International Journal of Child-Computer Interaction 2 (2014) 48–59

Contents lists available at ScienceDirect

International Journal of Child-Computer Interaction

journal homepage: www.elsevier.com/locate/ijcci

Aligning technological and pedagogical considerations: Harnessing touch-technology to enhance opportunities for collaborative gameplay and reciprocal teaching in NZ early education

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ARTICLE INFO

Article history:
Received 17 May 2013
Received in revised form
30 May 2014
Accepted 2 June 2014

ABSTRACT

New Zealand early childhood education (ECE) aims to provide a mix of teacher and child-led learning. A non-prescriptive curriculum allows for broad and rich early years teaching and learning experiences, with teachers responsive to devising engaging activities to align with children's diverse interests. However, such spontaneity presents an on-going challenge for teachers. Using a combination of Action Research, elements of User-Centered and Participatory Design, and Scrum software development approaches, we conducted a multi-disciplinary study which leveraged joint contributions of software engineers and experts, including practitioners (teachers), users (children and teachers), and domain experts (in ECE curriculum and pedagogy, and early childhood psychology). Examination of teacher–child interactions with our software demonstrated that our game was *engaging*, promoted *collaborative gameplay* (by promoting mutual awareness, opportunities for information, and equitable control) and supported *reciprocal teaching* (by aligning children's interests with content knowledge). Finally, it opens new avenues for introducing research and pedagogy-informed interactive educational software in the NZ ECE domain.

1. Introduction

The New Zealand Ministry of Education's *Te Whāriki* (curriculum) framework for early childhood education aims to provide a mix of teacher and child-led learning [1,2]. A non-prescriptive curriculum allows for broad and rich early years teaching and learning experiences, with teachers responsive to devising engaging activities that are aligned with children's diverse interests (e.g. dinosaurs, vehicles, robots, birds) with the related content knowledge (e.g. number, measurement, shape, alphabet). However, such spontaneity presents an on-going challenge for teachers. For example, in a teacher-led classroom setting, the teacher is driving the choice of activities and related learning processes for the entire class. Conversely, in a child-led learning environment such as that in NZ ECE, children are free to play individually or in groups and it is the teacher's role to notice what activity the child is engaged in and create opportunities for learning in that activity. For example, if a group of children are playing with a board game such as Bingo (see Fig. 1) the teacher will join the group and will ask questions related to the game such as "what colour is that castle?" while also encouraging the completion of the activity.

Herein lies the challenge for the teachers, they must constantly recognize opportunities for learning within the scope of each child's interest at a given time. The main aim of our study was to design and develop a software solution to address and resolve this challenge in the domain of early childhood education (ECE). The specific goals of our study were to *better understand* different aspects and challenges of the problem domain, design and develop an *engaging* software solution that would preserve the principles of *reciprocal teaching* and support *collaborative gameplay* among teachers and children as widely adopted and practiced in New Zealand.

A strong criticism of child–computer interaction software solutions is the inattention to studying them in real-life contexts [3] and to aligning technological and pedagogical considerations

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http://dx.doi.org/10.1016/j.ijcci.2014.06.001
2212-8689/

Fig. 1. Physical pattern-matching Bingo game based on popular cartoon used at ECE center.

[4,5]. Our study acknowledges these as imperative steps in designing not just usable, but useful, software solutions. To this end, we conducted a multi-disciplinary research and development study which leveraged from the joint participation and contributions of software engineering expert and workers (principal investigator/supervisor and students), practitioners (teachers), users (children and teachers), and domain experts (ECE expert and early childhood psychology expert) to achieve its goals. We employed a combination of Action research [6–8] as the overall research framework, elements of User-Centered (for evaluation by end-users) and Participatory Design (for collaborative design with inputs from teachers and education/psychology experts) [9,10] as the design frameworks, and Scrum software development [7,11] as the software development framework. Using Action Research, we collected initial requirements through observations of child–teacher interactions at an ECE center. We designed and developed the software solution in an iterative and incremental manner in close collaboration with the end-users and experts using the User-Centered Design and Participatory Design approaches and Scrum software development respectively. Finally, we evaluated the software in three phases and made a number of refinements in response to the results and analysis. In this paper, we present the design, implementation and results of our multi-disciplinary study along with implications for research and practice.

