ReadAR

Helping children find books in the library through a playful and social application of Augmented Reality.

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Abstract

This study investigates a solution to help children find books in a (school)library through a playful Augmented Reality approach. During this project there was close collaboration with three primary school teachers and an education coordinator at the library, especially during the research and ideation phase of this project. Using PLEX [1] as a starting point for the ideation, a solution is created that includes broad reader profiles that are user-curated and engaging 3D animations in the form of reading stereotypes. Additionally, the solution uses localized content in the form of user-created videos that are shown to children in Augmented Reality. Evaluation of the product with 15 primary school students shows that children experience fun when selecting one of the reading stereotypes and while watching the videos. The evaluation also shows that children experience shame when recording the videos, therefore an alternative for this should be considered. We conclude that these user-created reading stereotypes and videos seem a good fit to help children find books, but a longer-term study should be done to look at the effectivity of the product as a whole.

Acknowledgement

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1. Introduction

In 2020, the popular Dutch satirical news show ‘Zondag met Lubach’ dedicated a section of the show towards something that Lubach called the ‘reading crisis’ [2]. This made me aware of the severe problems that are currently playing within the literature education in the Netherlands.

Dutch primary and secondary school children have the lowest reading enjoyment level of all 79 countries participating in the PISA research program [3]. This is an alarming statistic, because reading enjoyment has a positive influence on the development of reading skills [4]. The effects can be seen in other statistics: children in the Netherlands are reading less than in years before, and reading levels are decreasing [3]. Likewise, it can also be assumed that if children enjoy reading more, they will read more books.

Children between the ages 8 to 11 stated in a study that finding the right books is important to creating this reading enjoyment [5]. The children commented that they have difficulty finding books that suited their taste. Several primary school educators that were interviewed for this ReadAR project reiterated this problem.

Various factors make finding a book hard for children. Problems children mentioned in the study mentioned before were a ‘lack of strategy to support choice’, and not having access to the right books [5]. Some teachers mentioned in my interview that children simply do not know where to start when looking for a book. Often, children choose a book based on first impressions, like the design of the cover. Another challenge they identified is the fact that choice is sometimes overwhelming. A library can be filled with hundreds of books, which could induce choice overload. Additionally, the traditional library is not a very stimulating place for children. It is a static place with rows of books.

While libraries have created many initiatives to make the library more attractive for children, there is the potential to make this space more playful and interactive. There are several examples of more playful library buildings, like the Hjørring Library in Denmark [6], or the ‘KID’S REPUBLIC’ in the Poplar Library in Beijing [7]. These initiatives transform the library into a more playful space by changing the design of the library.

Transformations like the ones mentioned have their limits, the main problem being cost. It is expensive to the change the physical space of the library on a large scale. Additionally, there is little to no possibility for personalized experiences, something that might be valuable when helping children find books.

These issues could be addressed by creating a personalized Augmented Reality experience. By using an interactive layer over the real world, the library can be brought to life. This way, the library can be made more engaging and interactive without having to change the physical shape of the space. Using Augmented Reality (AR) also creates the opportunity to establish more personalized and

targeted experiences, to support children with finding books and to stimulate them to explore the library.

Therefore, the biggest challenge that will be tackled is transforming the process of finding a book into a playful and engaging experience. This will be done through the use of Augmented Reality because of its potential to transform and personalize a space in a flexible and attainable way.

1.1 Research questions

The objectives mentioned before will be pursued through addressing the following research questions. The main research question of this thesis is:
How can a playful AR experience be used to help children find suitable books in a (school) library?

This research question will be answered in three stages. Firstly, the background of the children's book selection process and the problems they encounter will be studied. For this, the research question is:
How can you help children with finding a book that suits them?

How do children find a book, what do they look for?

What difficulties do children experience when looking for a book?

The second stage of this research will be focused on designing a solution. The research question for this is:
What is a good new design and implementation to transform the action of finding a book into a playful activity using AR?

Finally, the third stage of this study will focus on evaluating the developed AR application(s), with the research question being:
To what extent does the new AR application make the process of finding a suitable book for a child easier and more enjoyable?

By finding answers to these questions, this research contributes to the field by gathering more detailed and practical, case-based information about the problems that children encounter when selecting a book in a primary school setting. This study will also describe an ideation process closely involving stakeholders and making use of the Playful Experiences framework [1]. Furthermore, this study creates a design exemplar that illustrates a playful intervention for the identified problems. Finally, we will describe the elements from the intervention that help in solving the identified problems, and the elements that could be improved.

1.2 Report structure

This report will start with research on the context of the children's book search process. In this, we will look at how children choose a book, what children's experiences and opinions are on the book search process, and we will look at the problems that children experience when choosing books. After this, research will be done towards the state of the art of playful children's libraries and playful experiences in general. Different AR experiences target at children will be analyzed, along with several AR technologies that can be used for this context. The findings from these chapters will be used during the ideation phase, in which the concept for this solution will be created. This will be done by brainstorming, rapid prototyping and stakeholder evaluations.

The concept will be further specified in the specification chapter, in which decisions will be made about the execution of the product. The different technologies used and the prototype that has been built will be discussed in the realization chapter. This prototype will be evaluated with children, to test if it achieves an improvement over the current situation. The results of this evaluation will be reported in the results chapter. In the discussion chapter, these results will be interpreted, and the limitations of this research will be addressed. Based on this, recommendations for future work will be made. In the final chapter, we will summarize the contribution this research makes to the research territory. We will conclude this thesis by reflecting on the context in which this product exists.

2. Context

In this chapter, several problems concerning the book choice process of children will be identified. Secondly, children's current practices and experiences concerning the book choice process will be examined.

This will be done by interviewing three primary school teachers working at the primary school that is participating in this research, and one education coordinator of the Z-O-U-T Library. The three teachers work all at the same school in the south-east of the province of Utrecht. They all have over 20 years of teaching experience. One of the teachers is the reading coordinator at the primary school. The interviews are held online, in an unstructured manner. Additionally, a survey will be conducted among primary school students, and literature will be evaluated to back up and supplement the findings from the interviews.

2.1 How do children choose books?

In order to identify possible problems and solutions, it is valuable to know more about how children choose books. This will help with putting focus on specific aspects of the book choice process and create an overall better understanding of the problem.

The teachers and education coordinator were asked about what children do when they are looking for a book. Their observations are valuable to map out what happens in practice when a child goes to the library.

The teachers mentioned that most children primarily look at the cover of the book. They also look at the images inside of the books and the font size. Another teacher mentioned that children look at the number of pages in the book, with some children looking for the thinnest book possible. The blurb on the back of the book is often ignored by the children. Most children choose books based on first impressions. This is supported by a study done in the Journal of the American Society for Information Science and Technology (ASIS&T) on what influences children to choose a certain book from a digital library [8]. Out of seven dimensions analyzed in this study, the dimension that was mentioned to have the biggest influence on book choice was the metadata and physical entity of the book. This contains elements such as the title, cover and front matter [8].

Furthermore, one teacher mentioned that sometimes children simply walk up to the shelf corresponding with reading level and choose a random book. If the cover does not appeal to them, they will put it back. They do not have a systematic way of choosing a book. Children do know what their reading level is, so they know what books they can choose. The books are clustered by this level. According to the previously mentioned ASIS&T study, this so-called accessibility is the second most

prevalent decision factor [8]. In the library of the school where the interviewed teachers are employed, the books are not sorted by theme.

Finally, another teacher mentioned that he notices that children sometimes influence each other when choosing books. If his students spend more time in the library, he noticed that children start conversations and recommend books to each other.

To sum it up, children primarily look at the external qualities of the book when they are searching for a book. It was also found that children lack a strategy when fining a book. Finally, it was found that children sometimes influence each other when selecting a book. Keeping these insights into the book choice process of a child in mind, we can more effectively apply an AR experience on the book choice process of a child.

2.2 What are children's experiences concerning book choice?

To gain a better understanding of children's experiences of choosing books, a survey was conducted among students at the participating primary school. The main goal of this survey was to map children's attitudes towards the library and towards choosing books, focusing on how easy and fun children consider the process of choosing a book to be.

2.2.1 Participants

In order to recruit respondents for the survey, a letter asking for consent was delivered to the parents of students at the participating school. This filled in form was returned to the teachers of the students, who were responsible for making the students who had written consent fill in the survey. This study was approved by the ethical committee of the EEMCS faculty under RP 2021-14.

There were participants in total, of which 25% were in the fifth grade (US school system: third grade), 37,5% in the sixth grade, 20% in the seventh grade and 17.5% in the eighth grade. Gender and median age are unknown because as little information as possible about the participants was collected, but the general ages for school children in the fifth grade until the eighth grade are between 8 and 13 years old.

2.2.2 Survey design

The survey was conducted online, using Google Forms. The results of this survey are stored on Google's servers, but no other human have access to the data, as per GDPR requirements. The survey had a total of 16 questions, of which 10 questions used the Likert-scale format. These questions covered two potential constructs: the amount of fun experienced while choosing books, and ease of

finding books. The Likert-scale questions were created using a smiley-o-meter [9], which has been used multiple times before in research with children. It consists of a Likert-scale which is represented by smiley faces. The questions can be found in appendix 1.

The other questions were focused more on the children's attitude towards reading in general, with the goal of getting a more complete image of the situation. Children were asked with a Likert-scale question whether or not they enjoy reading. They were also asked to judge their library by giving it an overall grade, mention their favorite book, and to explain why this is their favorite book.

2.2.3 Results

A reliability analysis was carried out in order to validate the reliability of both constructs. For the first construct, the amount of fun experienced while choosing books (Figure 1), Cronbach's alpha showed that the questions achieved acceptable reliability, with $\alpha = 0.896$. All questions are worthy of retention, as deleting any one of them would result in a lower alpha.

For the second construct, the experienced difficulty of finding books, Cronbach's alpha showed that the questions had an acceptable reliability, with $\alpha = 0.742$. Removing the statement 'I know what kind of books I like' would result in a higher $\alpha = 0.761$.

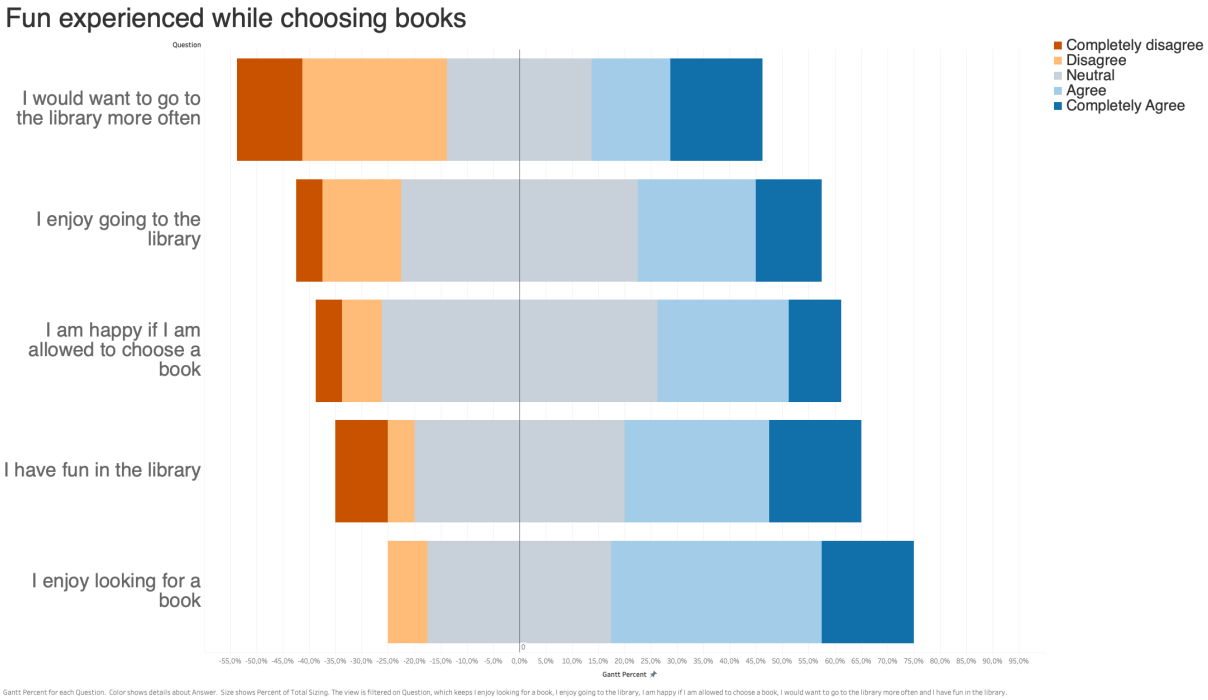


Figure 1, Fun experienced when choosing books

From Figure 1 we can read the percentage of responses within a certain category for each question, grouped per construct. The questions were posed in Dutch but were translated to English as closely as

possible. The center line in the graph offers us the possibility to examine whether the answers are mainly positive or negative.

Looking at the data presented in Figure 1, several things stand out. The respondents disagree more with the statement ‘I would want to go to the library more often’ than with other questions. Another key observation is that a majority agrees to the statement ‘I enjoy looking for a book’, however, there is still ample room for improvement, as can be seen in the answers.

