

TaBooGa – A Hybrid Learning App to Support Children’s Reading Motivation

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Figure 1. We present TaBooGa, a hybrid reading app that supports children’s reading motivation by combining an electronic book with tangible elements. Children read a story on a tablet (a). To progress through the story a figure of the main character needs to be moved on a physical gameboard (b). The reading task is interlaced with real world tasks (e.g., building a bridge with LEGO), which is integrated with the story by taking a picture (c).

ABSTRACT

In this paper we present TaBooGa (Tangible Book Game), a hybrid learning application we developed to increase children’s reading motivation. As children are exposed to digital devices early on (e.g., smart phones and tablets) weak readers are particularly apt to prefer digital offers over reading traditional books. Prior work has shown that ebooks can partially address this challenge by making reading more compelling for children. In this work we show that augmenting ebooks with tangible elements can further increase the reading motivation. In particular, we embed tangible elements that allow for navigating through the book as well as in the form of mini-games that interlace the reading task. We report on the results of an evaluation among 22 primary school pupils, comparing the influence of the approach on both strong and weak readers. Our results show a positive influence beyond reading motivation on both weak and strong readers. Yet, the approach requires to strive a balance between the tangible elements being motivating while at the same time not being too distracting.

ACM Classification Keywords

K.3. Computers and Education: Computer Uses in Education

Author Keywords

reading; motivation; literature; book-app; hybrid; tangible

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INTRODUCTION

Reading is one of the most essential skills in our daily life. As Clark et al. state, ‘reading is an important gateway to personal development, to social, economic and civic life’ [5]. At the same time, the plethora of compelling alternatives in the form of games or video clips on smart phones and tablets leads to an ever decreasing amount of time children dedicate to training the skill of reading. As a result, many children are exposed to reading only at school. This raises the question, how to involve young people and increase their interest in literature.

Prior research tried to address this challenge and increase the motivation for engaging with literature by transferring the reading task to the digital world through interactive ebooks and storytelling authoring tools [7, 16, 19, 25]. At the same time, prior work showed that the involvement of multiple senses (e.g., visual, acoustic, haptic) increases motivation and supports learning [2, 21]. Tangibles were found to be particularly useful for reading tasks [1, 9, 15, 20, 23].

In this work, we combine the strengths of both approaches. As with an interactive ebook, the reading task is performed in the digital world. At the same time we enhance the reading task with tangible elements, hence creating a multi-sensory experience. We implemented a tablet app for the reading task. To further increase the reading motivation, we augmented the reading task with two kinds of tangibles: First, to progress through the story (flip pages), children need to move a figure of the main character across a physical board. Second, the story includes short tasks that need to be performed in the physical world (e.g., building a LEGO bridge to cross a river). Results are integrated into the story through taking pictures (see Figure 1). Thus we make the reading task more attractive and motivate weak readers in particular to read the entire story.

We report on the design and development of the app and present a user study among 22 primary school children aged 7–9. The evaluation focuses on a comparison of how the presented concept of a hybrid book-app impacts on the reading motivation of weak and strong readers. Our results show that both types of readers (weak and strong) can benefit from hybrid apps enhanced with tangible elements. At the same time, the app design needs to strive for a balance between the tangible and digital interactive elements being motivating but not distracting from the main task of reading, hence being in line with findings from prior work [7].

RELATED WORK

Our work draws from several strands of prior research: reading motivation, digital reading, and hybrid apps.

Reading Motivation

Reading is an essential skills to partake in the cultures and society of our modern world. To become a strong and fluent reader, the act of reading has to be effortless and exciting to get young people interested [23, 27]. Basically, involvement in literature should not exclusively be supported in school, but be brought to the children’s homes. As low performance in reading leads to low motivation for reading, a change in attitude has to start here. Motivation for reading and fascination for stories are the decisive factors. Reading may become boring if it is mandatory and not an experience of ‘flow’, where children can explore new worlds with their imagination [6].