2. Related works

Our project combines aspects of three areas that have a strong influence in ECE today: curriculum and pedagogy, and early childhood socio-cognitive development, and more recently, child–computer interaction. In the following subsections, we discuss some of the previous work in each of these areas as they relate to our study.

2.1. Early childhood curriculum and pedagogy

ECE in New Zealand follows the principles of *Ako* [12–15]. Ako is perhaps best described by the whakataukī (traditional Māori proverb) [16].

'Mā tōu rourou, mā tōku rourou ka ora ai te iwi'.

'Through your basket (contribution) and my basket (contribution) we can feed our people.'

This proverb captures the essence of Ako to mean both teaching and learning. It recognizes that both teachers and learners contribute, as partners on equal terms, to learning interactions, and acknowledges the importance of shared learning experiences in the creation of new knowledge and understanding [12].

The principles of Ako are manifested and practiced in a number of ways in the NZ ECE context. The most prominent of these include a non-prescriptive curriculum as a means to a broader and richer learning experience, *reciprocal teaching* as a two-way learning process, and *collaborative gameplay* as the stepping stone for shared learning experiences in groups.

Reciprocal teaching

Reciprocal teaching is an instructional approach developed by Palincsar and Brown in 1984 [17] that is described as a "*dialogue between teachers and students for the purpose of jointly constructing the meaning of text*". It is designed to improve students' reading comprehension by teaching four key reading strategies: summarizing the main content, formulating questions, clarifying ambiguities, and predicting what may come next.

Reciprocal teaching is known to allow teachers to guide students towards greater autonomy within their learning groups [18,19]. The three main components of reciprocal teaching therefore include the presence of guidance (from teacher), fostering of autonomy (in students), and collaborative learning (in groups).

An in-depth study into the use of reciprocal teaching for imparting mathematical education in New Zealand [19] recommends that teachers need to: align critical mathematical components within particular concepts; support variety of problem-solving approaches attempted by students; and support collaborative learning amongst students. Our software solution was aimed to assist teachers in practicing reciprocal teaching of numeracy through supporting these dimensions.

2.2. Early childhood psychological perspectives on collaboration

Collaborative activities are activities in which individuals coordinate their actions to attain a common goal [20]. A growing body of evidence suggests that children's understanding and engagement in collaborative activities develop significantly across the first four years of life [21].

Within the first year of their lives, children demonstrate early forms of collaborative skills by coordinating their actions with their caregivers in simple and highly ritualistic collaborative social games such as ball toss. By 24 months of age, toddlers demonstrate an understanding of the shared nature of collaborative action [22] and are able to skillfully coordinate their own actions with that of a social partner in novel collaborative problem-solving tasks, such as helping someone retrieve a toy from a puzzle box [23]. Also, by the end of the second year of their lives, evidence has revealed marked increase in the extent to which toddlers successfully coordinate their actions during cooperative activities with same-aged peers [24–26]. Children's abilities to collaborate continue develop throughout the pre-school years with significant improvements in the extent to which children are able to coordinate their actions with and be responsive to same-aged cooperative partner [27,24,28,29]. Indeed, the ability to engage in collaborative action has been shown to play a significant role in promoting a number of facets of children's cognitive development [30], such as planning [31], problem-solving [32], and memory [33].

Although there is now significant research evidence demonstrating that children make remarkable strides in their ability to collaborate with peers across the first three years of life, research surrounding the role of collaboration in facilitating learning in early childhood is in its infancy. As such, our study extends our understanding of how touch-based tabletop software applications may support collaboration between preschoolers in an ECE context.