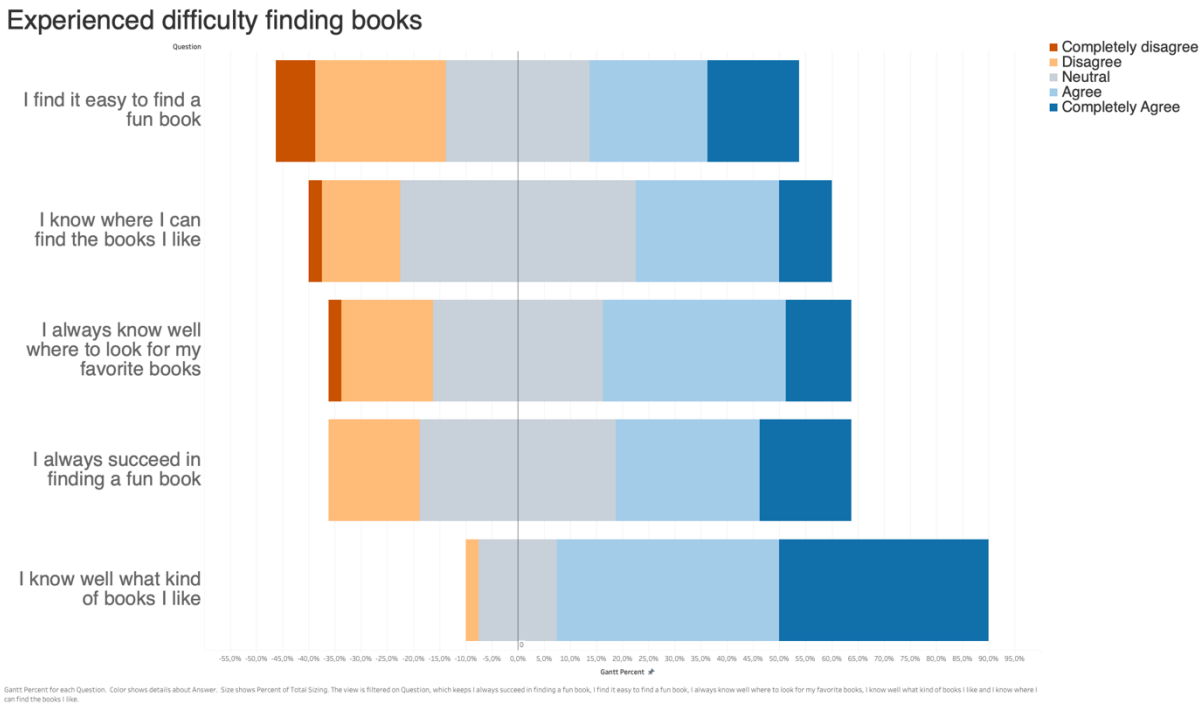


Figure 2, Experienced difficulty finding books

From the data from Figure 2, Experienced difficulty finding books, it is noticeable that a majority agrees to the statement ‘I know well what kind of books I like’. The statement ‘I find it easy to find a fun book’ seems to result in more mixed answers, fitting the premises of this study.

The written responses to the question ‘why is [this] your favorite book’ are all quite short. Children made two common arguments on why a certain book was their favorite: there were 10 mentions of a book being ‘spannend’ (exciting, thrilling) and 9 mentions of a book being ‘grappig’ (funny).

In addition to this, it was noticeable that many of the children did not give very strong arguments for why they liked a certain book. Many of the arguments focused on only one or two aspects of a book; whether it is funny, thrilling, has nice images or is adventurous.

2.2.4 Conclusions

From Figure 1, we can conclude that the majority of the respondents do enjoy searching for a book. The results are quite mixed, however, and showed room for improvement. A small majority of the respondents disagrees with the statement ‘I would want to go to the library more often’.

Secondly, the reliability analysis showed that the statement ‘I know well what kind of books I like’ seems to negatively influence the reliability of the construct ‘Experienced difficulty finding books’. It can also be seen that children answer much more positively to the statement ‘I know well what kind of books I like’ then to the other statements. Because of these two observations it seems like the problems that children experience while looking for books are not related to knowing what books they like.

Finally, it is not immediately clear why children give such uncomplex answers to the question ‘why is [this] your favorite book’. It could have something to do with their reflective capabilities, their lack of reasoning skills or perhaps that the task of writing their reasoning down for the survey was not engaging enough for children to put much effort into. Meanwhile, it is expected of children to be familiar with such questions, as similar questions are asked on book reports. This might be a sign that traditional ways of reflecting on books, like with a book report, might not be the best way to do it.

2.3 What problems do children experience when choosing books?

During the interviews with the teachers, the primary school teachers were able to identify multiple problems that student experience in their decision-making process. One of these problems is choice overload. Because libraries offer so many different choices, children often do not know where to start. An abundance of choice can be overwhelming for a beginning reader. Choice overload has been proven to have a multitude of negative effects, like reducing the quality of the decision that is taken [10].

Another issue is that children often lack the verbal tools to describe which books they might like. They might know what books they like but lack the tools to define their taste. This was also found in the survey: when asked why the children liked their favorite book, many answers were simplistic. In this case, it would be beneficial to have someone help the child discover their literary taste. This person could be a teacher or a librarian. This person can ask the child questions and guide the child in finding a suitable book. However, the problem with this is that several teachers stated that while they would love to help their students find a good book, they simply lack the time to do this for all of their students.

An additional problem that teachers identified is that some children are unmotivated to make an informed decision on what book they are going to read. The process of choosing a book is deemed as unimportant. Children often do not examine the contents of the book, but instead focus on external things like the images on the cover and the size of the letters.

Finally, the way books are stored in a library makes it hard for children to see what is available. The library education coordinator identified this issue and said that the way the library is set up, with rows upon rows of book spines, makes it hard for children to choose a book. They need to have more information. The library does try to solve this by placing some books with the cover towards the outside, but this is not possible to do for all books.

2.4 Key findings

The interviews and literature show that children primarily look at the external qualities of a book in their decision-making process. The accessibility of the book, like reading level, is also an important factor. Another relevant finding is that most children do not have a strategy when choosing books. Additionally, children might help and influence each other when choosing books, especially when children are allowed to spend more time in the library.

The most noteworthy finding from the survey was that knowing what books one likes seems to not influence the experienced difficulty of finding books. It was also found that when children are asked to motivate the reasons why they like a certain book, the answers are short, uncomplex and not very explanatory.

Finally, the experts were able to identify four main problems that are compromising the book selection process of children. The first problem is the overload of choice, which can be overwhelming for children. Secondly, children often do not know how to describe their literary preferences. This was also observed in the survey. The third problem was that some children are not engaged enough to spend the time and effort to make an informed choice. Finally, the library setup was said to be lacking in some areas, like in the way books are stored and displayed. These findings offer concrete points of improvement for the book choice process and can serve as starting points for designing a solution.

3. State of the art

To gain insight into what is currently being done to help children choose books, and to find opportunities to improve this activity, a vision of the state of the art of multiple areas relevant to this project will be useful.

3.1 Techniques to help children find books

There is a multitude of ways educators are trying to help children with choosing books. Some practices that help children can be identified from the interviews with experts. These are the same four experts as mentioned in the chapter before. In addition to this, different tips were found on online platforms, ranging from teacher blogs to the websites of publishing companies.

One technique that is mentioned across multiple sources, is the PICK strategy [11] [12]. This is an abbreviation of **P**urpose, **I**nterest, **C**omprehend, **K**now all the words. The first step when choosing a book, is determining the purpose of picking a book. Children should ask themselves: 'Why am I choosing this book?' Secondly, the book should be something that fits the child's interests. Children can determine if the book fits their interest by looking at the cover, reading the blurb, and flipping through the pages. Thirdly, the book should be comprehensible for the child. This can be easily checked if the book is marked with the level, which is the case in the vast majority of libraries. Children know which of these books they can pick, as they are often well aware of their own reading level. Finally, the children should know the all the words in the book. This can be checked with another technique, the 'Five finger rule' [13]. To know if the child´s vocabulary is up to the task of reading a certain book, a child should read a page in the book, and for every unknown word, they should stick a finger up. If they stick up 2 to 3 fingers after reading a page, the difficulty of the book is just right. If they stick up less fingers, the book might be too easy. If they stick up more than 3 fingers, the book is probably too difficult.

Another way to help children find a book that fits them, is to encourage them to spend more time inside the (school) library [14] [15]. This gives them more time to browse what is available, and to make an informed decision [11]. However, during the interviews one teacher mentioned that, in the case of the school library, that extra time inside the library would be at the expense of actually reading the book during class. Because of this, this teacher sometimes puts a time limit on how long a child is allowed to browse, which makes them search for a book more efficiently. However, he notices that as a result of this, sometimes a child just picks a random book.

Another important aspect of the decision-making process is allowing the child authority over their book choice, which is also advised to parents. [14]. In this case, it is less important to look at the

objective qualities of the book. It is more important that the child wants to read it themselves. If it turns out the child has chosen the wrong book, perhaps because it is too hard for them, it is important to let the child know it is OK to stop reading the book [14]. Making them read the book anyway could lead to negative reading experiences.

One technique to help children identify books they may like, is to make them make a list of preferences in advance. Rickert [16] has created a list of qualities of characters in books, for example: characters who are strong, or are ghosts, or play football. The child has to state which of these qualities they like, and this list can be given to a librarian, who can help them pick books with these qualities.

Another tip from Rickert is a 'book scavenger hunt'. The goal of this is to increase the exposure to the diversity of the library's collection. The children are given a list titled 'Find a book that…', with a bunch of qualities written underneath: '… is set in the future', '… is a mystery', '… is set on another planet'. For every quality (or for as many as possible), children have to find a book. One way to implement such a scavenger hunt, is by making children visit the library, and have them find books there. This makes them aware of the content of the library's collection, and what to look for when finding a book [16]. This scavenger hunt can also be done in pairs, making this a social and cooperative activity [15]. Another way to do this scavenger hunt is doing it in-class. In this case, all the children have already picked a book for themselves. They then go around the classroom to find a book that someone else has brought in that fits the qualities that are on their list. This makes the children more aware of what their peers are reading, and also makes them talk to each other about the books.

Libraries often have a very broad selection. This can be overwhelming for a student [15]. Limiting the number of books children have to choose from was suggested by one of the teachers as a tip to combat this problem. This can be done by making a preselection of books children can choose from. The teacher mentioned that when his class is working with a specific theme, the library sends over a box of books that fits that theme. Another thing he mentioned was that some years ago, he had a miniature library inside his classroom, containing about 60 books that were available to his students.

The choice can also be limited by recommending or promoting certain books. This can be done through initiatives like the Kinderboekenjury (a contest for the best book according to children), or by simply placing some books in the spotlight [15]. Another way to limit choice is by picking a letter from the alphabet and making children choose a book with that letter in the title [11].

The way the library is set up can influence the process of finding a book as well. Having a good and board range of books is crucial. Along with this, there are some practical things libraries (can) do to help readers find books. [11]

Having clear and helpful signage and labels makes navigating the library easier. Displaying some books with visible front covers can also make the library more attractive. Libraries can also play around with the placement of the books. They can cluster series of books to encourage children to keep on reading. They can also arrange books by genre, to help finding preferences more easily. In addition to this, libraries can make special displays on themes, new books, or 'read-alikes' [11]

3.2 Playful libraries

Some libraries go even further to make the library child friendly. To get a better understanding of what these child-friendly libraries do well, and what they can improve, three case studies will be presented and analyzed.

3.2.1 Children's Interactive Library Project, Aarhus, Denmark

From 2004 to 2006, the library in Aarhus, Denmark, carried out a project called 'The Children's Interactive Library'. The goal was to explore new designs of spaces and look at innovative ways of engaging and communicating. For this library, six concept installations were designed, of which two were built as working prototypes.

Figure 3, StorySurfer installed at the library of Aarhus [17]

One of the protypes is StorySurfer [17]. The StorySurfer is a tool that children can use to search for books within the library in a fun and friendly way. It consists of one big floor surface where children

can stand on, and a tabletop. Books are projected on these surfaces. Various book covers are projected on the floor, within blobs of a certain color. These blobs represent a theme that the child can choose in advance. Children can add multiple themes to the search, which makes the blobs act like a Venn diagram; books that fit in multiple keywords are in the overlapping part of the blobs. Children can enter these keywords by stepping on one of the 19 buttons next to the surface, that each represent one of the themes. The user's position is tracked in order to make the body function as a magnifying glass. The user can enlarge some of the books in front of them to give them a better visual representation of the book. By keeping the focus on one book for a longer time, the book is selected and 'sent' to the tabletop.

On the table, the books that are selected are projected. Here, they reveal new properties that could not be displayed on the floor, for example the information about the author, a summary, and related books. If the user finds a book interesting, they can print directions to the shelf where that book is stored.

The StorySurfer was evaluated with children in the library, which resulted in the following findings. Firstly, the installation seems to be an equalizer between parents and children. Parents as well as children do not know how the installation works at first, which places both in a common unfamiliar ground. Secondly, the StorySurfer seems to foster social interaction between the users, partly because multiple users can use it at once. This creates the opportunity for children to 'look over the shoulder' of other children, potentially broadening their horizon.