Another important fact is that appreciation of literature and stories has a direct link to further motivation for reading [27]. An investigation on children’s (aged 6–12) usage of media in their spare time showed that the activity of ‘leisure reading’ is ranked far behind most computer-based activities [11]. Due to a remarkable difference in gender regarding reading motivation and reading skills – girls are on a much higher level – it is important to support both genders in different ways [13].

Digital Reading

Children grow up in households that cover a broad spectrum of different media, ranging from TV over computers to smart phones and tablets [11]. As smart phones and tablets are both popular and easily accessible for children, these devices are best choices of considered media for enhancing reading skills.

In Germany formal education at primary schools often has still no access to tablets or similar devices [4]. The acceptance of parents to use such devices as a possibility for learning and improving reading skills is also rather low. Only 16% of all parents use children book apps [8]. Their main concerns are that their children stop liking printed books, see inappropriate content, and spend too much time in front of digital devices.

There is indeed a difference between high and low quality ebooks. A high quality ebook has to strive a balance between reading and stirring up interest through interactive elements. These elements should be no distraction from the story itself [6, 21]. Furthermore, ebooks are able to support parents in their attempt to encourage their children’s reading, but they should not be misused as so called ‘pacifier toys’ [24]. The focus should always remain on the good story and not on

games or interactions [17]. With these guidelines at hand, high quality ebooks can be created in a way that satisfies sceptical parents and teachers alike. A further advantage of ebooks is that in particular children with an immigration background who still struggle with the new language may benefit from the combination of images and sound [22].

From our review of prior literature we learned that while training reading skills is important and ebooks are a promising attempt, there are still considerable reservations among parents and teachers. One of the reasons is the exclusive focus on the digital world that further increases children’s ‘air time’ with technologies, such as tablets and smart phones. This motivated us to investigate how to establish a link between digital and real world by means of tangibles.

Hybrid Apps

To do so, we consider a new approach: mixing digital elements with real-world physical objects. We envision this approach to both increase acceptance among parents for reading apps while at the same time increasing children’s motivation and engagement, ultimately leading to more quality reading time.

We realize this approach through tangibles that augment the reading app. Tangible user interfaces (TUIs) ‘augment the real physical world by coupling digital information to everyday physical objects and environments’ [14]. Here the physical world with all its objects becomes an interface for interaction with digital components [26].

In general, physical components already follow design guidelines like ‘form follows function’, hence being the best suitable choice for special tasks [12]. Tangibles enable haptic feedback that is usually missing from touch-based devices, but is well known to users through daily routines [18]. These benefits make tangibles particularly useful tools for learning [20].

In projects like ‘Click-Craft-Play’, children can draw or use bricks to create their own gaming area. A link between the virtual and the real world is created. The game becomes digital, when the children take a photo. In hybrid games, digital components are added to toys or vice versa to make playing more interactive and to stop parents from worrying about excessive digital gaming of their children [3].

Tangibles are mainly used in combination with digital games. An example where tangibles have been used in the context of reading is the work of Pinto. Here, the reading experience is enhanced through a multi-sensory approach that ‘involves haptic perception, and [...] in turn engages both tactile and kinaesthetic perceptions.’ [23]. In her ‘Book of Hours’, Pinto therefore enhances an ebook with a traditional book to enable haptic feedback and interactive elements [23]. In another project, Fan et al. [10] used alphabetical characters in the form of tangible objects to enhance reading and spelling acquisition among children with dyslexia.

Our work contributes a novel approach where tangibles are used beyond creating a haptic sensation during reading, but also adds playful, haptic elements that are aimed at further increasing motivation as well as establishing a link back to the physical world.



Figure 2. A Monsterly Adventure in the Mountains: on a tablet, children read the study about the main character, Jonas, who is on his way to the mountains to search for a legendary monster. Children progress through the story by means of a physical game board (cf. Figure 3). The story is interlaced with physical tasks in the real world (see Figure 3-right).

TABOOGA – A HYBRID BOOK APP

The following section presents our design and development of an interactive ebook enhanced with tangibles (hybrid app).

Concept

In our work we adapt the concept of hybrid games, i.e. games where physical toys are combined with digital components. To support leisure reading, we created a digital reading app and augmented it with various physical elements, to support leisure reading. The physical elements are used for navigation and games related to the plot.

