Design Implications for Supporting Students' Conceptualization of Science with New Media Tools

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Abstract

This paper presents an exploratory study that started to investigate how learners' media creation skills impact on their ability to take advantage of inquiry based learning approaches and externalize/share their understandings of complex scientific concepts and problems. This study is part of an on-going research project, the Let's Go project, focused on making mobile science inquiries more accessible and effective to the everyday teaching. Preliminary findings suggest that there is a need to improve new media creation skills and tie them to the different steps involved in inquiry based learning activities. Such approach can probably leverage learners' motivation towards the creation of exciting learning objects that can be co-created and shared.

1. Introduction

The value of providing students in formal education with digital skills has become a key driving force in education policy [1]. The widespread availability of ubiquitous and mobile devices that range from smart phones, tablet computers, to laptops coupled with high speed terrestrial and wireless networks offers students new learning experiences [2]. Learners have the opportunity to create their own multimedia-learning objects, such as photographs, videos, animations, and interactive data visualizations [3]. The creation of these multimedia-learning objects can be seen as a particular example of externalization of thought and such process has been considered beneficial for the learning (see [4]). Chi and colleagues [5] highlight the importance fostering learners' self-explanation in order to promote deep understandings. Furthermore, these new learning practices and available digital tools provide opportunities for "seamless learning" experiences that enable the creation, exchange, and sharing learning assets.

Ecological science is a domain that clearly provides opportunities to leverage these different tools, technologies, and learning practices for deeper understanding of complex science phenomena that combine multiple digital skills like data collection from different sensors, digital image capture, information visualization with low costs computers and mobile devices. Taking inspiration from professional collaborative scientific laboratories, we envision the empowerment of learners and educators with mobile science collaboratories for inquiry-learning [6], [7].

The exploratory study presented in this paper inscribes itself on an ongoing project that has explored how to develop and implement mobile collaboratories for ecology learning over the last 3 years. The focus of this present paper, relates to our efforts in trying to better understand how to design learning activities that introduce digital skills to the science classroom. The main research question is, how can we better support student's conceptualization of science with new media tools? The rationale behind the research question has grown out of previous interventions that have focused on the implementation of mobile and visualization tools [8]. In fact, based on our previous findings, we believe that in order to successfully utilize these tools in everyday classrooms we also need to provide opportunities for digital skills building. Therefore, understanding how to support and design for the students representation and understanding of science through the use of image making and, especially, be able to integrate such activity as part of the inquiry process raises new design implications and challenges.

1.1. Background

Similar computer based inquiry-learning based research projects have provided good examples of research that has both supplied technology and explored new digital learning practices [9], [10]. Few of these science-based projects have implicitly investigated the need to support digital skills both for students and teachers. As different national educational policies shift the focus to providing these digital 21st century skills as part of everyday curricula, more focus needs to be put on developing the level of skills of that students and teachers [11]. This issue of skills can be echoed in the debate

about “digital natives or naives” [12]. Furthermore, it is important to consider the role of the teacher’s skills and the school’s infrastructure to support the required practices for digital literacy. Recent research highlights the importance of suporting the teachers’ digital skills and the impact that these skills have on the students [1], [13],

2. Method

This paper describes a new exploratory study with 13 high school students and the teacher at the end of the school year (June 2011). The students had participated in ecology classes over the school year with the teacher. Based on results from previous interventions [8] we wanted to investigate how the students conceptualize science with different new media tools afforded by the use of the mobile devices, sensors, digital still and video cameras, and the visualization tools. The subject of the students’ fieldwork was local water quality.

