Augmented and Tangible Environments: A Tool for Physicalization of Contents by Children in School Context?

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Abstract
The aim of this communication is to present our approach to design a tangible and augmented environment for learning. In addition to the well-known user centered methods for designing interactive systems, our approach integrates disciplines such as HCI, Ergonomics, Instructional design, and Pedagogy. Our work will be illustrated with the presentation of a project founded by the French Government. This project aims at enabling children and teens to conceptualize by themselves. Its main goal is to enhance children and teenagers disciplinary and collaborative learning at school by promoting social relationship, knowledge sharing and the construction of concepts to learn through various levers of physicalizations.

Author Keywords
Tangible Augmented Interface; Physicalization; Collaborative Learning; Pedagogy; Affordance.

ACM Classification Keywords
H.5.1. Information Interfaces and Presentation (e.g., HCI): Multimedia Information Systems; H.5.2.

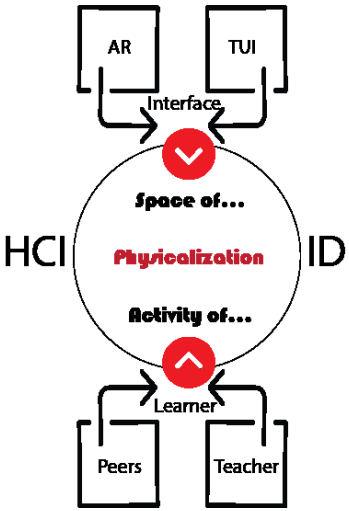

Figure 1: Illustration of our instructional design space and processes. It shows how the learners, the teachers, the contents and the technological modules are integrated in the design of the instructional environment.

Information Interfaces and Presentation (e.g., HCI): User Interfaces; K.3.1. Computers and Education: Computer Uses in Education

Introduction

In educational contexts (formal or informal), many difficulties met by the learners come from the abstraction level of the contents they have to learn. The knowledge can remain elusive to the students. Consequently, the teaching can become meaningless for them and their motivation can decrease. It is very common that a modeling representation, i.e. a physicalization of a concept, designed by the teacher or provided by a pedagogical support (physical and/or digital), does not make sense to the students. Moreover, the modeling of content, mediated through a support or an interface, cannot be considered without taking into account the contents to learn. For example, the nature of the knowledge, its didactic structure, as well as the educational objectives influences the modeling of a concept and its meaningful potential.

In this position paper, we describe our approach in providing a new way to design instructional environment for both the learners and the teachers (Figure 1).

Empowering the learners in content physicalization

As for the affordance concept defined by Norman [1], the previous experiences and/or learning influence the perception and the meaning of the environment a user-learner may have. In the same way, the personal needs or what the learners expect from a content to learn could influence their appraisal [2] and their selective attention. Then, the gap between the learners' mental model and the mental model of the person who designed the support can make the representation of the content to learn too complex for the students preventing them from learning. Furthermore, the learners' characteristics such as their age, cognitive developmental stages and/or learning abilities, impact their conceptualization possibilities. Therefore, the content modeling should be learner-centered. However, the diversity and the heterogeneity of the students in a given classroom represent a real difficulty for a designer (both form Instructional Design -ID- or Human Computer Interaction -HCI-) wanting to provide an adapted model for each learner profile.

All those arguments, supported by active learning principles, converge through the need to enable the students to physicalize, structure and/or construct by themselves the contents to learn. More than providing data or knowledge totally modeled by someone else, teachers and/or a learning interface should securitize and/or guide (i.e. scaffold) the learners in this task.

Tangible and Augmented interfaces to scaffold learning

The IT field currently takes advantage of the technological maturity of the Tangible User Interfaces (TUIs) or Augmented Reality (AR) to develop new human-computer interactions. AR and TUI, as expose in numerous previous studies [3-7], open up new perspectives for tomorrow's teaching applications. For example, a TUI provides a very hands-on approach by offering different input affordances (as well as physical constraints) to the user, while AR offers a flexible and situated way to give visual feedback. As discussed in our previous works, the content to learn can then be manipulated and augmented in many dimensions of

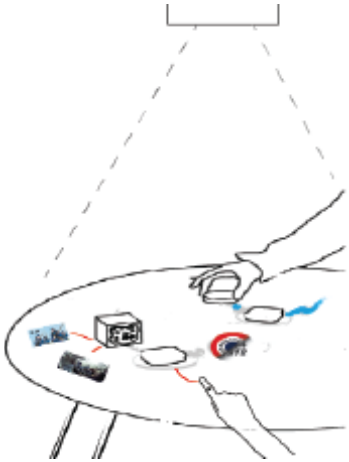

Figure 2: An example of a e-TAC that could be developed in the project.

space and time directly in the physical space (e.g. [8, 9]).

Taking into account the two dimensions of the notion of tangibility, this type of interface provides the learners with various contents that become more tangible; i.e. a content to learn i) that the reality could become undeniable; and ii) that could be manipulated. Providing the possibility of a hybrid physicalization of educational contents through Tangible and Augmented interfaces may enable the learners to visually and physically interact with the knowledge. Therefore, this type of interfaces could scaffold the construction of robust mental conceptualization and could empower the students in their learning tasks.

Collaborative learning in an hybrid environment

A tangible and augmented environment could enhance the nature of the visualisation, and enable the users-learners to investigate the structure of the knowledge through direct manipulation. But, we also consider essential to develop an environment that enables collaborative learning. Such learning aims at encouraging knowledge acquisition [10-12], disciplinary competences and psychosocial competences (such as problem solving, decision-making, critical/creative thinking, eloquence and interpersonal skills).

We think that a Tangible and Augmented Collaborative learning environment (i.e. an e-TAC)(see Figure 2) could empower the children or teenagers, individually and collectively, in the specific skills necessary to become autonomous in their learning process. Providing the students with multimodal and hybrid interactions in their real social environment could scaffold their abstraction mind in development, and their capabilities towards content representation, helped by new possibilities to collectively physicalize the content to learn. To this end, we will focus on the learners' interactions with the interfaces, the knowledge and their peers to identify the factors (ergonomics, digital and didactic) that facilitate or not learning, while taking into account the heterogeneous nature of our target population.

The e-TAC project

During the workshop, we will discuss the grounding elements that guide our approach in designing a Tangible and Augmented Collaborative learning environment.

Our project, which started in January 2017, is driven by the high expectation for educational and technological innovation of the French government. In this interdisciplinary project involving digital sciences and human sciences, Human-Computer Interaction (HCI), Ergonomics and Instructional Design (ID) are coupled in a systemic approach in order to develop not only the interface but also the content to learn.

Its main goals are to enhance children and teenagers disciplinary and collaborative learning at school by promoting social relationship (pairs exchange, work groups…), knowledge sharing and the construction of concepts to learn through various levels of interactions. More precisely, this project aims at enabling children and teens to conceptualize by themselves through a new type of hybrid space of physicalization.

Finally, another aim is to develop an e-TAC that can be expanded outside of the project's action area while meeting learners and teachers needs.

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