One challenge was to maintain the focus on the story and associated images, as known from traditional children's picture books. The reading content is presented to the children on a tablet. In addition to the app, a physical game board is provided (see Figure 3-left). It enables the reader to progress through the story and to flip pages of the digital book. In addition, the concept includes a number of tasks in the real world by means of pen and paper as well as by using LEGO bricks. Another challenge was to connect the tasks from the physical world with the digital reading app. This was done by enabling children to take photos of what they achieved in the real world (see Figure 1-c). These photos are embedded into the text.

The physical components are characters and elements of the story, that also appear in digital form. The plot called 'A Monsterly Adventure in the Mountains' revolves around the protagonist Jonas and his friend, the jackdaw-bird Petry (see Figure 2). They are on an adventure in the mountains, where they try to find and catch a famous monster out of legend. On their way, they need the help of the reader to progress up the mountain slopes (for example, building a bridge, catching a water flask from a river). In addition, the reader is provided hints about the monster's features (claws, horns, eyes and teeth), which are later used in a task where the monster has to be drawn. The story finally reveals the monster as the silhouette of four mountain animals, whose shadow resembles a monster.

Components

The hybrid app consists of one tangible element, two physical tasks, and two digital components.

The tangible element is a game board showing a mountain path where the figure of Jonas can be moved up and down (see Figure 3-left). The steps in the path mark the pages of the book: the further the figure moves on the mountain path, the further the story progresses. Making a step on the game

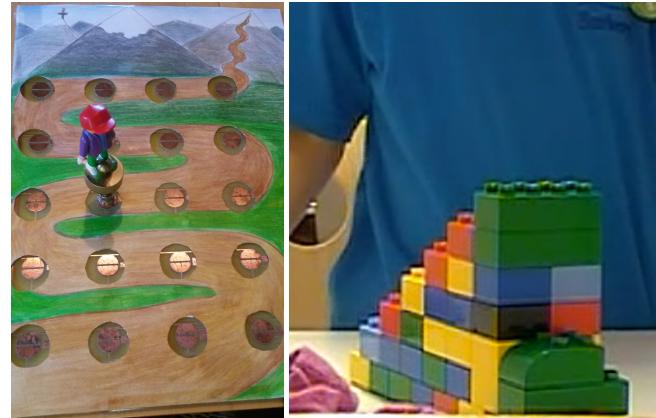


Figure 3. Tangible game elements: to progress through the story (flip pages), children need to move a physical representation of the main character on a game board (left). In addition, the story is interlaced with task, such as building a bridge using LEGO bricks (right).

board with the LEGO figure triggers a digital image of the walking Jonas on the tablet. This is an indicator of the story's overall progress and helps readers to understand how much of the story they have already finished.

Two physical tasks help Jonas to progress in the story. First, the reader has to build a LEGO bridge to aid the protagonist (see Figure 3-right). The second physical task is to draw their version of the monster Jonas and his bird encounter (cf. Figure 5). These tasks are solved with everyday objects such as bricks, pencil, and paper. The goal is to encourage imagination and creativity among the children – two aspects of reading that need to be present for enjoying and comprehending stories [27]. To establish a connection between the real-world task and the app, the children are required to take a picture of both the bridge and the monster using the book app. The picture is integrated with the story (see Figure 1-c).

Finally, there are two digital components. One is a backpack (see Figure 4-left) that is filled with hints or helpful gear to solve riddles and tasks. In this hybrid app, the backpack contains the hints about the monster Jonas collects on his way up the mountain. The children can look at the backpack's contents when drawing their version of the monster. This helps weak readers to remember parts of the story that happened some time ago. The second digital component are three 'mini-games' that have to be solved to continue the story (see Figure 4). Their



Figure 4. Two digital components support the reading task. First, the contents of the backpack (left) help readers during their task of drawing the monster, by providing hints that were presented throughout the story on the monster's appearance. Second, three mini-games interlace the content to further increase motivation – a puzzle, a skill game, and a navigation game.

purpose is to increase the reading motivation through gaming actions, known to the children from many apps. In particular the games include a cave game, where children need to navigate through a dark cave, a skill game, where children need to fish a bottle out of the water, and a puzzle game, where children need to solve a puzzle depicting a signpost.