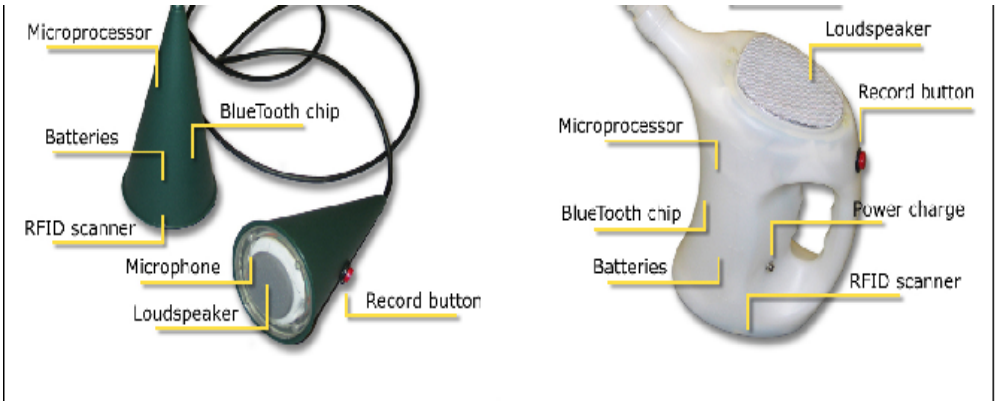


Figure 4, BibPhone [18]

Another prototype from the Interactive Library Project is the BibPhone [18]. This device makes it possible for children to add audio annotations to books, which other children can listen to. This is done by adding RFID tags to the books. When these tags are scanned by the BibPhone, a child can either listen to what is recorded onto the book or leave a message behind for someone else.

This device was created without a clear predetermined use. Possible use cases could be a treasure hunt, where prerecorded messages are added to the books. Another case is adding other sounds to books, for example adding soccer sounds to soccer books.

Their evaluations showed that most children liked listening to the recorded messages on the books. Recording messages themselves, however, was often found to be embarrassing by the children. This also ties in with another issue; the BibPhone is only as interesting as the content on it.

3.2.2 Hjørring central library, Hjørring, Denmark

The Hjørring central library [19], designed by Rosan Bosch studio, gets its child-friendliness by the playful interior design. Playful elements, like nooks and crannies, surprising book displays, and fun furniture make the library a playful place for children. When designing this library, the designers focused on facilitating serendipity, i.e., unexpected discoveries.

Figure 5, portion of the red ribbon with various uses [19]

One major design element in this library is a big red ribbon that spans across the different library spaces, tying it all together. This ribbon is used for different things, e.g. as a table, shelves or a book showcase.

Other notable design elements in the Hjørring library are the bubble wall, where children can read a book in peace, the various showcase shelves that show the covers of the books clearly, playful elements like bright colors and even a slide.

All these elements make up for a playful looking library. However, there is no information on whether this library is more helpful to children than a regular library. There is also no personalized support to make it easier for children to find a book that might suit them.

3.2.3 NLL Children's library, Riga, Latvia

Figure 6, National Children's library, [20]

The goal for the National Children's library [20], designed by architecture firm GAISS, is to encourage children to discover the fun of reading a book. To achieve this, the architects positioned playful elements across the library do support different types of reading experiences.

The reading room contains many options to read a book in or at. For example, there is a desk, a couch, a hammock and even a playhouse. There is also 'unprogrammed' furniture that children can use in any way they can imagine.

Just like the Hjørring library, this library contains plenty of bright colors, face-on displays and surprising elements. However, one element in the library is not very suited for children. There are bookshelves that reach from floor to ceiling, so to reach the books on the top row, a ladder is needed. Not only is this unsafe, it also prohibits effective browsing books.

3.2.4 Key findings

The libraries in Riga and Hjørring have a common design philosophy that can also be found in other children's libraries around the world. By enhancing the typical furniture of the library with playful and unexpected elements, the library becomes a more inviting and inspiring place for children to visit.

However, there is no proof that these changes actually help children enjoy reading more, nor is there research done that would confirm or deny whether these libraries actually help children

choose books. Essentially, these libraries are similar to traditional libraries, but with a fresh look. A possible addition to these libraries could be to design a more personalized experienced for children, to cater to their personal needs. It can be argued that these libraries have the potential to succeed in making the library more fun and playful. However, there is no evidence to prove this.

3.3 Playful experiences

As briefly touched upon in the introduction, the focus of this research will be on improving the experience of choosing a book. The playfulness of the product is one aspect of focus. As seen in the various examples of the analyzed children's libraries, playful elements played an important part in creating a child friendly experience. However, as mentioned in the conclusion, these meticulously designed libraries are expensive and still do not allow for a personalized experience. Therefore, for this project it was decided to try and create this playful experience through Augmented Reality technology.

A literature review will be performed in order to acquire an overview of the aspects related to creating playful experiences. To get an understanding of similar products and the possible technologies to use, we will do a state-of-the-art research on augmented reality products for children.

(Note: this literature review was first performed for the Creative Technology graduation semester course 'Academic Writing')

3.3.1 Defining playfulness

Playfulness has different definitions in the reviewed literature. It can be looked at as a quality of a person, as an attribute of a product, or as an action. Traditionally, research defined play as the actions of an individual. Recently, this view has shifted towards play being a characteristic of a person or child [21]. Based on previous research, Barnett describes play as a tendency of a person that is distributed across many personality factors [21]. Playfulness can be described as the attitude or state of a person when engaged in an activity [22] [23]. Play can also be described as 'a voluntary activity which we engage in in order to have fun and feel pleasure' [24].

Playfulness can also be seen as a property of a product. A playful experience is mostly none-goal-oriented [22]. The enjoyment from this experience can arise from the interaction itself [23]. The playful experience is, at least partly, evoked by the pleasurable aspects or the affordances of the product [25] [22].

Finally, play itself can be seen as an activity. Poppe et al. [25] define play as 'a social, bodily activity that children engage in for the fun of it'. Arrasvuori et al. [22] [23] take a broader approach in

defining play. In these papers they describe play as a broad range of activities and experiences that are perceived as pleasant.

3.3.2 Differences between play(-ification) and game(-ification)

The domains of playing and gaming are similar in plenty of ways, but they are different in some key areas. Nicholson describes playful design as something that stimulates playful behavior, which is different from gaming behavior [26].

A second difference is that gaming is more rule-bound and focused on goals, while playing is more open-ended, and allows for more exploratory activities [24].

Another important difference is that gamified experiences, such as exergames often rely on extrinsic motivation [27] [26]. Extrinsic motivation can undermine intrinsic motivations [24], and none of the exergames that rely solely on extrinsic motivation are very popular [27].

Despite the differences, playification and gamification are not completely unrelated. Playification is simply a broader concept than gamification [22] [26].
Elements of games can be incorporated in other (playful) activities. Segura et al. [26] even define playification as ‘the use of game design elements in non-game contexts’. For example, Clanton has collected elements from games that can be used in playful interactions: Conflict and Challenge, Point of View, and Fun [28].

In conclusion, the relationship between gamification and playfulness can be seen in two ways and is slightly recursive. Gamification can be considered a complement to designing for playfulness. But, since play is also a part of games, it is also possible to see play as a part gamification [24]. Thus, gamification can be seen as a tool to design for playfulness, while at the same time playfulness is an important tool when creating enjoyable games.

3.3.3 Effects of playful experiences

Playful experiences, interaction and ‘playification’ can have various positive effects on products. Including playful elements into a user experience can make the experience more pleasurable to use and increase overall user satisfaction [28] [23].

In addition, a playful approach can positively benefit serious activities, like educational or work-related activities. By including playful elements, these activities can become more bearable and fun [22]. When people are in a playful mindset, they are more willing to put effort into doing tasks, and difficult tasks feel less overwhelming [23]. This is motivated by the reversal theory by Michael Apter. This theory describes that playfulness and seriousness are two opposite states. In the playful state, the user is protected by a psychological protective frame. This frame inspires confidence and

protects a person from potential harmful consequences of an activity [23]. The same can be said for children, as they often link the idea of fun to challenges [24].

Furthermore, according to Lazzaro, emotional products can have 5 benefits on users: strengthening enjoyment, focus, decision making, performance and learning [23]. A playful product can be considered an emotional product as it brings enjoyable emotions.
Another merit of playful designs is that it stimulates the user to move into do-mode as opposed to goal-mode. In goal-mode, users are more concerned with meeting their goal, instead of taking the time to explore or to be playful. [28]

Other benefits of playful products are that the pleasures of using the product motivate people to use the product more often. It also allows people to experience a wider range of (positive) emotions, which makes these products self-motivational. [23] Products where the activity itself is enjoyable, like in successful exergames, create more intrinsic motivation [27].

3.3.4 Creating playful interactions

What contributes to fun in interactions?
There are several factors that contribute to the fun-aspect of an interaction. Firstly, what makes things fun is described in the self-determination theory. This research demonstrates that fun activities create more intrinsic motivation [27] and improve well-being [24] if they satisfy three human needs: competence, autonomy and relatedness [27]. These factors help create convert extrinsic motivations into intrinsic motivations [24].
Secondly, Fontijn et al. propose a theory that suggests that fun is an evolutionary mechanism that rewards behaviors that makes it more likely to survive [24]. Based on this, they have designed the three core sources of fun: accomplishment, discovery and bonding.

Additionally, children often link the idea of fun to challenges, social interaction, and control over their world [29]. Solving challenges can be seen as competence and accomplishment, social interaction helps with bonding, and children's control over their world applies to autonomy.

Furthermore, it is possible to identify three dimensions to having fun: expectations, engagement and endurability [9]. Expectations is the fun expected by the user, and the fun that is actually experienced. Engagement is the involvement of the user in the experience. Endurability a combination of remembrance and the desire to do an activity again. The former is based on the concept that people are more likely remember things they have enjoyed. This is called the Pollyanna principle.

Finally, As mentioned before in this paper, incorporating playful elements from games can make activities more fun [24]. Clanton has taken elements from games that can be applied in playful applications. These are: conflict and challenge, point of view, and fun. Lazzaro describes four types of

fun, which were identified from games: hard fun, easy fun, people fun and serious fun [28]. Costello and Edmonds have fabricated a framework that applies research on what makes games fun to interactive experiences. By cross-referencing sources, they ended up with 13 categories [22]. This 'pleasure framework' was used in order to create the 'playful experiences framework' (PLEX) [28]. This is a longer list of qualities of playful properties, sourced from literature.

What contributes to playful interactions?

The PLEX framework, henceforth also simply referred to as PLEX, is a list of playful experiences, which can be interpreted as attributes of experiences. PLEX is based on theoretical work, like the work by Costello and Edmonds, and work on pleasurable experiences, game experiences, emotions, elements of play and reasons why people play [28].

In 2010, PLEX was revised, and two categories were added based on reviewing literature [22]. The result was a list of 22 qualities that appear in playful experiences. These are qualities like exploration, discovery, control and humor. A full list of all 22 elements of PLEX can be found in appendix A.

Playfulness does not necessarily only depend on *what* the user does, but it also often depends on *how* a certain action is performed. Arrasvuori et al. [23] give the example that enjoyment can arise from doing mundane activities in a new way. This ties into the theory mentioned before, that the activity itself should be enjoyable [27]. Schneiderman [29] calls this fun-in-doing and describes three ways to achieve this: provide the user with the right functions so goals can be achieved, offer usability and reliability to prevent frustration from undermining the fun, and finally, engage the users with fun features. Some of these fun features are alluring metaphors, compelling content, attractive graphics, appealing animations and satisfying sounds. These extra elements in interfaces can delight and amuse users. [29]

3.3.5 Evaluating fun and play for children

In order to effectively evaluate the 'fun-ness' of an experience, tools are needed to measure the amount of fun a child has. Measuring fun is not an easy task, especially when dealing with children and technology. If the interface is easily enchanting, children often already have a positive bias towards the experience. [9]

Observation is a possible technique to evaluate an experience. [25]. This is often done by analyzing video footage or observing live use sessions. One of the tools for observation is the playfulness instrument by Lieberman. This is a questionnaire meant to be filled out by an observer. This questionnaire is based on 5 components of playfulness: physical, social and cognitive spontaneity, manifestation of joy, and sense of humor [21]. Observation and analysis do have issues

however: it is lengthy, cumbersome, and prone to inaccuracies and subjectivity. An alternative described in [25] is making the prototype itself collect much of the data.

Additionally, expert evaluation of the prototype is also an option. While the PLEX framework is originally meant to aid in designing experiences [23], it can also be used to assist in evaluating playfulness in experiences [28]. The elements in PLEX provide anchor points to discuss playful elements in experiences. By breaking down each element in PLEX, a checklist can be created to assess playfulness [28].

Finally, various methods of asking the user's opinion are also an option. However, there are some difficulties regarding opinions. Play is a peculiar metric. Read et al. [9] do not consider fun as a usability metric of a product but does consider it to be a useful description of the experience a user has. The goals of playful experiences are hard to evaluate by questionnaire or interview, because the goals of an experience might not be explicit. Also, some of the elements one might want to evaluate in the interaction could be experienced subconsciously [25].

Luckily, fun is a concept that children are comfortable with [9], meaning that a child can state whether or not they found an experience to be fun. [25], [30] and [9] all propose the use of Likert scale questions to evaluate different aspects of an interactive experience. The 'smiley-o-meter' is an adapted version of a Likert scale made for children. The use of smileys makes the scale options more informative [9]. An image of such a 'smiley-o-meter' can be found in appendix B.

