Assessing the Design of Collaborative Mathematical Activities for Preschool Children Using Interactive Tables

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In the Swedish preschool curriculum, it is stated that children's learning should happen through play. There is also an expectation that children will engage with ICT and be provided with situations that require them to engage with mathematical concepts. Consequently, the object of this research project is to evaluate mathematical games designed for interactive tables in regard to children's needs and intersts. Four mathematical games are analysed to determine whether they utilise the affordances of the interactive tables in ways that were likely to support preschool children's possibilities for learning mathematical concepts and language as well as how to interact with each other. This investigation provides information about how the affordances of interactive tables can be utlised to best meet the needs of young children for future design projects.

Introduction

In Swedish preschools, children are expected engage with ICT (Utbildningsdepartmentet, 2010). However, there has been little research on the affordances of different technologies and how they can be utilised with software applications, to support the simultaneously development of young children's motor skill co-ordination, use of language to communicate, mathematical understandings. Young children also are interested in many things, some of which adults do not find interesting. Therefore, the sorts of activities and how ICT can be utlised to meet young children's needs and interests must be considered carefully (Hvit, 2010).

Recent research on slightly older children provide promising results. Riesbeck (2013) showed that children in the first years of school can use technology to reflect on their mathematical learning. Davidsen and Georgsen (2010) found that ICT, including touch screens, support children's collaboration on tasks. However, Ladel and Kortencamp (2012) found that the teacher's role and the type of questions that they asked were very important for supporting German preschool children to externalise their number understandings using a multi-touch table.

Understanding the possibilities of different technologies requires identifying the relevant features, or affordances (Bower, 2008). For example, children's use of multi-touch versus single-touch technology will affect the kinds of discussions that arise from such collaborations (Harris, et al., 2009). Therefore, the type of discussion needed to promote learning within the possibilities of a specific game should determine the technology that is used.

Interactive tables are like interactive whiteboards but are positioned as a table that young children can stand around. In our study, we explore whether four games designed for an Interactive Table have the potential to simultaneously foster preschool children's mathematical engagement and language skills by identifying the affordances of the Interactive Table to meet the project initiators' suggestions for what would make educationally interesting tasks.

Methodology

In the research, we used Bower's (2008) affordance analysis of e-learning design methodology (see **Figure 1**). Bower's (2008) different kinds of affordances which are identified in Table 1. Although a model for designing educational ICT tasks, in previous research (Lange & Meaney, 2012), it was used to retrospectively evaluate a teacher's decision making in regard to developing a lesson with ICT. By working through this model, the use of different affordances of the Interactive Table in the games can be evaluated against the requirements of project initiators who identified the educational goals and suggested what would be suitable task features.

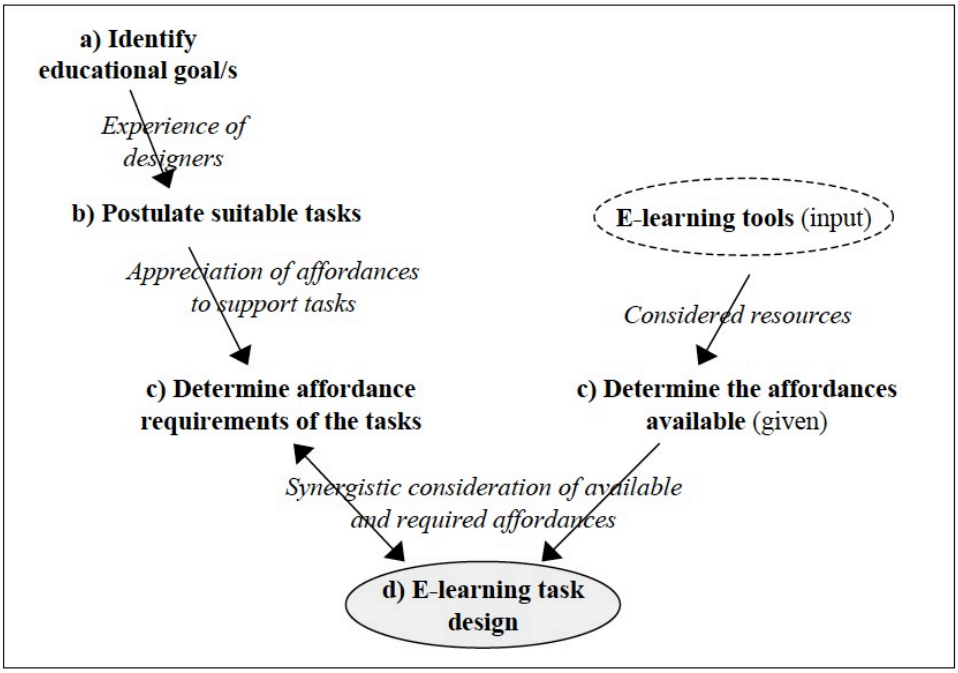

Figure 1: The affordance analysis e-learning design methodology: matching tasks with technologies to construct e-learning designs (Bower, 2008, p. 8).