The intervention consisted of 4 sessions with the students over 5 weeks in the late spring of 2011. The first session introduced the LETS GO project with the inquiry problem for the students to investigate: “Are local bodies of water clean or polluted”? The instruments, for theses learning scenarios were the mobile phones, digital cameras and different scientific sensors. The students then conducted a small classroom inquiry to determine the quality of three different water samples to get familiar with the tools and the methods. In session 2, the students got a quick refresher on the instruments and then headed out to sample four local bodies of water. Each group was assigned a different location. Additionally, groups 1 and 3 used a still digital camera to capture the inquiry process and to further document the location, while groups 2 and 4 recorded video. The following week for session 3, the groups rotated to a new location and investigated the water. The groups rotated the documentary methods as well. This was followed by a discussion that included the comparison of the different locations and the changes in water quality across temperature, pH, conductivity, and dissolved oxygen. In the final session students made scientific reports in the form of computer-based presentation with several slides that incorporated the data and the digital media. Each of the students' presentation led to a class discussion about the different factors that influence water quality across the locations and the level of pollution in these different bodies of water.

A pre and post explorative survey investigated how students can conceptualize science using different media and their opinions on group work. Additionally, we collected the students’ photographs, videos, and final presentations. We also observed the discussion between teachers and students and discussed the intervention with the teacher and colleagues at the high school.

2.1 Technology

The mobile data collection was developed from “Open Data Kit”. ODK provided a collection of tools for collecting and sharing rich data that include text, photographs, and video that can easily deployed using Android mobile devices. ODK is constructed from several tools and provides an open framework for deploying mobile data collection and aggregation that utilizes different Google services. The visualization tools were developed using Google Visualization APIs and JavaScript/AJAX. The content repository for storing data used was Google Spreadsheets since ODK toolset outputs the collected data via Google’s app engine seamlessly [8].

3. Results

The preliminary results reported in this paper concern the two surveys run and overview analysis of the visual media produced by the students. The aims of the first survey were to inquire learners about the following topics: (a) experience with the media at their disposal and (b) their understanding of the pros and cons of using the distinct media and producing meaningful learning content. In relation to the first survey, thirteen participants answered the questions.

In the second survey, the idea was to follow up some of the questions initially posed concerning the use of the different media. For the second survey, only seven of the initial sample fully answered the questions posed, due to end of school year obligations for some of the graduating students. The overall results from both surveys suggest that:

- The students felt that they had strong confidence and familiarity in making images, but also stated that they had no formal training in using digital tools to document schoolwork.
- There seems to be a lack of digital media creation in the classroom and minor experience of creating artifacts outside of school.
- The use images or graphic charts for schoolwork could be further encouraged. This seems to lead to a lack of skills in using digital artifacts to conceptualize science.
- Scaffold the creation of images and clear connections with the different steps of the scientific inquiry.

Observation and informal discussions with students, illustrate their lack of experience in doing inquiry learning and reflecting about the results in the larger context. The finding from this study raise interesting points to the research aims of the LETS GO project that has implications for the future designs.

A preliminary analysis of the photographs and short videos created by the students in the pilot point towards the potential of exploration of the notion of "novelty spaces" that provide catalysts for learning [14], [15]. Additionally, the combination of data collection and the visualization tool that aggregates the images, the data, and location into interactive maps provides new opportunities to think about how the concepts of "novelty maps" can be used to interpret mental learning maps of the students over a course of the interventions.

4. Discussion

In this exploratory study, and comparing with earlier interventions, the students collected data over a two-week period from several locations [8]. But, the limited data (in terms of number of locations, images created, and scientific sensor data) could be seen to impede the students' ability to conceptualize science. The lack of formal or informal training in using digital tools raises interesting opportunities for incorporating some skill building into the Let's Go project. We are considering the prospect of exploring the value of novelty spaces to provide support for other knowledge making tools like concept maps [16]. The rationale for such is that creating concept maps provides the necessary externalization and structuring activity that enables the emergence of links between the creation of the images and the knowledge derived from the inquiry learning activities. However, this does raise questions about how to provide training for teachers to support the students' use and understanding of media in learning context. The LETS GO project has focused on learners' data collection and initial data visualizations activities, but it seems we need now design ways to foster integrating the mobile collaboratories into a larger framework of inquiry tools that include image media and knowledge making. Preliminary findings suggest that there is a need to improve new media creation skills and tie them to the different steps involved in inquiry based learning activities. Such approach can probably leverage learners' motivation towards the creation of exciting learning objects that can be co-created and shared.

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