This smiley-o-meter is one of the proposed ways of evaluating expectations category described. Other tools for evaluating this are the 'fun-o-meter' (appendix C), a temperature-like scale that children can fill in, and the 'fun sorter', where children rank different experiences from best to worst. When evaluating expectations, it is important that children fill in the questionnaires both before and after interacting with the experience, so that the difference between expectations and actual experience can be measured. [9]

It is said that observations are effective to evaluate engagement. Although observations are time-consuming, logging actions and interpreting these actions still seems useful. Observers can look for positive and negative instances when children are interacting with the product to measure engagement [12]. Additionally, the Lieberman's playfulness instrument mentioned before could be used for this [21].

As mentioned before, there are two aspects that contribute to endurability. Firstly, the aspect of remembrance is relevant when doing a comparative study. To find out what a child has remembered, it is useful to ask them to write down the activities they can remember. Whether or not children want to do an activity again, can be measured using an 'again-again' table, on which children can mark down which activities they would like to do again.

Of course, asking the users to give their opinion gives a subjective image of the level of fun an experience creates. However, since fun is a subjective feeling, this can still be valuable information.

3.3.6 Conclusion

After analyzing 11 papers with various perspectives on play, information on different aspects of the research question *'How to create playful interactions for children?'* is bundled, from which some key findings can be highlighted.

From analyzing the different descriptions of play in the literature, three different perspectives could be found: play as an activity, playfulness as a trait of a person, and playfulness as a property of a product.

Next, it was found that the mechanics of gamification and playification are similar, but gamification adds a layer of extrinsic motivation. It can be said that gamification can be a tool for playful design, but it is also positive to call playfulness a trait of gamified experiences.
Following this, the potential effects of playful interactions that were identified in the literature were examined. It was found that adding fun and play to serious activities can make them more bearable and can help with motivation. Because the process of using the product is fun, these products become self-motivational.

In addition, it was found that fun is one of the goals that people want to achieve by playing. Therefore, both factors that make experience fun, and factors that make experiences playful have been analyzed. It was found that fun activities contribute to creating intrinsic motivation. Different sources of fun were identified, like the three sources of fun by Fontijn et al. and the three dimensions of fun (expectations, engagement and endurability). The playful experiences framework (PLEX) gives a good overview of factors that contribute to playful interactions. It was also found that playfulness can arise from the way something is performed, as opposed to what the actual activity is.

Finally, the different ways papers propose to evaluate fun and playfulness for children were identified. Expert evaluations based on the PLEX framework is an option. Three dimensions were proposed to measure whether or not children find an experience to be fun. Different tools to evaluate these dimensions were identified.

Based on the literature found, a good evaluation can be done by first doing an expert evaluation based on PLEX. After that, the three dimensions of fun should be evaluated. Expectations should be evaluated by using a 'fun-o-meter', engagement should be evaluated by using Lieberman's playfulness instrument for observations. Finally, endurability should be evaluated by looking at what the child remembers, and by letting the child fill in an again-again table. This could give a comprehensive overview of the level of fun, and the playfulness of an experience.

3.3.7 Discussion and recommendations

After performing this literature review, a few things became clear. Firstly, there is a suspected research gap in the field of doing effective evaluations of fun with children Only one concrete source that covered this aspect was found. More research in this field would be valuable.

Finally, it stood out that there is much more research done in the field of gamification, compared to playification. This might be due to the fact that playification is often seen as an element of gamification. It is valuable to do more research specifically on play and playification, as it might lead to more insights in both the domain of gamification and playification itself.

Playification is a good starting point for the ReadAR project. As was found in the literature, playification can motivate children to do mundane things that would otherwise be less engaging.

The PLEX framework can also be an interesting resource for the ReadAR project. It can be used for heuristic evaluation of ideas or prototypes, and also for developing ideas. The evaluation methods described in this paragraph will be valuable during the evaluation phase of this project.

3.4 AR experiences for children

In this paragraph, several state-of-the-art AR experiences twill be described. These examples will serve as inspiration for the ReadAR project, and also paints an image of the status quo of children's AR experiences.

3.4.1 Quiver

Figure 7, Quiver in use [31]

One AR application focused on children is Quiver. Quiver allows children's drawings to come to life. it is not unique in its implementation of Augmented reality but is representative of similar

applications. For example, Disney has an application called Color and Play, which does something similar to Quiver.

How the application works, is that children can color in predetermined drawings that are enabled in the Quiver app. When these drawings are scanned with a mobile device like a phone or a tablet, they come to life as 3D models. The texture of these models is matched with the way the children colored in the drawings. The 3D models can also be interacted with. For example, as seen in this video [31], one of the models the children can color in starts to dance with the press of a button.

Quiver also has a version focused on education. This version relies on the same principles. The child colors in a drawing, which then comes to life. However, the content of this education edition is focused on teaching children things. Examples are: the different layers of the earth's core, a DC motor, or a cross section of a volcano. Once these are colored in, they come to life in a 3D model which children can interact with to get more information. In the example of the earth's core, children can touch each layer, and a dialog box of information is shown, as can be seen in the figure below.

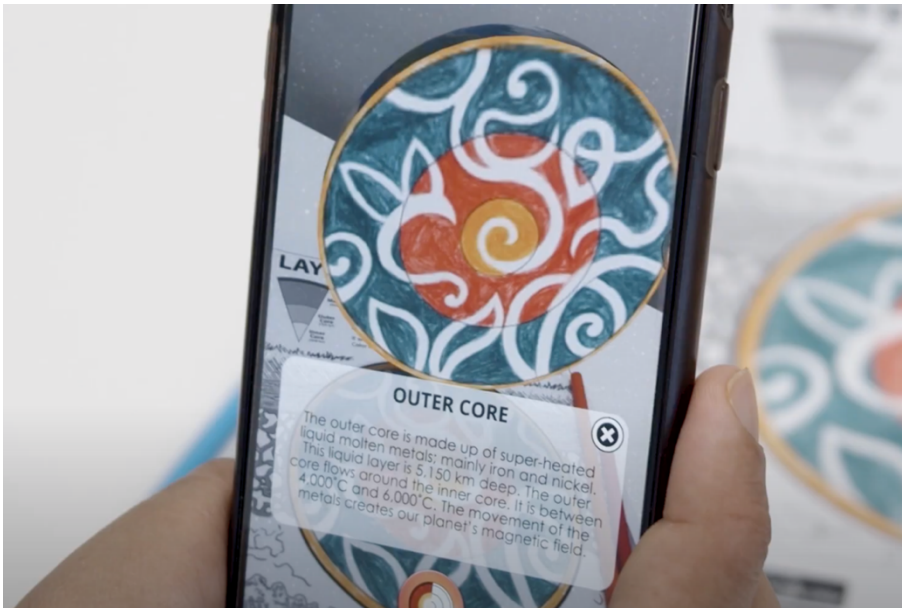


Figure 8, Quiver education in use [32]

3.4.2 INDOAR / GuideBOT

Figure 9, INDOAR in use [33]

INDOAR is an Augmented Reality navigation system primarily meant for museums. Currently, it is in use in the Technical museum in Vienna, and in the MAMUZ Museum in Mistelbach. Museum visitors can scan a QR code on their phone which brings them into the AR application. Here, users can tap a point of interest they want to visit, and a virtual guide will lead them there. The guide walks ahead of the user to guide them, and the user can follow them. Once arrived at the point of interest, the application will give some context to what the person is seeing. Sometimes this is done with an AR overlay, sometimes it is a text article the user can read.

The INDOAR experience is created with a 3D scan of the museum. This is done with either Matterport or Navvis Digital Twin infrastructure and use scanners to make a 3D model of the space. Points of interest can be added to this scan to create the map of the museum. However, INDOAR is rather inflexible and possibly expensive; making a 3D scan of a room can be time consuming (depending on the size of the area) and has to be redone if the space changes. [33]

ViewAR, the company behind INDOAR, has an alternative for this: GuideBOT. This is a simpler version that can also guide people through a room. The big advantage of GuideBOT is that it can install an indoor AR navigation system with several options for tracking systems: QR codes, Bluetooth beacons, compass, WiFi, Ultra-Wideband signals and visual recognition (SLAM).

Perhaps the simplest of these systems is the one with QR codes. These codes can be printed out and stuck to the floor to create anchors which the GuideBOT then uses to navigate the area. The

administrator can link these QR codes to a point of interest. This makes the system easy to use, since the administrator can set up the system, without expensive equipment. [34]

3.4.3 Augmented reality children's books

Augmented Reality children's books is another AR experience that is becoming increasingly common. The concept behind these books is that AR has the potential to elevate the story time experience to make reading compete more with other types of media that are easier to consume. This type of AR experience seems to be quite popular, as there are 287 results on Amazon.com for the query 'Augmented Reality Children's Books'.

One successful execution of this concept is Bookful. This company has a big library of licensed books from other companies like publisher Penguin Random House. When children scan the book with their phone or tablet, elements from the book come to life on the screen. This can simply be a 3D model of one of the characters in the book (**Error! Reference source not found.**), or a complete a nimated scene (**Error! Reference source not found.**). Some books also include games to make it even more interactive.

Figure 10, simple 3D animated characters [35]

Figure 11, complex AR scene [35]

Bookful works with virtual books, meaning that the users don't have a physical copy of the book in front of them. There are also AR-enabled books that use physical books to project on. This application of AR uses the book as an anchor to add a 3D object to. One of these is Wonderland AR, an AR enabled book about Alice in Wonderland. Here, the reader scans the physical book with an application on their phone. The app recognizes the image and adds sound and 3D animations to the illustration of the book.

Figure 12, Example of a page of Wonderland AR [36]

3.4.4 Lumin / Detroit Institute of Arts

Lumin is an AR experience created at the Detroit Institute of Arts to connect people to works of art by adding more context. The AR experience runs on a phone which is equipped with Google's Tango sensors, an Augmented Reality computing platform that uses computer vision to recognize their location inside a building. Therefore, no other way of tracking the position of the phone is needed.

This allows AR to be used in multiple interesting ways in the museum. Firstly, it is used for navigation, to help visitors find the works they want to see. Secondly, it augments works of art with more information. For example, when users hold up the device over a mummy, an x-ray view of the skeleton inside appears. Additionally, when the phone is held up to an old limestone structure, the phone shows the original colors of the object. Thirdly, the AR experience allows users to see objects that they would not be able to access. For example, users can walk through a reconstruction of the gates of Babylon. [37]

3.5 AR technologies

To get an overview of the AR technologies that can be used, a small state-of-the-art research is done on the different types of Augmented Reality and different AR displays.

3.5.1 Triggers

Edwards-Stewart et al. [38]. were able to classify the different types of Augmented Reality, with examples and characteristics, as can be seen in Figure 13. There are two main categories: Triggered AR and View-based AR.

Among triggered AR, four types of triggers can be identified. First is Marker-based AR. This requires a visual cue to activate the AR experience, like a QR-code on paper, or an object. Secondly, there is location-based AR. Like the name suggests, location-based AR uses location information to trigger information. Edwards-Stewart et al. mention GPS as one way of activating the experience, but other technologies like UWB positioning [39] can also be used to pinpoint location. The third trigger is dynamic augmentation, which responds to the view of an object, and can change the projection as the object moves. It utilizes different sensors to detect objects which are then super-imposed by a digital layer. Finally, complex augmentation is a combination of dynamic augmentation and marker or location-based AR to create a dynamic view of the world augmented with additional information. [38]

View-based AR consists of indirect augmentation, which augments a static image of the world, and non-specific digital augmentation, which adds a virtual layer to the real world, without reference to what is viewed in the real world. [38]

Triggered	1a. Marker-based: Paper	String (string.co) Blippar (blippar.com)	Paper marker activates stimuli.
	1b. Marker-based: Object	Aurasma (aurasma.com)	Most objects can be made into markers.
	2. Location-based	Yelp (yelp.com) PAJ (t2health.dcoe.mil/positiveactivityjackpot) Instagram (instagram.com)	Overlay of digital information on a map or live camera view. GPS may activate stimuli.
	3. Dynamic Augmentation	Video Painter (itunes.apple.com/us/app/video-painter/id581539953?mt=8) Swivel (Motion; facecake.com)	Meaningful, interactive augmentation with possible object recognition and/or motion tracking.
	4. Complex Augmentation	Google Glass (google.com/glass)	Augment dynamic view and pull internet information based on location, markers, or object recognition.
View-Based	5. Indirect Augmentation	Wall Painter (itunes.apple.com/us/app/wall-painter/id396799182?my=8)	Image of the real world augmented intelligently.
	6. Non-specific Digital Augmentation	Swat the Fly (inengy.com/swatthefly) Bubbles (virtualpopgames.com)	Augmentation of any camera view regardless of location.

Figure 13, summary of Augmented reality categories and types [38]

3.5.2 Display technologies

Van Krevelen and Poelman [40] have created a survey of the different AR display technologies. This has resulted in an extensive overview of the different AR technologies available now and in the future. First, the technologies are categorized into one of three categories based on positioning, Head-worn, Hand-held, and Spatial. These categories are subdivided in different technologies that are used. Each of these categories is evaluated against a list of properties. The complete table of strengths and weaknesses can be seen in Figure 14

TABLE 1: CHARACTERISTICS OF SURVEYED VISUAL AR DISPLAYS.

