ClueKing: Allowing Parents to Customize an Informal Learning Environment for Children

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Abstract. This paper introduces ClueKing, a children's pervasive game which encompasses context-aware and parents mediation to create an informal learning environment. In this paper we review related theories of inquiry-based learning and parent involvement, the basic pedagogical model, and mobile learning and pervasive games as the technological framework. The basic concept of ClueKing defines an interactive environment where teachers define the learning goals and challenges and parents mediate their application on the home setting, the children schedule and how to promote their engagement. The system's architecture is also presented, as well as the workflows for the development of ClueKing. Since this is work in progress the paper concludes with the next steps and future work to be carried out.

Keywords: Mobile learning · Location-based games · Inquiry-based learning · Parents' mediation · Children

1 Introduction

In the twenty-first century we are literally surrounded by digital devices. Digital devices, such as mobile phones and tablets, are transforming the way children interact with multimedia content. Whether we are at home with our families and friends, at school or work, or on the move, most of our activities are mediated through technology, including often digital games. Blanchard and Cheska [1] hold that play is widely perceived not as the opposite of work, but as an accepted form of learning.

Everything today is interactive, even education is turning more interactive with the advent of mobile learning and games-based learning. A number of educators agree that the variety of popular game types that we are noticing today are "*untapped educational resource*" [2] that might "*give a glimpse of how we might create new and more powerful ways to learn*" [3].

For players and educators, the power and appeal of games comes from its capacity to generate intrinsic motivation in the players [4]. With this capacity to engage, playing

becomes something absorbing, and hence much more memorable and meaningful to the player.

In such digitally rich space there is a unique opportunity to design and create new modes of supporting children in learning through pervasive games. However, it's hard to find a children's game where parents have an active role. Mediation can add several benefits and strengthen motivation in children's learning activities, where both children and parents could benefit from it [5]. Mediation is a crucial component to any digital experience that targets young children and has as a goal a specific learning outcome, it can play a substantial role in supporting children's learning in digital environments. The role of mediation in its various forms can benefit both children and the adults working with them [5]. In the next section we will outline the main areas that interplay at the basis of this concept. Afterwards we will describe both the initial concept and the system's architecture. We will conclude with future work and next steps.

2   Inquiry-Based Learning and Parent Involvement

Inquiry-based learning is a pervasive activity [6]. Such technique is intended to engage and motivate the learners by immersing them into authentic situational contexts in order to allow them to practice skills prior to mastery [7]. Song [8] suggests that the use of mobile devices can create seamless inquiry-based learning environments, consisting of six activities: explore, engage, explain, observe, reflect and share. In inquiry-based learning the teachers in school have a supportive role in these tasks, as described in the problem-based learning pedagogy. We argue that parents can take up a complementary role at home. Since parents often help their children executing their home works at home, we envisage the scope for an application that facilitates this process by engaging children in a gaming experience that encompass specific contents appropriately tailored for each one, and adaptable to distinct places and times. With this approach, children might be immersed in a learning environment that benefits the children's learning process either at school with teachers or at home with parents. Moreover, improving inquiry-learning is very important throughout life as it supports a lifelong learning attitude [9].

Parental influences on children's early cognitive development and parental involvement in children's education have been widely explored. Parents have a significant impact on how children spend their time during early years. According to some researchers in the area [10, 11] parents shape the environments that establish the scene for children's time-use, they have the power to determine the type and number of activities that children are involved in [12, 13] and the toys they play with [10, 14]. Such research shows that parents tend to choose games that have a wide variety of activities and content over games that do not allow customization between the content itself.

A study by Hoover-Dempsey et al. [15] have explored parental involvement in their child's homework and have identified two main categories of practice: (1) enhancement practices which included monitoring children's learning and engaging in the homework process; and (2) basic practices which encompassed setting a time-table for homework completion and interacting with children's teachers. According with this study, parental

involvement in homework was seen as a positive influence on children's academic achievements through role modelling, reinforcement and instruction. We are envisioning a similar positive influence on the child through mediation in digital games by empowering parents to customize the inquiry-based learning activities for their child.

