An Integrated Edu-Media Framework for Collaborative Learning on Handhelds

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Abstract. Technology has changed the landscape of how education is delivered to society. Despite the many innovative ideas adopted in education applications, research has been insufficient on developing a central collaborative edutainment interface, complemented by mobile communication and social media to enhance learner performance, especially for interpersonal and social skills. We review how technology influenced education in the last two decades and propose an integrated framework, which not only addresses the above issue, but also strengthens family and society values via participation. We also discuss the influence of advanced HCI techniques on collaborative learning environments.

1. Introduction

In pace with technological advances, especially in the last two decades when Internet and mobile infrastructures successfully facilitated global communication, curriculum content and learning media have evolved from the traditional paper-and-pencil format towards a digital representation. The popularity of games, social media and handheld devices also play an important role in the innovative process of learning and testing.

Digital multimedia representations were conceived as alternative means for more effective education [1, 2, 3, 4, 5]. Surprisingly, there have been few studies on the design of multimedia items until the last decade [6]. The design of innovative multimedia items makes use of the diverse capabilities in a computer, *e.g.*, graphics, sound, speech and responsive interactions. Furthermore, adaptive learning and testing can be implemented using these items to achieve individualized learning and student modeling. Computer adaptive testing (CAT) [7, 8] has been adopted by education boards to assess students' skill levels. It also helps educators to provide timely guidance to students. Computer analysis can be performed to trace how a student arrives at a particular response, which provides a more precise assessment metric compared to scoring based on the final answers [9]. In contrast to the standard multiple-choice layout, the generation of a multimedia item database in CAT requires setting up a large number of complex templates. To assist educators and curriculum designers, authoring tools have been developed [10]. As computer games have become a preferred choice for entertainment in our society, educators also consider using the interactivities, appealing graphics and rewarding environment in serious games or edutainment to keep learners engaged [11, 12, 13]. The design of educational user interface has been inspired by research in Human Computer Interaction (HCI). As an alternative to mouse input, many schools set up Smartboards, where students can execute commands by touching the display, using either hands or tools, such as a brush or a toy [14, 15]. As mobile networks and handheld devices integrate with daily activities, educational opportunities have become more accessible and affordable to the general public, including people in remote areas and developing countries [16, 17].

Despite these revolutionary developments, what is lagging compared to other components in education is *collaborative learning in a social context*, which is needed to nurture *interpersonal and social skills*. Individuals have the potential to develop intelligences, *i.e.* skills to resolve problems and create valuable contribution to society, entailing the potential for identifying problems and the acquisition of new knowledge. Gardner [18] classified intelligences into seven components: Linguistic, Logical-Mathematical, Spatial, Bodily-Kinesthetic, Musical, Inter-personal, and the ability to acquire, be aware of self-knowledge and effectively apply it to the previous six components. While current innovative item design provides a good coverage of the first five, the development of interpersonal intelligence poses a bigger challenge when a learner is constrained by location, resources and peer contacts.

To address this deficiency, we propose an integrated framework that can help position learners in a social collaborative setting and to utilize technology to effectively enhance their interpersonal and social skills. Our framework (Fig. 1), which can accommodate regular curricula, defines collaborative edutainment as the core component. Collaboration is extended by including social media, taking advantage of the latest wireless infrastructure to complement Internet communication. Affordable handheld devices and HCI technology facilitate portability and user-friendly input. Importantly, the flexibility of inviting family and friends to collaborate helps strengthen family and society values.

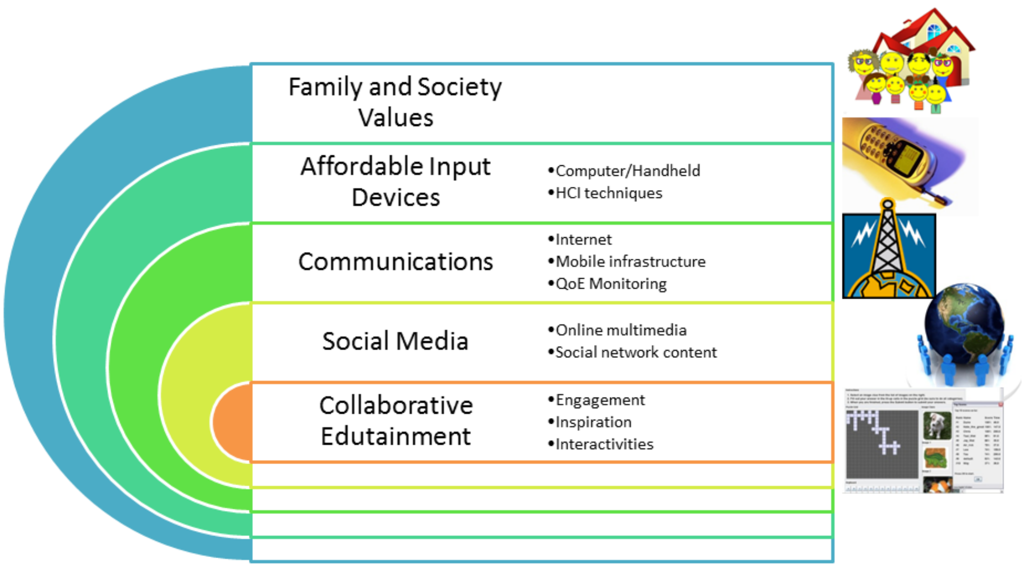


Fig. 1. Proposed framework: By utilizing the latest communication technology, affordable devices and HCI techniques, our design aims to put edutainment players in a collaborative social Media (Edu-Media) environment.