Positioning	**Head-worn**				**Hand-held**	**Spatial**		
Technology	**Retinal**	**Optical**	**Video**	**Projective**	**All**	**Video**	**Optical**	**Projective**
Mobile	+	+	+	+	+	−	−	−
Outdoor use	+	±	±	+	±	−	−	−
Interaction	+	+	+	+	+	Remote	−	−
Multi-user	+	+	+	+	+	+	Limited	Limited
Brightness	+	−	+	+	Limited	+	Limited	Limited
Contrast	+	−	+	+	Limited	+	Limited	Limited
Resolution	Growing	Growing	Growing	Growing	Limited	Limited	+	+
Field-of-view	Growing	Limited	Limited	Growing	Limited	Limited	+	+
Full-colour	+	+	+	+	+	+	+	+
Stereoscopic	+	+	+	+	−	−	+	+
Dynamic refocus (eye strain)	+	−	−	+	−	−	+	+
Occlusion	±	±	+	Limited	±	+	Limited	Limited
Power economy	+	−	−	−	−	−	−	−
Opportunities	Future dominance	Current dominance			Realistic, mass-market	Cheap, off-the-shelf	Tuning, ergonomics	
Drawbacks		Tuning, tracking	Delays	Retro-reflective material	Processor, Memory limits	No see-through metaphor	Clipping	Clipping, shadows

Figure 14, Characteristics of surveyed visual AR displays [40]

Where possible, for each of the technologies, a state-of-the-art product will be identified. To find out which of the AR technologies should be taken into evaluation for the ReadAR project, the products will be empirically analyzed focusing on use for children, potential cost, and ease of use.

Technology	**Product example**	**Strengths**	**Weaknesses**
Head-worn, retinal			
Head-worn, optical	Hololens (2), Magic Leap	Higher level of immersion, both hands stay free	Not intended for use under 13 years old [41] [42]. High cost (magic leap starting at $2,295.), small FOV
Head-worn, video	Oculus Quest (2) (passthrough mode)	High level of possible immersion, possibility to switch between AR and VR, portable, relatively expensive	Not intended for use under 13 years old [43], passthrough video is very poor quality
Head-worn, projective			
Hand-held	Smartphone, tablet	Portable, ubiquitous, relatively inexpensive	Less immersive, user needs to hold product at all times
Spatial, optical	Head-up display		Not portable
Spatial, video	Transparent OLED		Very expensive, not portable
Spatial, projective	Projector (projection mapping)	Relatively inexpensive	Need for darkness, occurrence of shadows, need for blank surfaces, not portable.

3.5.3 Key findings

From evaluating the strengths and weaknesses of the AR display applications currently on the market, it can be concluded that the head-worn applications are no option for this project, as they are not compatible with the target audience. This makes the hand-held experience like with a phone or a tablet the best option for the ReadAR project, as portability would be a desirable trait of the project. Together with the relative low costs and the ubiquity of phones and tablets, this makes this the best option.

As for tracking techniques, marker-based AR seems to have the most potential for use inside of the library. There is no need to install any additional hardware, and by using either paper markers like stickers, or object recognition, the library can easily and inexpensively add markers to objects. This would also make it possible to distribute the experience across multiple libraries without having to make any changes to the AR experience, since the same markers would be used, albeit in different locations.

4. Ideation

During the ideation chapter, several new ideas and concepts will be generated to aid children in finding a book by making use of AR. The ideation phase started with using the PLEX framework. From this, four directions were found which the ideation could take. These four directions served as a base for a stakeholder brainstorm. From this, several concepts were developed. These concepts were used to create four ideas, from which Lo-Fi prototypes were developed. These were discussed with a stakeholder, which resulted in the final concept. A general overview of the ideation phase can be seen in Figure 15. This overview was made after the ideation in order to illustrate the process that was taken.

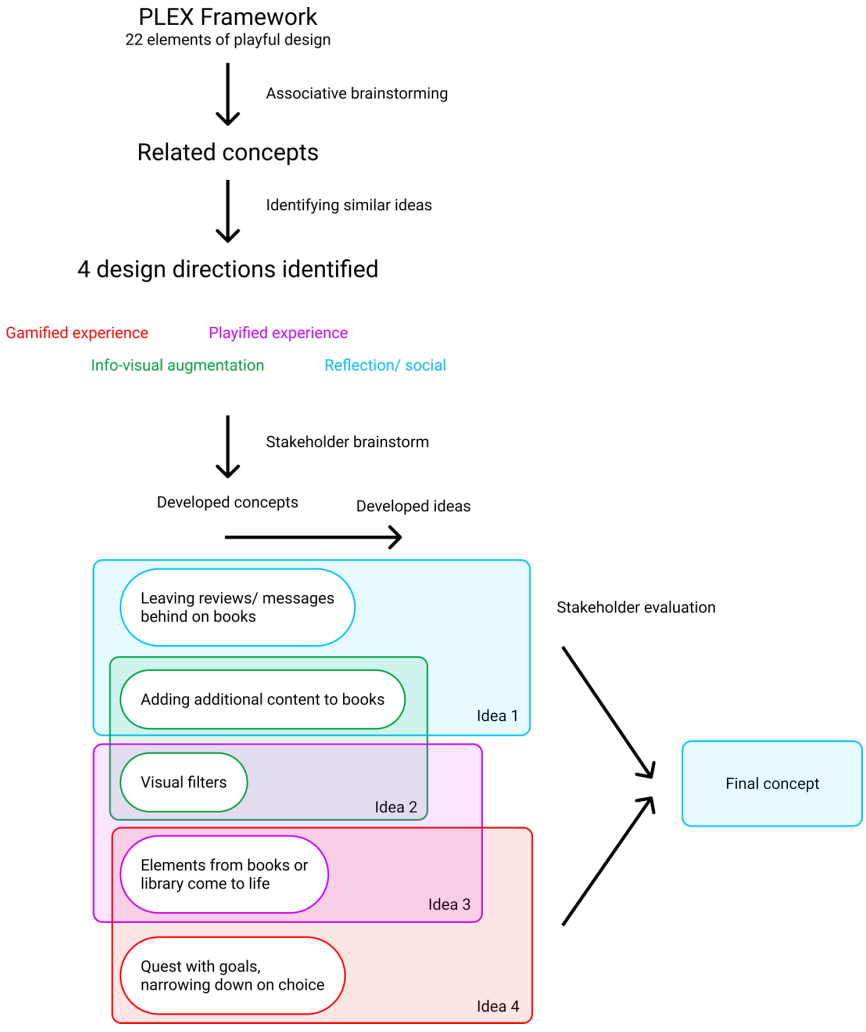


Figure 15, Ideation outline

4.1 Plex associative brainstorm

As identified in the literature review on playful experiences, the PLEX framework offers an extensive list of qualities that playful experiences have to offer. The framework can be used as support during ideation. Lucero and Arrasvuori offer two ideation techniques making use of PLEX, Brainstorming and Scenario [1]. These techniques are best done collaboratively, which make them suboptimal in this research context.

Therefore, it was decided to design a custom ideation process, based on the elements of the PLEX framework. The process was started with writing all the elements of PLEX on separate postcards. The next step was to fill these cards intuitively with ideas fitting the PLEX element and the ReadAR project, with the goal being to develop initial concepts and ideas (see appendix 2). This was done for all but three elements (suffering, eroticism, cruelty) as these were believed to not suit children, which is the target audience.

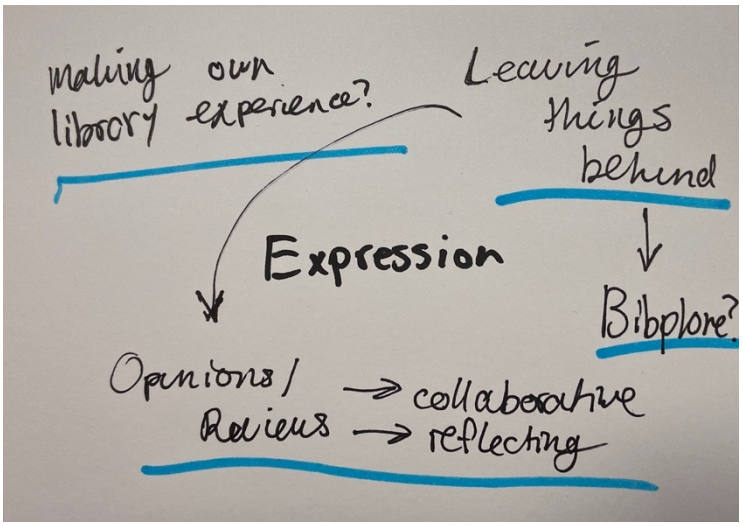


Figure 16, example of PLEX-element with associated concepts

After this, intersecting themes within the concepts on the cards were identified and marked with the same color. From this, four distinct directions in which the ReadAR project could be taken to were identified. These four directions were a starting point for the next step in the ideation process, in which more concrete ideas were generated with the help of a stakeholder. The four directions that were found were:

Gamified experience

A gamified experience includes a clear goal for the users, that could consist of tasks that have to be done in order to get a reward.

'Playified' experience

A 'playified' experience would focus on making the process of finding a book simply more fun. This differs from the gamified experience, where there is a clear goal present.

Info-visual augmentation

Info-visual augmentation would make the process of finding a book easier by providing more visual information about the books.

Reflective or social elements

Creating product with reflective or social elements would help children by not only helping them in finding a book, but also by teaching them the necessary tools to reflect on their book choice. By adding social elements, children are also capable of helping and influencing each other when choosing books.

4.2 Stakeholder brainstorm

To generate ideas for the ReadAR project, a brainstorm together with a stakeholder was done. The stakeholder in this case is a primary school teacher with over 25 years of experience teaching. It was decided to do a brainstorm together with a primary school teacher, because this person is both an expert on the subject, and a potential stakeholder. Moreover, she has ample knowledge of what kind of ideas would be effective because of her involvement with both the problem and the target audience.

The brainstorm was based on the four directions identified from the PLEX brainstorm. This was done to direct the brainstorm process. Each of the four directions were written on a piece of paper as a word cloud (appendix 3). After the brainstorm, the ideas that were written down were analyzed together to see if there was any overlap between them. From these ideas, five broad concepts could be identified: leaving reviews or messages behind on books, adding additional content to books to add context, visual filters, elements from books or libraries that come to life, and finally a quest with goals. These five concepts formed the foundation for more concrete ideas

4.3 Idea development

Four general concepts were created by combining the elements found during the stakeholder brainstorm. Low-fidelity prototypes were made in the design program Figma, that showed the key interactions of the product. This was done to illustrate these ideas, and to make it possible to present them to a stakeholder for initial evaluation and critique.

Content and reviews

The first idea combines the concepts ‘leaving reviews or messages behind on books’ and ‘adding additional content to books’. This idea essentially continues the idea behind the BibPhone [18]. The concept would allow people to add additional content to the outside of the books that are stored in the library. This could open up several opportunities; a teacher can give their students recommendations, an author can tell a little bit about their book, or an excerpt of the book can be given as a preview. It can be seen as an augmentation of the blurb that can traditionally be found on the back of the book. It could also be possible for a teacher to make a certain selection of books, perhaps based on the theme the children are currently working with.

Figure 17, Frame from 'Content and reviews' prototype. Full prototype in appendix 4

Magnifier

The magnifier is a simple concept that aims at providing a better preview of the book while it is still on the shelf. When the user hovers the virtual magnifying glass over a book in the library, the front of the book is shown along with some additional information like the number of pages. Because of this, the book doesn't have to be taken off the shelf in order to inspect it. Since children mainly look at the cover and the number of pages when choosing a book, this can make it easier to find one.

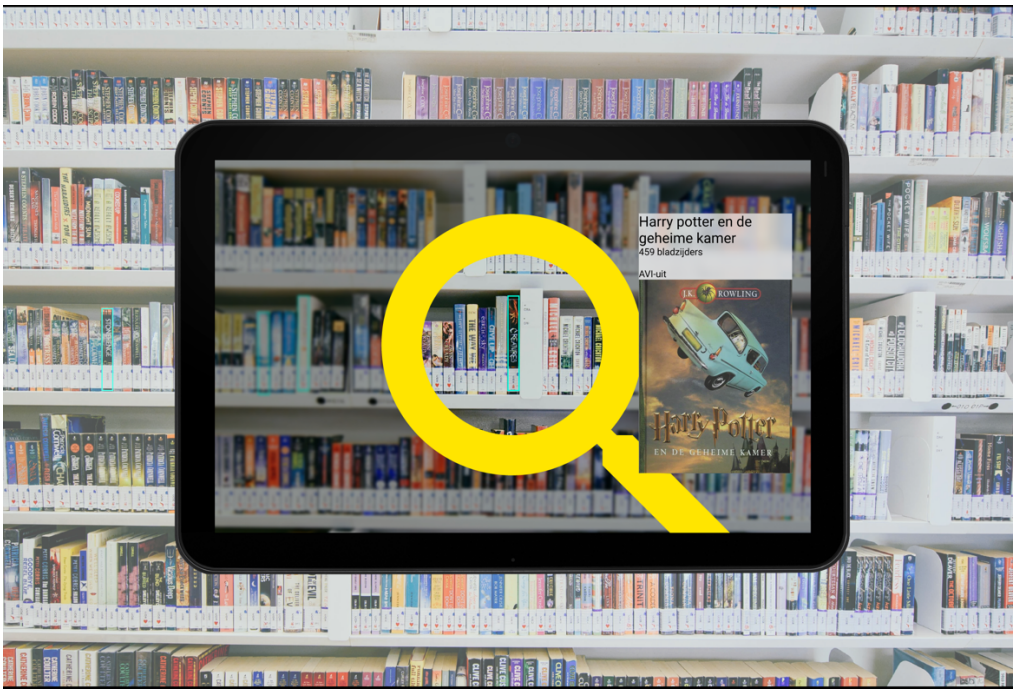


Figure 18, Frame from 'Magnifier' prototype. Full prototype in appendix 5

Visual filter

Visual filters would augment the library by allowing the user to set a filter when exploring the library. The user can pick a genre, and the programme will apply a visual filter to the library, highlighting the selected type of books. In addition to this, the library will contain virtual elements that fit the selected theme to make the experience more fun and immersive. For example, when a child selects the genre ‘scary stories’ the books containing scary stories could be marked by lanterns, for example.

