the authors and do not necessarily reflect the views of the sponsors. We are grateful to Imaculate Mosha for software development platform. We would also like to thank all the study participants.

REFERENCES

Beasley, C. J. (1997). Students as teachers: The benefits of peer tutoring. In Pospisil, R. and Willcoxson, L., editors, *Proceedings of the 6th Annual Teaching Learning Forum*, pages 21–30, Perth. Murdoch University.

Bowman-Perrott, L., Davis, H., Vannest, K., Williams, L., Greenwood, C., and Parker, R. (2013). Academic benefits of peer tutoring: A meta-analytic review of single-case research. *School Psychology Review*, 42(1):39–55.

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 13(3):319.

Dillenbourg, P. (2013). Design for classroom orchestration. *Computers & Education*, 69:485–492.

Evans, M. J. and Moore, J. S. (2013). Peer tutoring with the aid of the internet. *British Journal of Educational Technology*, 44(1):144–155.

Falchikov, N. (2001). *Learning Together: Peer Tutoring in Higher Education*. RoutledgeFalmer, London, 1st edition.

Fielding, R. T. (2000). *Architectural Styles and the Design of Network-based Software Architectures*. PhD thesis, University of California, Irvine. http://www.ics.uci.edu/ fielding/pubs/dissertation/top.htm. Accessed: November 15, 2016.

Greenwood, C. R., Arreaga-Mayer, C., Utley, C. A., Gavin, K. M., and Terry, B. J. (2001). Classwide peer tutoring learning management system applications with elementary-level english language learners. *Remedial and Special Education*, 22(1):34–47.

Hart, S. G. and Staveland, L. E. (1988). Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. *Advances in psychology*, 52:139–183.

IMS Global Learning Consortium (2003). IMS Simple Sequencing Specification. https://www.imsglobal.org/simplesequencing/index.html. Accessed: November 15, 2016.

Johnson, D. W., Johnson, R. T., and Stanne, M. B. (2000). Cooperative Learning Methods: A Meta-Analysis Methods Of Cooperative Learning: What Can We Prove Works. *Methods Of Cooperative Learning: What Can We Prove Works*, pages 1–30.

Kulkarni, C. E., Bernstein, M. S., and Klemmer, S. R. (2015). Peerstudio: Rapid peer feedback emphasizes revision and improves performance. In *Proceedings of the Second (2015) ACM Conference on Learning @ Scale*, L@S '15, pages 75–84, New York, NY, USA. ACM.

Muñoz-Cristóbal, J. A., Prieto, L. P., Asensio-Pérez, J. I., Jorrín-Abellán, I. M., Martínez-Monés, A., and Dimitriadis, Y. (2013). GLUEPS-AR: A System for the Orchestration of Learning Situations across Spaces Using Augmented Reality. In Hernández-Leo, D., Ley, T., Klamma, R., and Harrer, A., editors, *Proceedings of the 8th European Conference, on Technology Enhanced Learning*, pages 565–568. Springer Berlin Heidelberg, Berlin, Heidelberg.

Niramitranon, J., Sharples, M., Greenhalgh, C., and Lin, C.-P. (2007). SceDer and COML: Toolsets for learning design and facilitation in one-to-one technology classroom. *15th International Conference on Computers in Education: Supporting Learning Flow through Integrative Technologies, ICCE 2007*, pages 385–391.

Phiri, L., Meinel, C., and Suleman, H. (2016a). Ad hoc vs. Organised Orchestration: A Comparative Analysis of Technology-driven Orchestration Approaches. In Kumar, V., Murthy, S., and Kinshuk, editors, *IEEE 8th International Conference on Technology for Education*, pages 200–203, Mumbai. IEEE.

Phiri, L., Meinel, C., and Suleman, H. (2016b). Streamlined Orchestration: An Orchestration Workbench Framework for Effective Teaching. *Computers & Education*, 95:231–238.

Prieto, L. P., Asensio-Pérez, J. I., Muñoz-Cristóbal, J. a., Jorrín-Abellán, I. M., Dimitriadis, Y., and Gómez-Sánchez, E. (2014). Supporting orchestration of CSCL scenarios in web-based Distributed Learning Environments. *Computers and Education*, 73:9–25.

Roschelle, J., Dimitriadis, Y., and Hoppe, U. (2013). Classroom orchestration: Synthesis. *Computers & Education*, 69:523–526.

Topping, K. J. (1996). The effectiveness of peer tutoring in further and higher education: A typology and review of the literature. *Higher Education*, 32(3):321–345.

Topping, K. J. (2005). Trends in peer learning. *Educational psychology*, 25(6):631–645.

Tsuei, M. (2009). The g-math peer-tutoring system for supporting effectively remedial instruction for elementary students. In *2009 Ninth IEEE International Conference on Advanced Learning Technologies*, pages 614–618. IEEE.