The remaining of the paper is organized as follows: Section 2 describes the proposed collaborative framework. Section 3 discusses potential trends and Section 4 summarizes our discussion.

2. Proposed framework for collaborative Edu-Media learning

Feedbacks from our previous study [16] show that learners prefer to study in an environment that is non-invasive and connected to their daily activities, such as sports, TV/movies, travel and hobbies. Our framework design is thus partly motivated by the popularity of handheld usage, which provides attractive features such as texting, image capture and web search, representing part of daily life.

2.1 Collaborative session at a central site

Since 2006, we have been developing and adding new components to our Computer Reinforced Online Multimedia Education (CROME) System. The main focus of CROME is adaptive learning and testing (http://crome.cs.ualberta.ca/) using innovative multimedia item types. In this paper, we focus on a new item type for *collaborative problem solving*, which can be either a stand-alone application or an integral component of CROME. Fig. 2 (left) describes the design platform composed of three major components: Database Server (repository of questions, user information, and so on), Web Server (resource files, *e.g.*, images, audios and videos), and Collaboration Server/Controller (responsible for routing request/response messages among players).

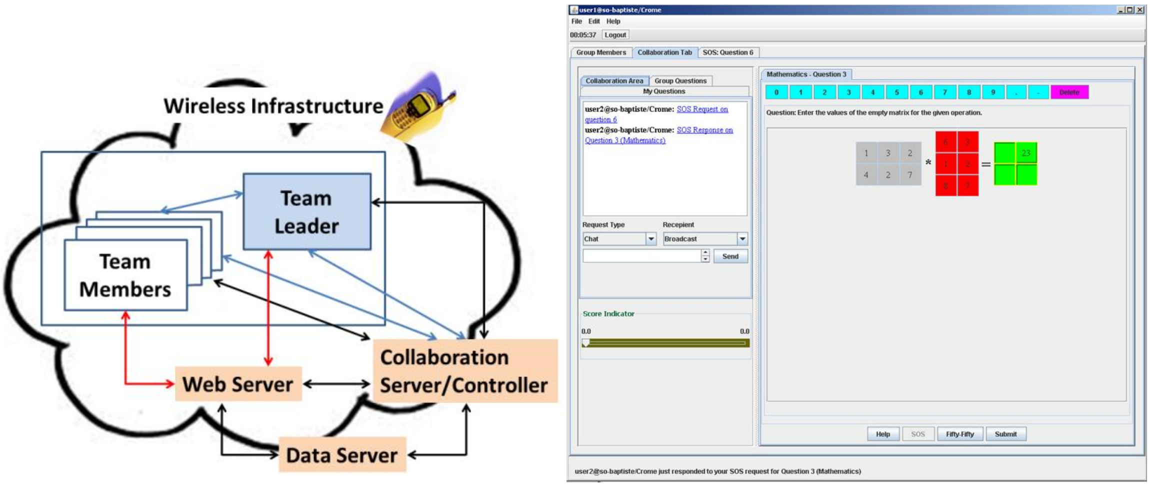


Fig. 2. (Left) Collaborative Item Type Architecture, and (Right) an example interface showing a matrix multiplication problem to be solved by team members.

In a collaborative session, the goals of team members is to solve problems individually or collaboratively. A collaborative session consists of an individual session and a group question session. In the individual session, each member receives a set of questions they answer themselves, but they can use a variety of built-in features to interact with other members in order to get the answer. These features include: *plain text chat*, *SOS* where a member can request help from another member (as well as family and friends), or a broadcast to all the team members, *a fifty-fifty* feature where the choices/options in the questions are reduced so as to give a 50-50 chance of getting the correct answer.

For a group question session, the team leader first receives a group question. Based on the specifics of the question, the leader breaks it down into a series of questions and assigns them to each member who in turn then send responses back to the team leader, who finally assembles the answers before submitting the merged response. An example of a collaborative session user interface is illustrated in Fig. 2 (right). A member navigates to a specific work space by choosing the corresponding function tab, *e.g.*, group member, collaboration, and so on.

This interface is intended for display on conventional desktops at the central site, and not for handhelds. A major obstacle associated with handheld devices is their limited display size, and thus simple compact content is needed in order to fit the display; complex layouts are displayed on the central interface.