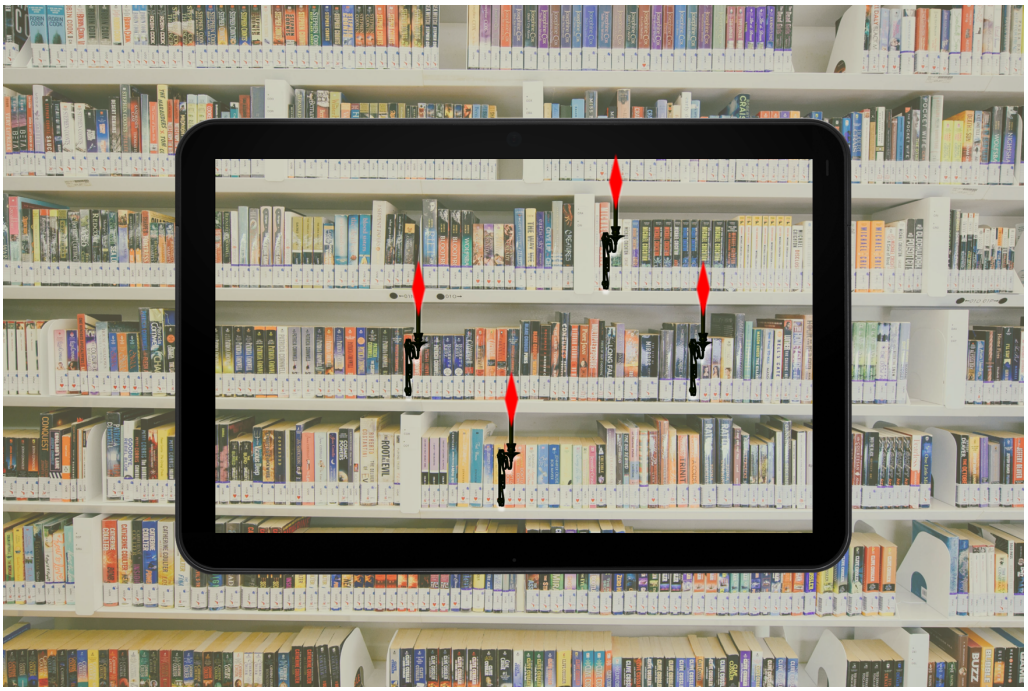


Figure 19, Frame from 'Visual filter' prototype. Full prototype in appendix 6

Scavenger hunt

An AR library scavenger hunt builds further on the activity developed by Rickert [16], where children are tasked to find books with a certain quality in the library. The child first selects their reading level. Next, the child is shown various characters that represent different general categories of books, but not yet specific genres. The child chooses one of these characters and gets a list of books they have to find for that character. This is done by finding the book and taking a picture of it. When all the books are found, the child is presented with all the images they took, and it is suggested to choose one of the books they have found.

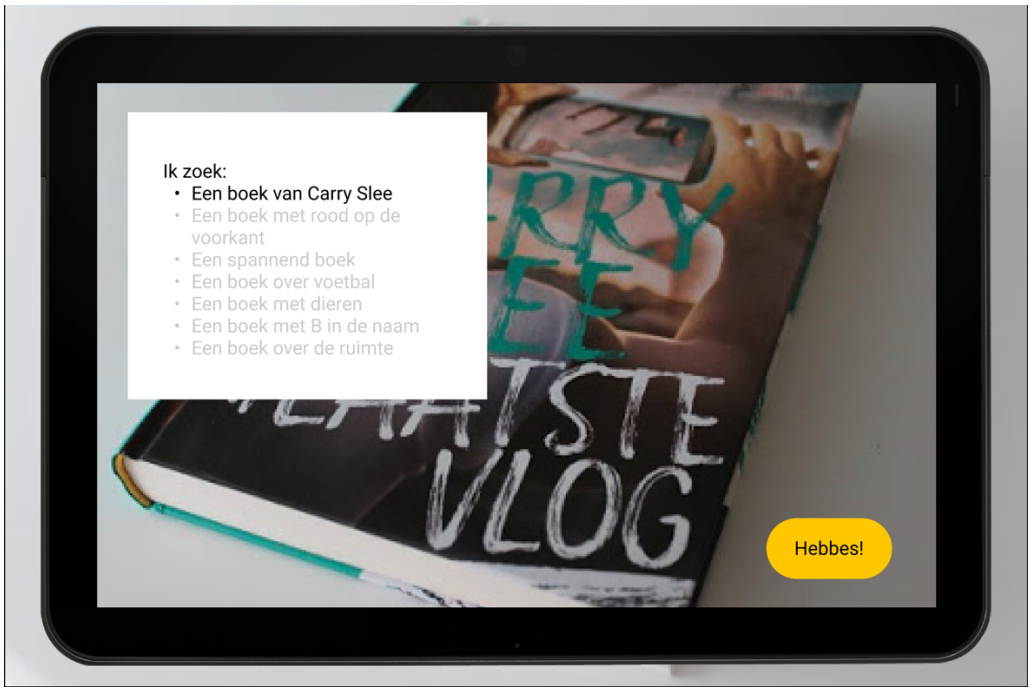


Figure 20, Frame from 'Scavenger hunt' prototype. Full prototype in appendix 7

4.4 Stakeholder evaluation

To evaluate the ideas, and to discover potential flaws, the four ideas were presented to another primary school teacher. This teacher is the reading coordinator of the school. The prototypes were presented through a screenshare. After the ideas were shown, the stakeholder was asked what elements from each prototype she did and did not like. She was also asked to pick the idea she believed to have the most potential to solve the issue.

Content and reviews

The teacher was the most enthusiastic about this concept. She believed this concept to be the most effective among the ones presented. She remarked, however, that there is no way to filter books. She

also made the remark that this idea might not appeal to kids as much as the visual filter and scavenger hunt ideas.

Magnifier
The teacher was critical about this idea. She mentioned that she expected that the effect it would have on children would be minor. When she was presented with the fact that children mostly look at the outside of the book to make their decision, and that this concept would aid in doing that, she mentioned that that behavior should not be stimulated, as it does not benefit the book choice. The teacher also mentioned that it would be logistically hard to get a database of all book covers, since the school library she manages does not even have a complete overview of their collection.

Visual filter
The visual filter was well received, however, the teacher mentioned that the envisioned effect it would have on children can also be achieved by marking the books with stickers for each genre. She also made the remark that children should be able to filter on reading level along with the proposed genre.

Scavenger hunt
The teacher liked this idea, but she expected children to get bored of looking for random books. She also expected some kids to cheat the system by taking pictures of books that do not fit the prompt. She also believed that children would start searching for books in a different way, not looking at their own preferences. However, the teacher did think that the way the avatars are used could be very enticing to children.

4.4.1 Conclusion

When asked again which idea the teacher liked best, she mentioned that she believes the ‘content and reviews’ idea would be the most effective. However, when thinking about which concept would be the most fun for children, she mentioned the scavenger hunt, especially the use of the avatars. The teacher also mentioned that she considers it important that children find books that fit with their reading levels. Therefore, to develop the final idea, a combination of ‘content and reviews’ and ‘scavenger hunt’ will be made.

4.5 Chosen direction

As mentioned before, the interesting elements from ‘content and reviews’ and ‘scavenger hunt’ will be combined. To do so, these elements from each of the ideas should be identified.

The key elements that define the ‘content and reviews’ concept are the social element of seeing classmates’ reviews and the reflective element of talking about why a child liked or disliked a certain book.
The elements that the teacher believed has potential from the ‘scavenger hunt’ idea is the addition of the avatars. According to her, this will appeal to children. It can also give a direction of what type of books are to be expected. Combining these elements, a new idea was developed.

4.5.1 Concept

The concept builds further on the concept of the BibPhone [18], which children can use to listen to messages that are attached to books. The concept for ReadAR is that the child can choose a character, with each character representing a category of books. The child can then see all the books that are recommended to this character, in the form of video reviews recorded by classmates.

These reviews are created in the second part of the application. After a child is done reading a book, they have to select the character they believe the book would suit best. After that, the children have to tell that character why they would like that book. This video is then linked to the book for that specific character. When the next child selects this character, the video will be linked to this book through an Augmented Reality overlay.

By making the children categorize the books themselves, it is expected that they will think about what kind of book it is, and who might like the book. Even when they don’t like the book, they can still give a recommendation to people who might like it. This also creates an automatic categorization of the books. By being prompted to explain why the selected character would like the book, it is expected that the answers will be more elaborate than when the children are asked about their personal opinion on the book.

A flowchart is made to illustrate the idea, and to show the possible design choices for every step. This helps in making decisions in the specification stage of the design process.

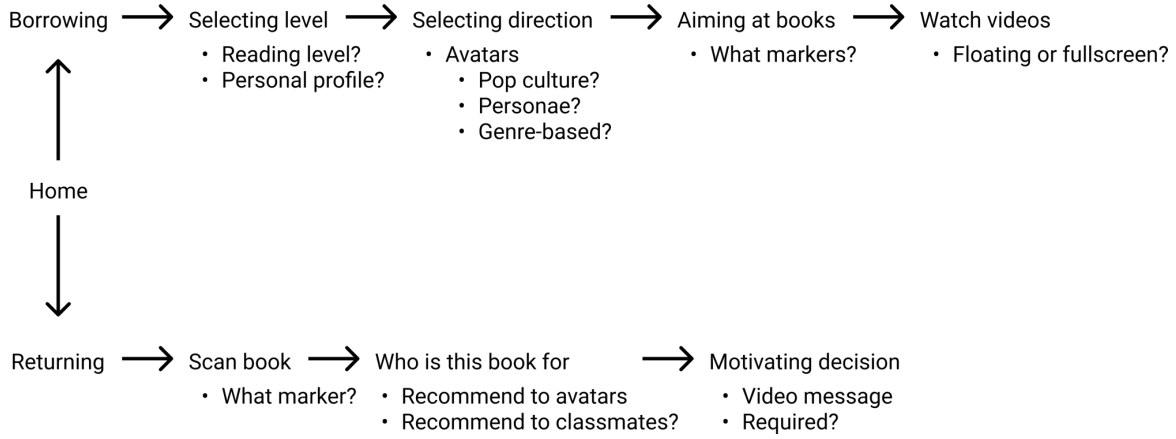


Figure 21, Application outline

5. Specification

In this specification chapter, the rationale behind the design decisions will be discussed, and a mid-fi prototype will be built to communicate the concept and to serve as reference for the hi-fi prototype.

This project will not follow the traditional design practice of constructing a set of requirements, because the source of the problem cannot be pinpointed to one issue. There can be multiple approaches that can be explored to tackle the design question. Additionally, because of rapid prototyping techniques used, and close ties to stakeholders, it was found that constructing requirements was not required.

5.1 Design rationale

5.1.1 Selecting reading level

From conversations with the reading coordinator at the primary school that is participating in this project, it became clear that the most important aspect of the book is the reading level. This is therefore the first point where books should be filtered.

This can be done in a multitude of ways. One option is to have the child select their AVI-level in a GUI. This is a standardized reading level and children are generally aware of their own. Another option is to create personal profiles for every child and connect their reading level to this profile. This could have multiple advantages because this way, educators can have a better overview over the reading behavior of their students. However, it would also require more work. Finally, there is the option of physically sorting the books on reading level. This eliminates the need of having to choose the reading level from within the app. This will also mean that the books don't have to exist in a database with the reading levels connected to them, saving work for the administrator and also making the system more dynamic.

Because of the time advantages, and because the books at the school where the prototype will be tested are already sorted based on reading level, the third option will be chosen for the prototype. However, if this product is to be developed further for use in a public library, this decision should be re-evaluated.

5.1.2 Selecting avatars

The next step in helping children filter the books is by a choosing a direction in their search. As with selecting the reading levels, this can be done in multiple ways. One possible way to do this, is having certain characters represent the different genres, as was the case in the 'scavenger hunt' lo-fi. The

reading coordinator commented that children probably find these characters very enticing. In that particular example the characters were popular cartoon characters, but this is copyright sensitive.

One interesting concept found on a teacher's blog [44] is (re)creating certain reading stereotypes. A reading stereotype is a description of a certain reader that a child might relate to. One example is a stereotype of someone who rather plays outside instead of reading a book. It is important to note that these stereotypes and the virtual characters that represent them are not enhancing certain existing, negative stereotypes. For example, a character that likes books about soccer should not enhance the stereotype that only boys like books about soccer. Therefore, the characters that represent the reading stereotypes should be as neutral as possible.