3 Mobile Learning and Pervasive Games

Overtime, mobile learning applications have evolved from the use of mobile devices as simple players to publish multimedia resources to more sophisticated learning applications which support the learning process in a complex way. Due to the increase of mobile devices and consequently mobile application revolution, a large diversity of learning applications has been developed, although a lot of these with a simplistic pedagogical framework. This might be one of the reasons why mobile learning is considered like other technically driven innovations that have come and gone in the past, as being a hype [16].

Mobile devices offer many different opportunities to detect the user's location, and especially how contextual information can be provided in the context of developing pervasive games and learning activities. The main technology used in outdoor settings to detect user's location is the GNSS (Global Navigation Satellite System) technology. Although the GPS (Global Positioning System) is the most common system, most recent devices have additional support to GNSS, Galileo or BeiDou, which increases the range and precision of the positioning. Nowadays, even the geolocation API, which can be used to track the user's position [17], is supported by HTML 5. Although the detection of user's location has improved over the years, the GNSS technology is only suitable to be used outdoors, and its accuracy can be problematic if required to be under a few meters precision.

Since GNSS can only be used outdoors, other technologies such RFID, QR codes and Bluetooth are used for indoor learning settings [18]. Through tag-based solutions such as RFID or QR codes we can easily identify the exact location of the learning object to present information to the user. When using QR codes the tags generated are physical objects printed in paper. And the content creator needs to take the QR codes to the destination beforehand, which might be complicated if the locations are far away. In the same way, Bluetooth technologies (such as beacons) need to be placed as QR codes are, the difference between them is that with QR codes the user needs to find the mark and capture it, while with beacons the user doesn't need to find any physical beacon, but the beacon itself, through Bluetooth finds the users and unlocks information for them as the user approaches the device. On the other hand, QR codes are cheap to produce and easy to print [19].

There are some mobile learning platforms which supports location-based learning content for outdoor, such as *QuesTinSitu* [18] and *Treasure-HIT* [20] and for outdoor and indoor learning alike, such as *Wandering* [21] and *Mobilogue* [19]. Learning authoring tools enable teachers to use a map to assign questions to a location by clicking on the desired location, although for this to be possible, it is necessary that someone physically explores those locations to retrieve content in order to shape the questions that will be answered by students [18]. These are usually simple questions

that requires the user to engage and interact with the environment in order to select the correctly answer [19]. The author of the learning content assignments can define a route that players have to follow, or this one can be automatically generated by the system with certain preconditions like calculating the route based on the shortest path, also the route can also be different for each player, based on the author's definition [20]. We have learned and adopted many of the lessons learned from the above systems in order to design our location-based learning game environment which will be described in the next section.

4   ClueKing Concept and System Description

ClueKing is a pervasive game which creates an informal learning environment customized and mediated by parents and teachers. Children are engaged on a sequence of learning activities under the inquiry-learning framework, where they are able to explore, engage, observe and reflect, advance their knowledge and improve their inquiry-based skills [8].

We propose a "parents + learning + location + play" quadruple, as the underlying framework for children to engage in the informal learning environment and to generate intrinsic motivation for the learning activities and to advance their knowledge.

The ClueKing concept relies on a location-based digital treasure hunt where parents are engaged in creating a setting for the challenges developed by the teachers in the form of questions and levels of difficulty. The questions or challenges will be distributed around the pervasive space and the game will be played with the child's or parent's mobile device. The child will move from one place to another as he/she successfully answers questions and the next challenge location is revealed. The parents together with the teachers if so desired, can set a specific final prize to be anything relevant to each child.

These inquiry-based skills mentioned above will be improved by various locations in the game. Each location consists of a challenge that the child would have to accomplish in order to progress further into the game. These challenges will be specifically tailored by the parents to that particular setting where the child is playing the game. For instance, if the child has the clue to go where the eggs are located in the house (fridge), they go to that specific place and will unlock that specific challenge (the unlock process will be triggered by a beacon which will be automatically read, or by reading a QR code). In this case, the challenge unlocked will be the one related to the fridge. For other subjects, like Mathematics, a suitable question for this case could be "If mom bought 7 eggs in addition to the ones in the fridge, how many eggs we will have in the fridge now?". For the answer the children will need to count how many eggs are in the fridge and do the calculation of adding 7 more. This example could be applied to other subjects and locations. It is a matter of imagination from parents, and from their awareness of what type of subject the child needs to focus more on.