Implementation

The book app and the digital components were implemented using SenchaTouch¹. To gain access to the native components of the smart phone or tablet (i.e. the camera that was required to include pictures from the real-world tasks with the story) we used the Cordova API². To control the app through the figure being moved on the game board, we connected the Arduino board integrated with the game board to the app using a NodeJS server running on a local computer which read data from the Arduino from serial line. Every time a contact on the game board was closed by the game figure, the actual position was sent to the book app.

EVALUATION

We evaluated the hybrid app to understand the impact on the children's reading motivation and behavior. In particular, we were interested in the influence of reading skills. Since reading motivation often correlates with reading skills, we compared rather struggling (weak) and strong readers.

Study Design

An increase in motivation is more important for struggling readers than for the group of strong readers, because improved reading skills have been shown to persist in the long-term. To measure an abstract concept like 'motivation' we assessed how many of the text passages were read. If no parts were skipped and the focus of attention remained on the story itself, a high reading motivation was assumed. In particular, we investigated whether the students were *reading*, *partly reading* or *not reading* at all. Furthermore, reactions towards the hybrid app were considered: Was there *laughing* or *help needed* and which *kind of remarks* were given? In addition, we collected interaction data with the hybrid app. Interaction could be *effective* or *exploratory* and, since we let participants act in teams, there could be *single* and *team* interaction.

In addition we captured reading and gaming affinity, age, gender and a migratory background.

¹<https://www.sencha.com/products/touch>

²<https://cordova.apache.org/>

Recruiting

For the study, we decided to recruit children from primary schools. This provided us the opportunity to let teachers assess participants' reading skills (see below). All in all 22 children were recruited in two schools – one in a rural and one in an urban area – for participating in the evaluation. Experiments were conducted onsite. The children were aged seven to nine, among them twelve girls and ten boys. Thirteen of them were eight years old, one girl aged seven and eight children were nine years old. 41% of students had a migrant background.

Procedure

At the outset, children were introduced to the procedure and their role in the investigation. We had teams of two children reading together to make them feel comfortable and also to provoke conversation between the students that we envisioned to yield further insights.

The procedure of the study was split into three parts. At the beginning, demographic questions were asked. Details about gender, age and migrant background were collected. We also asked about children's behaviour with books, tablets and smart phones in their spare time. Afterwards, children were asked to read the story using our hybrid app. Teams were mixed, i.e. we had teams consisting of one strong and one weak reader as well as teams consisting of two strong or two weak readers. To observe influences on behavior, we did not further specify how they should read the text (alone silently or together). There was no interruption by the experimenter, except for cases where children got stuck and explicitly requested help. Finally, we had children rate the reading app with regard to different aspects. Furthermore, their favourite media for reading stories was investigated. To verify the children's understanding of the story, each of them had to answer three contextual questions.

With the consent of the parents, children were video-recorded during the whole study to collect and later transcribe actions, reactions, questions, answers, and behavior. For 20 of the children we were granted permission to video-tape the experiment.

Results

In a first step, we identified strong and weak readers in our sample. This was done by assessing their reading preferences, evaluation of their teachers, and the difficulty of their favourite book. For example, some preferred rather simple books, such as 'Coconut – The little dragon', whereas others stated 'Harry Potter' to be their favourite book. Overall we classified 7 out of the 22 children as weak readers.