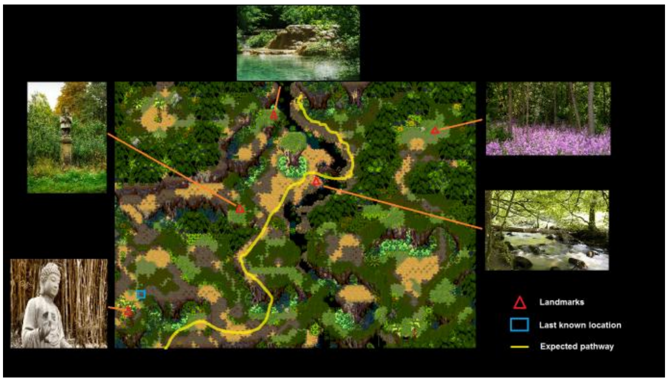
2.2 Collaborative session on mobiles

Handheld devices are omnipresent and their use in learning has been studied previously. A learning framework lets a student experience collaborative learning while interacting with their tutors using instant messages (IM) [19]. A pilot study on collaborative map-reading conducted by school children was developed on mobile devices [20]. Smartphones were used to improve the learning experience of adults for informal learning while performing daily activities [21]. Mobile phones were used for serious games designed for situational learning in real world tasks [22]. In fieldwork training, a portable wireless network and mobile devices were utilized to help workers obtain information from colleagues, who were at locations where resources could be more readily available [23]. Another use of handheld devices was to communicate with relief workers in a disaster zone via ad-hoc networks [24].

In contrast to existing designs, our collaborative Edu-Media learning framework has several unique features:

1. There is a central interface responsible for managing the collaboration and communicating information between distributed devices.
2. Collaborative work space is available on the central interface for either an individual session or a group session.
3. Separate display contents are appropriately designed for the central interface and handhelds to fit the display size.
4. Any handheld device with communication capability, not necessarily Smartphones, can join the collaborative session using voice or text to communicate with the central interface.

2.3 Collaborative edutainment example



(Top) Display on the central interface

Fig. 3. Screen shots of the Target Hunt edutainment design. The mobile members communicate with the central team mates for instruction to discover target landmarks.

There are a several ways to design collaborative edutainment items. In the *target hunt* example described below, the teams compete to finish the hunt with the assistance of social media, archives and any resources available. The team mates can be from the same class, different grades, and different schools locally or internationally. An effective way to improve interpersonal and social skill is to let students perform tasks collaboratively in a multi-cultural and global environment.

In the target hunt game, the mobile members need to locate landmarks, whose history or locations are provided by the central team mates, who have access to the game-play instruction. Whenever a mobile member encounters some landmark similar to the description given, they take pictures and send them back to the central site, or they can describe the appearance of the landmark via phones or text messages. The central team mates match the pictures/description with the target description or verify with additional information, and notify the mobile member of the next step. The team may need to use Internet resources or contact family or friends for assistance. Some screen shots of our target hunt edutainment design are shown in Fig. 3.

3. Future trend: Gesture-based collaborative learning

A recent development trend in collaborative user interface (UI) is towards a natural gestures based approach. Smartboards and multi-touch tabletops are other examples of advanced UI technology. While touch-based techniques are commonplace for a single user on small handheld screens, the use of gesture-based techniques provides a less constrained and more natural collaborative environment. In general, multi-touch tabletops are less scalable in term of size due to pre-fabricated electronic circuits, while gesture-based techniques are mostly software driven. Since the launch of Kinect, promising depth-sensing results have improved the accuracy of gesture-based approaches. However, gesture recognition is still an open research problem. Hand localization, on the other hand, is a necessary step prior to gesture recognition. Fig. 4 (Left & Middle) shows how a user's head and moving hand can be localized (illustrated by the regular boxes) using our algorithm based on depth-sensing. However, ambiguities can occur due to various factors, *e.g.*, lighting conditions, speed of movement, and neighborhood colors, making the target temporarily disappear.

Fig. 4. Although a user's hand can be localized by hand tracking algorithms (left & middle), there are factors, *e.g.*, lighting condition and neighborhood color; that can make it temporarily disappear. With a mobile in hand (right), localization is reduced to device tracking, which is easier due to the distinct outline and color.

In the context of our Edu-Media learning framework, we delineate this problem by making use of the handheld device already in the hand of the user for the collaborative session. Fig. 4 (Right) illustrates that the mobile is easy to detect because of its distinct outline and color. Once the hand is localized, further analyses can be performed to recognize hand or finger gestures.

4. Summary

We propose a collaborative edutainment framework, taking advantage of mobile technology and social media, to enhance interpersonal skills and learner performance. A central interface can be used by itself or complemented by mobile users. We discuss the potential of gesture-based HCI techniques that can provide a more natural collaborative environment. The taxonomy introduced by this framework supports family and society values, which are essential for building self-esteem. We believe that technology is a complementary component of innovative education, leading to more efficient teaching, learning and assessment. In future work, we will look into extending our framework to help physically disabled learners by incorporating multi-modal data, *e.g.*, facial expression, analysis.

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