4.1   The System's Architecture

Teachers and parents are allowed to customize the ClueKing game through a web based interface. Teachers should be the creators of the inquiry learning challenges (Fig. 1) and parents should customize it to the home setting and the children's preferences (Fig. 2).
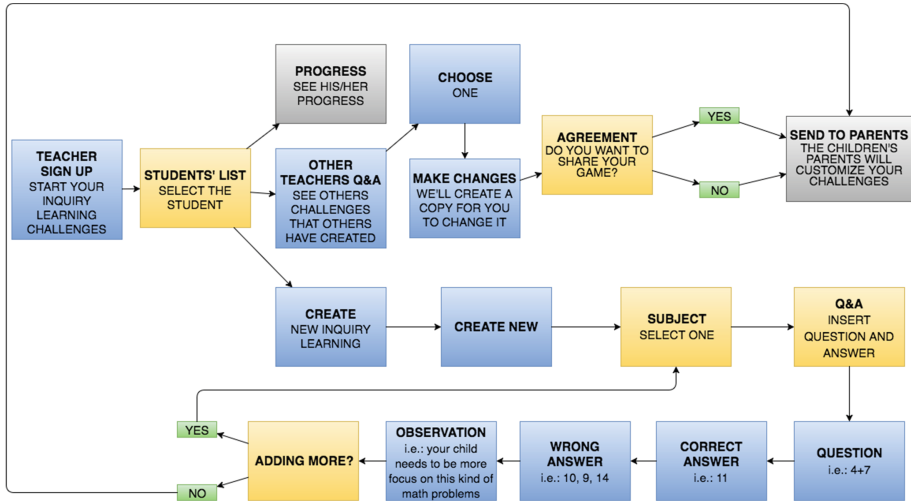

Fig. 1. Teacher's role in the web server of the ClueKing location-based game system with an example of a numbers' challenge.

Teachers have the role to create challenges in specific subjects (e.g. words, numbers, colors…) and to send it to children's parents. They are already able to see other challenges that other teachers have created and they can also see the progress of their students when they have finished a game.

In other hand, parents can select the teacher's challenges and can choose an indoor environment, for which they can use QR codes or beacons to trigger the position of the player after, or an outdoor setting, using the GNSS technology. After these steps parents are prompted to choose the type of game for that challenge that the teacher has created (e.g. puzzle, question, tasks…). Parents are also able to create games according with teacher's notes, and they are aware that those games will be seen by them.

When parents are interacting with ClueKing for the first time (via web), they will know that the triggers are assigned by utilizing QR codes or beacons for the indoor environments. In case they select the beacons, they will need to pair each beacon with the service (via web). Afterwards they are required to choose which beacon they will be using and just have to place the right beacon in the right location. If they don't have beacons, they can easily customize the game with the QR codes, by printing it.

Once the game is finalized they can download a PDF with all information of the game that they have created, the printable QR codes to place in the game setting, or the
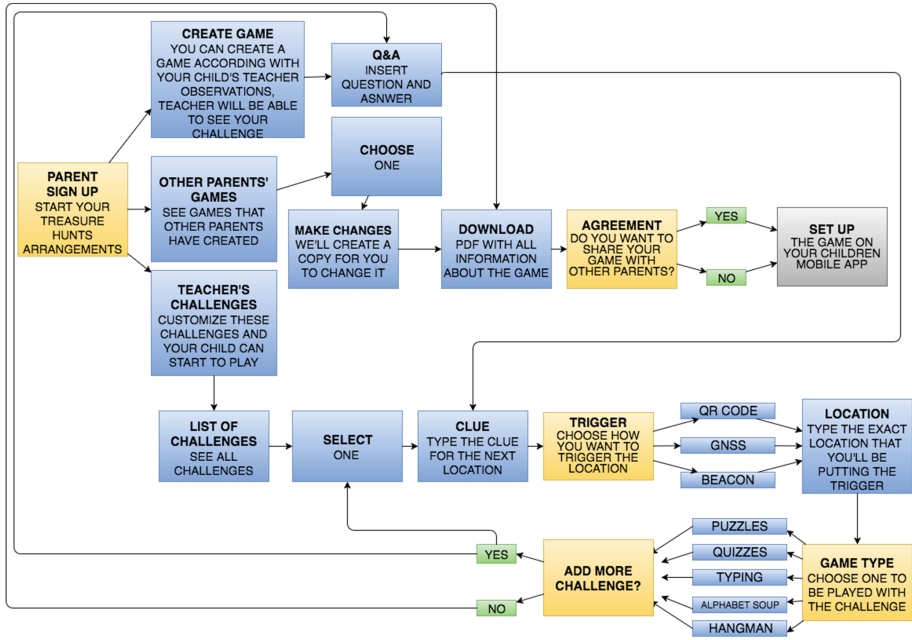
Fig. 2. Parent's role in the web server of the ClueKing location-based game system.

