

Learning and Creativity through Tabletops: A Learning Analytics Approach

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Abstract—The article presents the under progress project, Learning and Creativity through Tabletops. A series of workshops targeted to primary education students are being performed. In these workshops students enrolled with creative context and geometrical tabletop applications. Through these activities researchers are capturing a wide range of learning analytics data (surveys, observations, performance tests, interviews). These learning analytics provides an increased understanding of the learner behavior when he is enrolled with technology intensive creative activities.

Index Terms— Art and technology, educational activities, educational technology, computer-supported collaborative learning (CSCL), Student experiments.

I. INTRODUCTION

THE use of tangible tabletops in education has increased in recent years [1]. In addition to educational institutions, many businesses organizations, and government agencies use tabletops for a variety of purposes, from advertising, informing to collaborating.

While previous research has studied tabletops as a platform for efficient learning activities, only a few research studies have looked at the learner behavior with tabletops through learning analytics. For example, one of the pioneer projects named NIMIS used in elementary schools for reading instruction [2]. Another tabletop environment allows users to build a concept map by moving pieces of paper [3]. These and many other projects have demonstrated interesting results in the area [1]; however a learning analytics approach will shed light in the understanding of learners' behavior.

In order to cope up with the above challenge, we created a mixed reality based tabletop application to facilitate geometry learning for primary school children. Also we organize a series of workshops with a creative context, where students' engaged in the tabletop application. With students' engagement in the activity, we obtained a wide range of learning analytics data. By analyzing these data we aim to

explore students' learning and behavior in a tabletop environment.

II. THE LEARNING AND CREATIVITY THROUGH TABLETOPS PROJECT

The Learning and Creativity through Tabletops project is based on a series of workshops targeted to primary education students and enroll them with Information and Communication Technology (ICT) media with an emphasis on tabletops. These workshops are successors of the Art and Technology (ArTe) workshops [4], which aimed to increase excitement and visibility of ICT among children.

The workshops (Figure 1) are being held at several places throughout the year (i.e., ReMida Center, IDI NTNU) and most of the times are linked to bigger events and meaningful context, concretely Creativity, Art and Technology.

The workshops are based on the Reggio Emilia education philosophy¹ of materials use and creativity. Each group was given the task to create a 3-dimensional character of materials and import digital images of these into the tabletop Geometry application (Figure 2).



Fig. 1. Snapshot of a Learning and Creativity workshop

In particular, the workshop program started with a development of a physical character by students (Figure 2, left), continued with capturing and editing cutout images (Figure 2, middle), and completed with students' enrolment with the application guided by their physical characters (Figure 2, right).

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¹ <http://zerosei.comune.re.it/inter/index.htm>



Fig. 2. Students' creating (left) and capturing (middle) the physical character; and the physical character guide them in the tabletop geometry application (right)

Geometry software applications enable learners to explore the dynamic behavior and capabilities of a geometrical construction, i.e. what remain fixed under given constraints. Other studies [5] have identified that students appreciate the ability to repeat a geometrical construction and measurement and play it step-by-step as allowed by software applications.

In our approach we attempt to take advantage of the above benefits and to expose students to constructive notions (i.e., algorithmic thinking, spatial abilities), which are useful for their reasoning skills. In addition we aim to exploit the visualization capabilities [6] of technology-enhanced environments and interaction capabilities of the tabletop [7]. As such, we selected to obtain learning analytics data through a tabletop application in geometry for constructing (Figure 3, up) and measuring shapes (Figure 3, down).

III. DATA COLLECTION AND ANALYSIS

A wide range of learning analytics data is being collected to address the research goal of this project, including log files, performance tests, surveys and interviews. In particular:

Interactions: One of the main data collection methods is the interactions (log files) of the students with the tabletop.



Fig. 3. Snapshot of the tabletop application

With the assistance of those user data we will be able to address several issues concerning the learner-tabletop interaction.