The project initiators based their requirements on research about different apps for a tablet (Lange & Meaney, 2013). For a child to want to play an app, then the child needed to control it as much as possible. Apps also needed to provide enough challenge to be interesting but not so much that the child could not engage. Apps which included

something surprising in them prompted discussion. The Swedish preschool curriculum draws upon Bishop's (1988) six mathematical activities (Utbildningsdepartmentet, 2010), so a similarly broad perspective on mathematics was important in the design.

The task designers, first year university students enrolled in a gaming design course, decided on and developed the actual games, which were: Memory, Shapes, Balance and Cubes (see Figure 2). The Memory and Shapes games had two versions, a simpler and a more complex one.

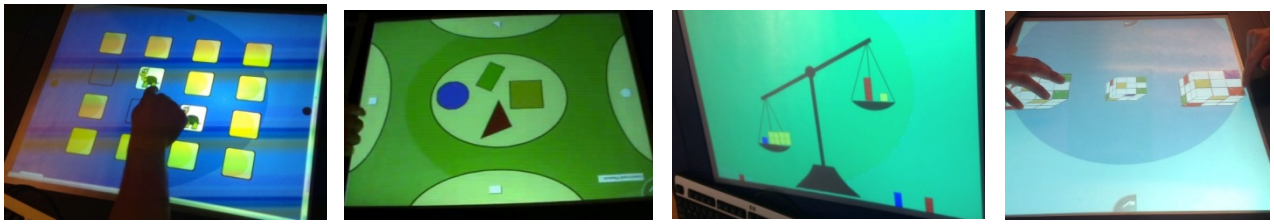

Figure 2: Memory, Shapes, Balance and Cube games for the Interactive Table.

Results

In Table 1, we outline the affordances utilised in the different tasks. Navigation, Synthesis and Technological affordances were not utlised by any of the games. Given that these affordances are related to being able to move from one resource to another and backward and forward between these resources, it is perhaps not surprising to find that games designed for preschool children did not include them.

Table 1: Affordances used by the different games.

Affordances	Memory	Shapes	Balance	Cube
Media affordances	Matching different images are important component of game.	Images of the different shapes are key component of the game	Images of balance and blocks are components of game.	Pictures are the main media. The representations on the blocks change.
Spatial affordances	Cards can be turned over by touching them, but cannot be moved.	Shapes need to be moved to appropriate place.	Players move blocks onto balance baskets. Balance then adjusts accordingly.	N/A
Temporal affordances	Must be played by one person at a time.	The shapes can be moved in any order and simultaneously.	Blocks can be moved in any order simultaneously.	Cube faces can be changed by players simultaneously.
Navigation affordances	N/A	N/A	N/A	N/A
Emphasis affordances	Turning over of cards.	Shapes are returned to centre when placed wrongly and place turns green when shape is placed correctly.	The balance is affected by the blocks put on it. When the baskets are equivalent then balance turns green.	N/A
Synthesis affordances	N/A	N/A	N/A	N/A
Access-control affordances	Game is played by several people but only one at a time.	Game can be played by several people simultanesouly.	Game is best suited to 2 children but they can operate it simultaneously.	Game can be played by several people simultanesouly.

Technical affordances	N/A	N/A	N/A	N/A
Usuability	Experience of card game makes it easy to play.	Intuitive to use and emphasis-ability provides support for this.	Intuitive to use.	Intuitive to use.
Aesthetics	The cards have simple designs.	Clear designs.	Simple colours and shapes.	Simple colours and shapes used.
Reliability	Robust.	Robust.	Bug in the software means that it does not always work as expected.	Robust.

The media used in all games were visual images. Given the children's age, instructions provided through reading, and to a lesser extent hearing, would not be appropriate. Consequently, the usability relied on the player's intuition, but was supported by the emphasis given to particular aspects of the games. However, in the balance game, there was a system bug which meant that blocks placed near the buckets but not in the buckets affected the placement of the arms of the balance. Nevertheless, the children used their intuition to work out what was wrong. The balance and shape games involved children moving components around the table. In the Memory game, the players, one at a time, could turn the cards over by touching them. The shape game could be played one player at a time but did not have to be. The aesthetics for all the games were based on simple primary colours and uncluttered screen design.

The games met some of the requirements of the project initiators. There were links to Bishop's mathematical activities of design (Memory, Shapes and Cube) and Measurement and Counting (Balance). Although the teachers could ask questions while the children were playing, the quick change over to a new game once the expected outcome was achieved reduced the possibilities for conversations. The Balance game when it required more than putting the same size of objects on each side, a surprising outcome, was the one which had the greatest potential for promoting conversations. The non-standard shapes in the more complex Shapes game also provided opportunities for the teacher to ask about different attributes of shapes.

Conclusion

The games were potentially interesting to children and provided possibilities to use and learn mathematics. The brightly-coloured layout was likely to attract children's attention and the intuitive nature of the games meant that preschoolers would work out what to do. However, the games used only some of the affordances of Interactive Tables, so future designs could incorporate other affordances, such as the resizing of objects or recording some of the results in games such as the Balance or Cube game. These affordances could increase the possibilities for discussion between children and with the teacher as they could contribute to making the games surprising in some way.

However, it is important to observe children using the games and hear from their teachers about whether they considered that the games met the children's needs and interests. This feedback will support us in determining what would be the best ways to ensure that children were at the centre of game designs.

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