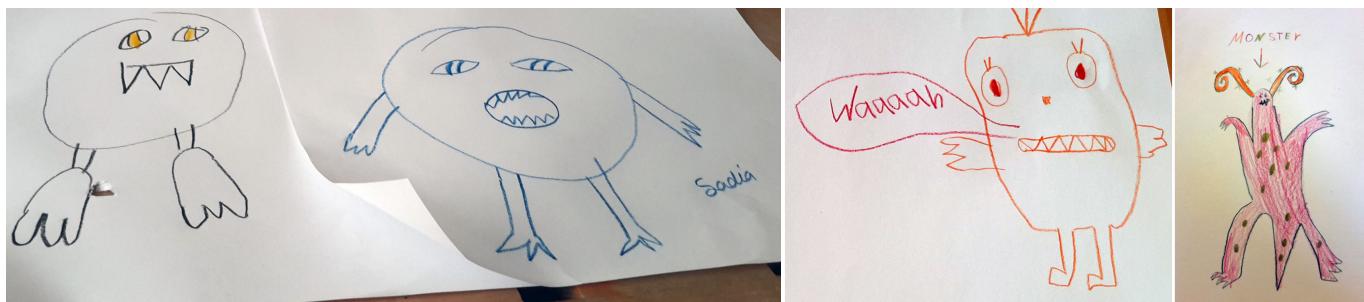


Figure 5. Examples of the monsters drawn by the children. During the story, several hints were presented as to how the monsters looked like. We assessed how many of the hints presented throughout the story were included in the drawing (claws, teeth, horns, eyes).

Quantitative Findings

Weak and strong readers had different preferences with regard to their preferred media for reading stories (options included ebooks, book apps, traditional paper books, and hybrid apps). Among the weak readers, only 20% preferred paper books, whereas 50% of the stronger readers preferred paper books.

From the questions on the content of the story presented through our hybrid app, strong readers could answer slightly more questions correctly. The children from this group answered on average 2.6 out of 3 questions completely correctly, whereas the group of weak readers only answered 1.6 questions completely correctly. In the group of weaker readers, about 50% of the questions were answered partly correctly.

Furthermore, we assessed the degree to which children understood the story by evaluating their drawings (see Figure 5). As previously mentioned, the story contained four hints about the monster's features (claws, horns, eyes, and teeth). Hints were included in the text itself. In addition, little picture items could be collected by tapping on them. Teeth (13 of 22 drawings), claws (17) and eyes (22) were contained in almost every drawing. The horns were included only twice.

In total, we collected 227 remarks by children. Out of these 60% were *positive* or *constructive remarks*. Most remarks occurred during one of the mini games where the children had to navigate Jonas through a digital cave. This seemed to be the most difficult task to solve. Most *constructive remarks* (24) were provided during drawing the monster.

We found that weak readers read on average 71% of all pages, whereas strong readers read 96% of the pages.

Finally we looked into how children interacted with each other during the reading task. Interaction differed between digital and physical tasks. Interaction with LEGO bricks and drawings was mostly conducted in teams. Collecting digital items in the virtual backpack had a high *exploratory* component. All in all, 75 out of 88 hints where successfully collected. On 8% of all book pages *help* from the observers was needed.

Qualitative Findings

We made a number of observations during the evaluation. We noticed *differences between the urban and rural students*. The story contained an allusion to a local country legend which was recognized by one child. Furthermore, all rural students were able to name the four animals in the story correctly, whereas only one urban child knew the correct name of the 'alpine ibex'.

For most of the urban children this animal was a 'goat'. Urban children also called Jonas' companion (a jackdaw) 'raven' or 'crow', as they knew these birds from every day life.

Children mostly read the story by themselves. With regard to the *interaction between children*, the faster reader usually asked once finished 'Are you done?'. In most cases the other child would negate and continue reading. This was interesting, as weak readers often simulate equal reading skills to other children [27]. This finding suggests a high motivation to carefully read the story.

We received several recommendations about possible *extensions of the hybrid app* in the future. Children would have liked to have more possibilities to interact with digital elements of the hybrid app. This seems to come from their earlier experiences with apps in general and has not happened a few years back, when smart phones and tablets where not so popular yet [16]. Furthermore, some of the children did not follow the mountain trail on the game board in a linear order but investigated what happens once they jump to other fields. This was technically possible, but mixed up the order of the story. A future version could either keep track of the already read pages and notify children about their mistake. Or this exploratory behavior could be exploited by designing a story with several options where the part branches and children could decide which route to take.

SUMMARY & DISCUSSION

All in all, our investigation showed that hybrid apps have a high potential to support reading motivation, in particular for struggling readers. Access to tablets and smart phones increased over the last years. As a result, most of the children had previous experience with these devices and favourite games they liked to play on them [11]. Most struggling readers chose the digital or hybrid variant as their favourite kind of experiencing stories.