Interactions like: number of touches per task, distances of the touches and types of gestures (i.e., rotating objects, moving) are being captured; and analyzed through descriptive and correlation analysis. This data analysis might allow us or others to add proper pop-up quizzes or scaffolds, in the near future.

Performance: Data related to the learning performance of the students are being collected in order to investigate the relationship between the use of tabletop (in contrast with non-use) and students' knowledge acquisition. Performance tests, which are related with the tabletop geometry application, are used at the end of each workshop and provide an insight to students' progress.

Students' performance will be measured in order to analyze how the process of understanding and knowledge acquisition was affected by: the degree of (i) difficulty, (ii) interaction capabilities, and (iii) visualization capabilities on each one of the Geometry topics.

Perceptions: In addition to testing the performance of the students, students report their beliefs regarding the system. On that direction, surveys with attitudinal questions are being used.

Students' perceptions like: easiness-to-use, attractiveness, adoption, and usefulness will be captured through surveys and interpreted with students' game elements of the tabletop application (i.e., time, success).

Emotions: A qualitative approach is being adopted in order to study the emotional [8] situation of the students when they enroll with the tabletop. In addition to the video and photo capture of the students; semi-structured interviews and researcher observations are being undertaken during and at the end of the workshops.

In the captured videos and photos, content analysis based on students' emotions will be carried out. The signals (i.e., mouth smiling, eyes damp, lips pinched) of the emotions will be served as a guide for the coding. The sound and the images of the videos, as well as the verbal communication, will be used. Ekman's [9] emotional categories (i.e., anger, anxiety, happiness and sadness) will be used to assess emotions of

perspective students. In particular, the video-photo content analysis procedures will be consisted of the following three stages: (1) studying the emotions protocol (signals) and viewing several example pictures, (2) viewing the collected photos and videos several times, and (3) documenting the emotional situation of each participant of the video and photo. The data from the study will be coded independently by two researchers who have experience of learning technologies and emotions coding and based on the reliability testing (i.e., Cohen kappa) we will be able to understand which emotions are dominating in the enrolment of students' with the tabletop application.

IV. DISCUSSION AND CONCLUSION

In accordance with BECTA "The question is no longer if technology helps learning, but what kind of learning and how" [10]. In our approach we aim to explore "what kind of learning" and "how" tabletop applications help students'. By investigating the aforementioned four learning analytics aspects, we will be able to improve learners' tabletop: a) experience, b) performance, c) adoption, and d) positive feelings, which are vital for successful learning (i.e., [11]).

We present a workshop program where children are engaged in creating artworks by using physical materials. We aim to explore the potential of this physical/digital combination as a means to increase students' interest in technology and to introduce them to become creators of new media expressions. One of the ideas underlying our work is to combine the physical use of materials and the digital aspects of tabletop capabilities to motivate and excite students.

The Learning and Creativity through Tabletops project attempts to provide an enrichment of the current knowledge regarding learners' behavior when they enroll with tabletops. The empirical data are being obtained from students (or learning analytics) are emerged as a necessity in the future of education, as clearly articulated by Siemens and Phil [12]. The outcomes of this project are expected to have a transformative impact on both the educational and the scientific communities. The communities will benefit from the learning analytics, which advance the understandings, potentials, and limitations of the usage of tabletops on education to yield the best practice and effective use thereof.

The combination of creativity and technology is a promising way to promote digital literacy among novice as young children. In current work we seamlessly incorporate a creative activity with a tabletop application in the area of geometry. By doing this we are able to collect wide range of data through a playfulness environment, analyze them and provide insights for students' learning through tabletop applications.

In the current phase of the project we have already conducted a series of creative workshops [4] with the open source software Scratch. In these workshops, we validated the procedures and extended our knowledge on learning in creative context. In addition we have completed the experiment methodology and we have planned to introduce

the tabletop into the workshops at the end of October 2012.

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