Deciding between having a categorization based on genre or on reading stereotypes, the reading stereotype seems more innovative and novel. At the moment, most libraries already sort their books by genres. Having a looser categorization like with the reading stereotypes could lead to new encounters in new genres, which may lead to new discoveries for that particular child. It also makes the aspect where children categorize the books themselves more interesting, as they have to think about who might like the book and why this book might fit them, instead of simply commenting on what the book is about.

5.1.3 Markers

Important for the AR aspect of the prototype is that children should be able to scan the books while they are still on the shelves. In order to achieve that, the back of the book should be identifiable. This can be done in two ways by making use of visual markers. One way to do so, is to use object recognition on the back of the book. However, it is unclear if this is feasible. It also makes it hard to have the database of reviews dynamically grow, as reference images are needed for every book. The alternative option that will be used is using visual markers that resemble QR codes. The quality of these codes depends on the amount of available tracking points on the image.

5.1.4 Watching videos

The videos that are attached to the books can either be watched full screen, where scanning the code on the book would either open up the video on the tablet or floating on top the books in Augmented Reality. The latter option is chosen, as it makes the product feel more in the moment and lighter. The interaction is more instantaneous and surprising. It is expected that this stimulates children to explore all the different books in a playful way.

5.1.5 Recommending & motivating choice

Another part of the product consists of recommending the book the child has read and motivating this choice. This recommendation will be given to the reading stereotypes. This way, the books belonging to the reading stereotypes get automatically added to this reading stereotype, essentially creating a self-sustaining system.

To aid the child when recording the review, some suggestions on things to talk about are placed on the screen. To make a fair comparison to the book report that the product will be compared to in the evaluation session, the same general prompts that are on the book report will be included as suggestions when recording the video.

6. Realization

In this chapter, the specific choices regarding the realization of the concept to prototype will be discussed.

6.1 Hardware

The prototype runs on an Apple iPad Air (2019). Initially, a Samsung Galaxy Tab A7, property of the University of Twente HMI lab, was considered. The iPad was chosen over the other device, due to support for Unity's ARfoundation. This native Unity framework requires ARkit (for Apple devices), or ARCore (for Android devices). The Samsung device has no support for ARCore, which made it unsuitable for this application.

6.2 Software

As mentioned before, the prototype is created using Unity, with the ARfoundation framework. The two main parts of the application, the AR experience when looking for a book and the recording of the video review when returning a book, were developed as separate apps to speed up the development process as it removed the need for a database to store the dynamically created AR content in.

6.2.1 Photo and video

The returning of a book consists of three main parts: taking a picture of the book that will be returned, choosing a character to which the book fits, and making a video telling of why this book belongs to this specific character. This part where children return the book was developed before the AR experience that children use when finding a book. The reason for this is that to create the AR experience, the videos that were created when returning the book are needed.

For recording and saving the picture of the book and the video, the NatCorder [45] and NatShare [46] API's are used. These allow for recording video, and to save it in a specific folder. Because both parts of the experience were held separate, a place was needed to safely store the recorded video. The photos and videos that were recorded were kept on device, with each video saved in a specific folder, representing the character the child has chosen. These videos are then manually added to the AR experience.

6.2.2 AR Experience

The AR experience was built on Unity ARfoundation. This framework has multiple options for input. For this project, it was deemed that an image tracker would be the most suitable. A good trackable

image has lots of contrast points in order for the computer vision to recognize the image. An AR marker generator [47] was used to generate good tracking images. This creates markers that resemble QR codes and are optimized for ARfoundation. These images were printed with a tab attached to them, which could be stuck to the spine of a book as shown in Figure 22.

Figure 22, AR tracker code attached to the spine of the book

The codes were linked to the corresponding video about the book. To make it possible to have multiple trackable images within a scene, an additional script was used on the Unity element ‘AR session origin’ [48].

6.2.3 Characters

The characters play a vital role in both parts of the experience. The children have to choose a character who they think would enjoy the book, when they are returning the book they have read. When choosing a book for themselves, they have to choose one of the characters that might fit their own taste. The content of these characters plays a big role. These experiences make use of reading stereotypes. These stereotypes can have negative effects on children. To prevent the negative effects. the reading stereotypes should be broad but specific, making it so that all children can find a reading stereotype they can somewhat relate to. The stereotypes should be deprived from any physical attributes that might alienate certain users on things other than reading preference.

For this prototype it was also important to not have too many reading prototypes present. The number of participants is expected to not be higher than 20. Having too many characters means that the number of books that are recommended per prototype is too little. Having four reading stereotypes

was decided to strike a good balance between having enough options to choose from and having enough books per character. The 4 reading stereotypes were created in discussion with a primary school teacher. In the app, the characters introduce themselves and which types of books they like.

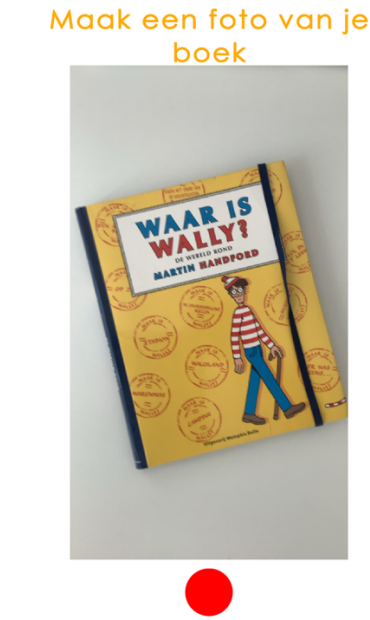
Targeted type of books	*Dutch description*	*English translation*
Funny books, sports books	'Ik houd niet zo van lezen... Ik ga liever buiten spelen! Als ik dan toch moet lezen, wil ik graag een grappig boek, of een boek over sport!'	'I don't love reading… I'd rather go outside to play! If I have to read anyways, I'd want a funny book, or a book about sports!'
Thrilling stories, fantasy books, history books	'Ik vind lezen heel leuk! Vooral spannende verhalen vind ik gaaf. Ook boeken over magie en vroeger vind ik heel leuk!'	'I like reading a lot! Especially thrilling stories. I also enjoy books about magic, and about the past.'
Realistic books, non-fiction books	'Ik houd het meest van boeken die écht gebeurd kunnen zijn! Ook informatieboeken vind ik heel erg leuk!'	'I enjoy books that could really have happened a lot. I also really like books with information!'
Picture books, comics, books about animals, funny books	'Ik vind lezen wel lastig! Daarom vind ik het fijn wanneer er veel plaatjes in de boeken staan. Ik houd ook heel erg van boeken over dieren!'	'I think reading is quite hard… That's why I like when there are a lot of graphics in the book. I also really like books about animals!'

As one might see, there could be some overlap between the different characters. For example, an informative book about an animal could be placed in two categories. This is not a big problem, as the categorization of the books is not meant to be perfect. This increases the chances of children finding new books that may be slightly outside of their comfort zone.

The models that are used to represent these characters, are anthropometric mice in four different colors. This was done to ensure the children would choose a certain character based on their contents, and not on their physical relatability. The 3D models and animations were downloaded from Mixamo [49]. The colors of the texture were changed in Adobe Photoshop.

6.3 Resulting prototype

6.3.1 Returning books



Returning a book consists of 3 steps. The first step is taking a picture of the book the user has just read. This is to identify the book the user is talking about. In a future iteration this should be done by scanning the code that is on the book.

The second step consists of choosing a mouse that fits the book. The user can navigate between different mice by pressing the two yellow arrows. Each mouse has a unique animation. The user goes to the next screen by pressing the green triangle.

The third step consists of recording the video. The user has to press and hold the red recording button to start the video. On the screen, in the colored text, some cues on what to say are added. These are the same questions that are on the book report. This is done so a fair comparison can be made between the book report and the app (more information about this in chapter 7).

6.3.2 Choosing books

Choosing a book starts with the user choosing a character that fits them. This is essentially the same interface as when returning a book, with the exception being that the descriptive text on the top of the screen is changed from ‘Choose a mouse who might like this book’ to ‘Choose a character to choose a book with’

After this, the interface becomes a viewfinder. When the user hovers the tablet over one of the codes that is attached to the books, and that fits the character they are looking with, a video starts playing.

7. Evaluation

7.1 Method

7.1.1 Evaluation goals

The main goal of the evaluation is to compare the prototype to the current situation, with the focus points being effectiveness in helping children during the book choice process and the amount of fun the subjects experience.

The evaluation of the prototype will be done in two parts. During the first session, the element of recording a recommendation for one of the avatars is compared to writing a more conventional book report. For this, the following evaluation questions are constructed, with their respective hypotheses and alternative hypotheses. Combined, these questions help us answer the overarching evaluation question that was constructed in the introduction: *To what extend does the new AR application make the process of finding a suitable book for a child easier and more enjoyable?*

> **EQ1**: Do children experience more fun when using the ReadAR app to reflect, compared to a conventional book report?

> **EQ2**: Do children show playful behavior when using the ReadAR app to reflect?

During the second session, finding a book with the help of the ReadAR app is compared to not using the app. For this session, the evaluation questions are:

> **EQ3**: Does ReadAR app make it easier for children to find book, compared to finding a book without the app?

> **EQ4**: Do children show playful behavior when using the ReadAR app to find a book?

> **EQ5**: Do children experience more fun when using ReadAR to find a book, compared to finding a book without the app?

7.1.3 Participants

Due to logistical efficiency and coronavirus regulations, it was decided to use students from two classes for the evaluation. These are children from the age of 8 until 11 with the mean age $M =$

8.8889 and standard deviation $SD = 0.96338$. From the $N = 18$ participants, 38.8% identified as male, 61.1% identified as female. 10 children were in the fifth grade, 8 children were in the sixth grade. All the children whose parents signed both the consent form (appendix 8) and the additional consent for use of video were selected to participate in the test. This study was approved by the ethical committee of the EEMCS faculty under RP 2021-14. The teachers were consulted to check if there were any children with special needs and that could not take part in the experiment. This was not the case. However, during the second evaluation session, some children were ill. Because of this, the second session only had 15 participants.

7.1.4 Procedure

Because this study is working with children, an important focus point is making them feel comfortable. Therefore, the evaluation sessions will be done in groups of two. First, the subjects will be explained about what is going to happen and how the how the app works.
After that, following the result of an online randomizer, one of the participants starts with the written book report, the other with the ReadAR prototype. After both participants are done, they switch.

After exposure to one of the scenarios, the subjects will fill in a form to assess how much they liked the certain activity (appendix 9a). This will be the same form across all activities. After the participants got exposed to both scenarios, they will fill in a form that compares the two activities (appendix 10a).

During the subjects' interaction with the prototype, observations will be done. These will be based on the PLEX categories. The 9 most relevant categories of PLEX were selected, along with the signals of these playful behaviors. The subjects will be monitored for these cues. This observation form can be found in appendix 11.

The second evaluation session will be done in a similar way. The starting conversation will be skipped, since the subjects already recognize the researcher from the previous session. Instead, the children will be explained about how the app works. One of the subjects will start to choose a book with the help of the ReadAR prototype. The other subject will choose a book without. When both subjects have chosen a book, they have to do it again, this time with or without help of the ReadAR prototype.

During the subjects' exposure to the prototype, they will be observed with the same PLEX-based form as in the first session. After each of the situations, the subjects have to fill in the standardized fun-assessment form, this time with additions for measuring the difficulty finding a book

(appendix 9b). After exposure to both the situations, the subjects again have to fill in the comparative form for this session (appendix 10b).

Figure 23, library setup with AR tracking codes attached to the books

7.1.5 COVID-19 Precautions

To limit the risk concerning the spread of Coronavirus during the evaluation, precautions were taken. These were in line with the advice from the RIVM. This included keeping as much distance to the participants as possible and wearing a mask when this was not possible. In addition to this, a self-test was performed both nights before the evaluations. This produced a negative result for each test respectively.

7.1.6 Materials

For the first evaluation session, along with a tablet running the prototype, a book report is required. This is a shortened version of the book report children are used to getting in class. For this, the teachers were contacted. This modified book report can be found in appendix 12.

For the assessment of the prototypes, various forms are used. Every time after being introduced to one of the situations, a fun assessment form needs to be filled in (appendix 9). This consists of a smiley-o-meter [9], a place where children can give the activity a grade out of ten, and a place where children can write down the elements that they found to be most fun and least fun. For the second evaluation session, this form is augmented with a question concerning why they chose the

book they did, and a Likert-scale is added to measure the experienced difficulty when looking for a book.

After exposure to both situations, another form is used to compare the two experiences (appendix 10). On this form, the participants have to pick their preferred situation. In addition, this form consists of an again-again table [9]. For each of the element of the experience, children can state whether or not they want to do it again. For example, the elements in the again table for the first evaluation session are: choosing a mouse (character), recording a video, writing down what the book is about, giving the book a mark. Along with the elements the children also have to fill in whether or not they would want to do either of the experiences again.