code of the beacon for each position. Afterwards they have the option to make the game public or private. If they make a game public, it will be available to other parents of the same children's class. Other users (parents) will be able to see and customize its locations along with their challenges.

Because of the spatial variation of the home setting, the tagging combinations might differ from family to family. ClueKing offers two approaches: when beacons are used in a game, a shared game in the beginning will ask the parents to select their previously paired beacons. So, if a parent will be using a game that is from another parent, they will need to select their own beacons in order to complete the creation of the game. Due to the diversity of contents in a single shared game, parents are able to customize not only the above mentioned features but also the subjects and types of the game. In the example above about the fridge and the eggs, a parent might want to use the same approach to a different learning challenge previously created by the teacher.

Parents configure the game in the mobile app by typing a code that the PDF has generated, then the rest of the game is to be played by the children (Fig. 3). They read and listen the first clue to reach the first location and unlock the next clue. When they reach the location they are either instructed to capture the QR Code or the content is automatically unlocked by the beacon or GNSS. Afterwards children are required to engage with the challenge that appears on the screen in order to get the next clue and reach the next location. This repeats until they get to the final location and solve the game to win the prize.
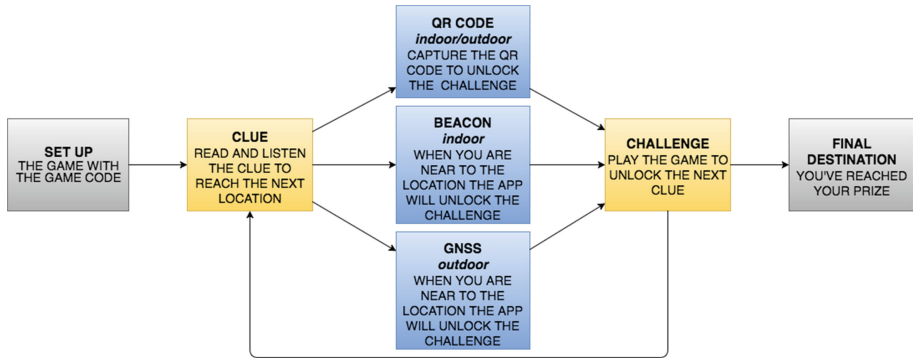
Fig. 3. Children's mobile app of ClueKing location-based game system.

5   Conclusions and Future Work

In this paper we have presented the theoretical background and preliminary design of ClueKing, a pervasive game intended to support parents' involvement in mobile based learning for children. Our application relies on inquiry-based learning theory in order to extend the learning opportunities of children outside the classroom as well as stimulating intrinsic motivation in learning and acquiring new knowledge. Through our system, parents are allowed to customize the game, its challenges and its final prize. In this way, parents take an active role in the ClueKing informal learning environment and can foster children's motivation to learn by playing. The children's inquiry-based learning activities will occur in each milestone through those challenges that parents have previously customized for them to play.

Our next steps involve the development of the pervasive game and the web-based, where parents can set up the game. The complete ClueKing solution will mediate parents, teachers and children interactions. Once a working prototype is ready we will proceed to cognitive walkthroughs, heuristic evaluation and user tests to inform the refinements of the next cycle of development.

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