The connection between story and physical tasks turned out to be particularly useful. The fact that the entire story had to be read in order to successfully solve the tasks / games led to 75% of the weak readers reading all pages to the end. Hence, in the follow-up questions also weak readers had a good understanding of the story's content and could answer them well. We conclude that during the design of hybrid apps an emphasise needs to be put on the connection of story and tangible elements in a way such that proper reading is motivated.

Interesting to note was the willingness of the team mates to wait for the slower reader to finish reading the page. We take this as an indicator for a strong interest in the story. Only through strong interest in stories, a kind of flow experience and curiosity about the content, characters, and suspense, a reader can achieve a higher reading motivation [27]. It seems that the combination of an easy access through digital media, general interest in games and experiencing a story can lead to more motivation for reading literature.

The group of strong readers also reported a positive experience with the hybrid app. Eight out of thirteen strong readers referred to both digital and physical games or tasks as their favourite elements in the hybrid app. For them the combination between tangible and digital parts added to their positive attitude towards reading through all kinds of media.

Reading itself is per definition a silent and individual activity, but by including games and tasks it may become teamwork and be shared with friends on a different level than traditional books. This could be pursued and intensified through hybrid apps that can only be solved by four hands instead of two.

The children easily adopted and liked the combination of digital and tangible elements [10]. Even if controlling action on the tablet with an external game figure was new to them, almost all teams quickly understood the concept. At the beginning of the story there is only a picture of Jonas in the app, telling the children to grab the game figure and move it forward. As they were obviously used to digital actions being triggered on the graphical user interface, many children tried to move the digital version of Jonas. The physical game board was easily visible, but not all of the students made the logical connection instantly. Yet, as soon as they were acquainted with the concept, they could easily handle figure and board.

The children merely had to be reminded of the LEGO bricks, papers and pencils to be used for some tasks. Taking a photo to transfer their creations to the digital world was always combined with many remarks. Two of the children for example wondered: ‘Is our stair high enough to bring Jonas up the rock?’. That is a clear sign that the students could combine the digital with the real world in their imagination and actions.

The success of such a concept depends on the acceptance of the parents. Parents have a strong influence on their children’s choice of literature and are equally responsible for increasing reading motivation. Understandably, some parents do not want their children to spend too much time with digital devices, as it shortens their time spent with the development of motoric and haptic abilities [24]. Time in front of TV, computers, or tablets is therefore often restricted. Here a combination of digital devices with tangible elements may convince parents to encourage reading using hybrid apps as well.

LIMITATIONS

We are aware of several limitations of our study. First, the hybrid app was a new concept for all participating children. This may have sparked their curiosity and have been served as an additional motivating factor. Second, we only focused on a particular age group of children (7–9 years) that already had a certain reading proficiency. It is not clear how the concept

would be taken up by younger children. Future work could investigate a ‘read along feature’. Third, we deliberately kept games and tasks simple. Future work could investigate more complex games and tasks for more experienced readers as well as an adaptation of the task to the gender of the readers. Fourth, it remains to be investigated how motivation is affected as children do not read in teams but alone. Yet, reading in teams occurs frequently, for example among siblings.

CONCLUSION

In this work we presented TaBooGa, a hybrid reading app for children. We reported on the design and evaluation of the application among 22 children, aged 7 to 9 years. We found that the combination of reading on a tablet combined with tangible elements that were carefully integrated with the story had a positive influence on reading motivation as well as interplay and behavior of both strong and weak readers.

We believe our results to be interesting for the designers of hybrid apps, since they point to challenges and opportunities in the design of such apps. In future work we plan to test how the concept can be applied to children of different age groups and gender and how individuals would use the application.

With our work, and in particular the combinations of physical and digital elements, we hope to have taken a first step towards a new class of systems that encourage literacy. In this way we want to trigger a discussion in the IDC community as well as motivate work on novel applications that cater to changes in children’s reading behavior as a result of digital technology being available to them from early on.

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