Finally, during the children's exposure to the prototype, they are observed for signs of playful behavior. This observation will be done with the help of the PLEX framework. The number of occurrences of cues of playful behavior will be counted. For this, a preselection is made for the 9 PLEX-elements that are most likely to occur. These are: captivation, completion, control, discovery, exploration, expression, fantasy, humor and sympathy. These elements are paired with the behavior that represents these elements. When this behavior is observed, this is written down. Because it is unclear when a certain behavior stops and starts, the frequency of this behavior during the exposure to the prototype is not measured. The observation form can be found in appendix X.

7.2 Data

7.2.1 Statistical design

In order to answer evaluation question 1, *do the children experience more fun when using the ReadAR app to reflect, compared to a conventional book report?,* we did a 2x2 within subjects design study. The independent variable in the experiment is either the interaction with a book report, or the ReadAR prototype. The dependent variable is the reported fun experienced. This will be quantified by using a smiley-o-meter. This results in a pair of ordinal values between 1 and 5 for each of the participants, where 1 represents 'Helemaal niet leuk' (not fun at all), and 5 represents 'Fantastisch' (fantastic).

The same statistical design is applied to answer evaluation question 5, *Does the ReadAR app make it more fun to find a book, compared to finding a book without the app?* The only exception in this case, is that the independent variable is finding a book without the ReadAR app, or finding a book with the ReadAR app.

To find the elements the subjects enjoyed most and least, two open answers concerning their favorite and least favorite parts of the experience are collected after each interaction. To find out if the participants would like to do each of the distinctive elements of both the prototype and its alternative again, the participants have to fill in an again-again table after being subjected to both the prototype and its alternative. This results in a set of ordinal values between 1 and 3, where 1 represents 'I do not want to do it again' and 3 represents 'I want to do it again'.

Two answer evaluation questions 2 and 4*, do children show playful behavior when using the ReadAR app to reflect / to find a book?* observations are done based on the PLEX framework. The dependent variable, the occurrence of playful behavior, is dichotomous. For each of the experiments, the occurrence of one or more elements of the preselected 9 elements of the PLEX framework is collected.

To answer evaluation question 3, *Does the ReadAR app make it easier for children to find book, compared to finding a book without the app?,* a Likert-scale question is used in order to measure the perceived difficulty of finding a book. Like the amount of fun experienced, this is a within-subjects study with the independent variable being finding a book with or without the ReadAR app. The dependent variable is the reported difficulty finding a book. This results in a pair of ordinal values for each of the participants, with 1 being 'Heel moeilijk' (very difficult), and 5 being 'Heel makkelijk' (very easy).

To see if the quality of the motivation why a certain book was chosen was changed between the independent variables, the subjects have answered the open question ‘why did you choose this book’. These open answers can give a more qualitative insight into the effectivity of the prototype.

7.2.2 Data analysis

The Likert-scale questions, like the smiley-o-meter and the difficulty of finding a book will be analyzed with the Wilcoxon signed-rank test, to test if the population mean ranks differ between the experiments. The tests will be done for $\alpha = 0{,}05$, with H_0 being ‘there is no change in the dependent variable when using the ReadAR prototype or not ‘. This dependent variable is either the amount of fun experienced, or the experienced difficulty finding a book. This analysis will be done using SPSS. The grade the child gave each experience will be analyzed with a paired-samples t-test, again with an $\alpha = 0{,}05$, with H_0 being ‘there is no change in the mean grade given when using the ReadAR prototype or not.’

The answers to the open questions, like ‘what was your favorite element’, ‘what was your least favorite element, and ‘why did you choose this book’, will be coded to find common themes and elements. The code will arise from the responses to the open questions (inductive coding).

8. Results

8.1 Do children experience more fun when using the ReadAR app to reflect, compared to a conventional book report?

The Wilcoxon signed-rank test on the reported amount of fun between writing a book report and using the ReadAR app to reflect on books showed that there is no reason to reject H_0 for a significance $\alpha = 0{,}05$, with $Z = -1{,}883$ and $p = 0{,}060$.

However, the median score for the amount of fun experienced did increase from 3 (‘Leuk’) without the prototype, to 4 (‘Heel leuk’) with the prototype. 61,1% of the subjects reported to have experienced more fun during their interaction with the prototype, 22,2% of the subjects reported to have experienced more fun during the interaction with the conventional book report, and 16,6% of the subjects reported to have experienced equal amounts of fun across the two situations. When asked to directly compare the two experiences in a dichotomous question after the subjects experienced both situations, 61,1% preferred the app, while 38,9% preferred the conventional book report. This seems to match up with the ranks from the signed-rank test.

The mean overall grade given for filling out the book report is $\mu = 8{,}21$, whereas the mean grade for interacting with the application is $\mu = 8{,}94$. From analyzing the overall grade given to each of the two experiences with a paired-samples t-test, it can be concluded that the means of the grades did not differ significantly, with $t(18) = 1{,}553$ and $p = 0{,}139$.

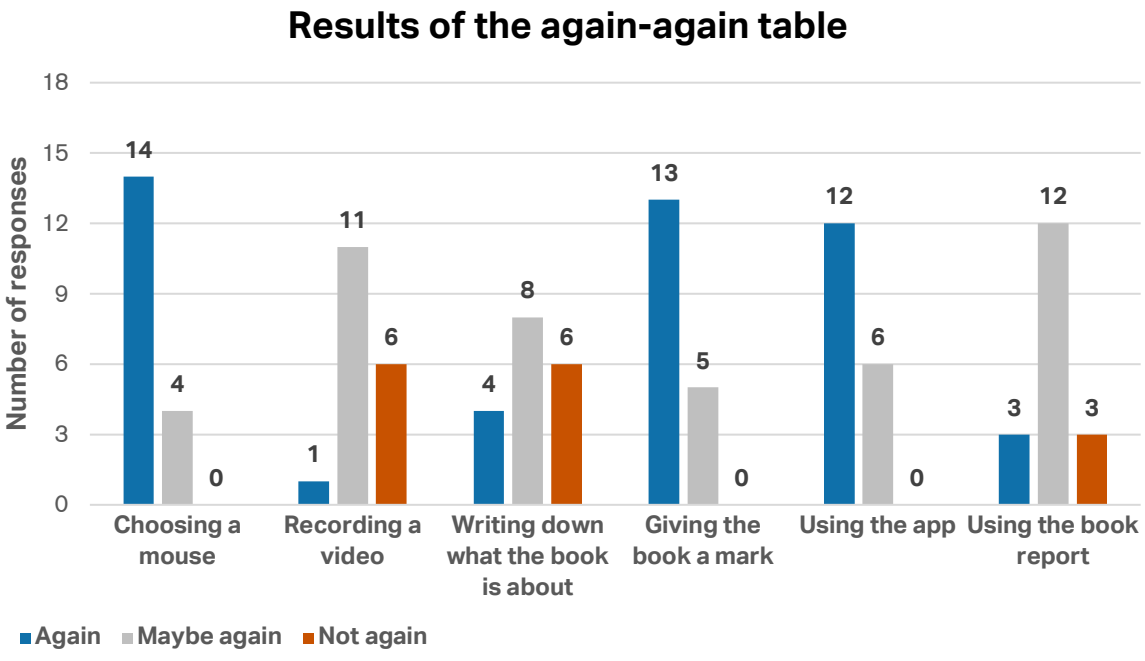


Figure 24, Results of the again-again table for session 1

Looking at Figure 24, we are able to observe that a majority of the subjects would want to do the activity of choosing a mouse again. The answers to recording a video are more unenthusiastic. A majority is either neutral or negative towards recording a video again. This matches observations that showed that children generally looked uncomfortable when recording a video. They often needed help on what to talk about. One participant did not want to make a video at all.

Results are also mixed for writing down what the book is about, while most subjects stated that they would want to perform the activity of giving a book a mark again. Meanwhile, most subjects stated that they would like to use the app again: 66,7% would consider doing it again, while 33,3% answered maybe. Children were more hesitant to use the book report again, with 16,7% considering doing it again, 66,7% answering maybe, and 16,7% answering they would not want to do it again at all.

The answers to open question concerning which parts of each experience the children like most are seemingly consistent. A majority, 77,8% of the participants, mentioned the characters as their favorite part of the experience. At the same time, 66,7% of the participants mentioned recording the video as their least favorite part of the experience.

Some subjects had difficulty picking their favorite elements from the book report. From the 18 responses, 8 responses mentioned either ‘nothing’, ‘everything’ as their favorite part, or left the question empty. From the 10 specific responses, 3 mentioned giving the book a mark, 4 mentioned checking the box that states what kind of book they have read. 2 participants declared giving their opinion as their favorite element, and 1 participant liked explaining the plot best.

There were also just 10 subjects that filled in their least favorite part of the book search. 4 children mentioned writing things down as their least favorite part, 2 participants disliked explaining what the book is about, and 2 participants did not like motivating the grade they gave the book. 2 other children mentioned deciding what kind of book they have read as their least favorite part.

A notable observation from the results of the book report is that children seemed to prefer simpler tasks (giving a mark, checking the box that states what kind of book they have read) over more complex tasks (writing, telling what the book is about, explaining their motivation behind the mark they gave the book). 70% of the answers to the favorite part of the experience mention a simple task, meanwhile the complex tasks make up 80% of the answers regarding least favorite elements.

8.2 Do children show playful behavior when using the ReadAR app to reflect?

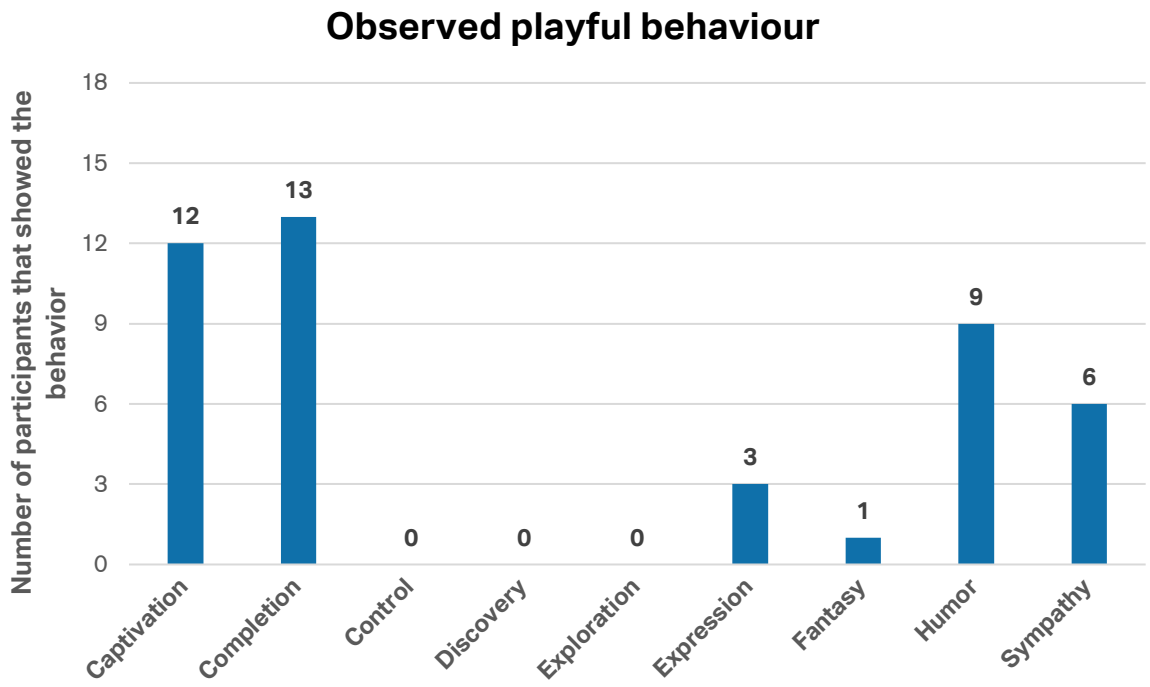


Figure 25, Observed playful behavior (returning a book)

Based on the results of the observations, it can be seen that most of the children showed signs of behavior that corresponds to one or more elements of PLEX. The most frequently noticed element was completion (13 out of 18 participants showed signs of this). This was most often observed when children were selecting a character to choose from. The participants wanted to see every possible character they could choose before making their decision. Captivation was also observed frequently (12 times). This was manifested by children ignoring their surroundings and focusing on the task at hand. Most often, this could be observed when children were taking a picture of the book, and when choosing a character. Notably, children become more aware of themselves and their surroundings when they had to record a video. This could be noticed from their uncomfortable looks, eye contact, and them looking around the room. 9 subjects showed signs of experiencing humor. This was often present in the form of laughing, which happened often when looking at the playful animations of the characters. 6 participants showed signs of sympathy. While it can be argued that all children have shown sympathy by imagining why a certain character would like the book they are reviewing, it was only noted when children specifically mentioned why the selected character would enjoy the book. A good example would be a line like this ‘I think [Character x] would enjoy this book because…’. This shows that the children are specifically showed sympathy for the chosen character. Furthermore, there were 3 accounts of expression that was observed. This was noted when a participant was freely and

comfortably sharing their knowledge about their book. There was one account of fantasy, where a child made a creative connection between the characters and the book.

8.3 Does the ReadAR app make it easier for children to find book, compared to finding a book without the app?

For the reported difficulty of finding a book, the Wilcoxon signed-rank test showed that there is no reason to reject H_0 for an $\alpha = 0{,}05$, with $Z = -1{,}633$ and $p = 0{,}102$. This means that the introduction of the ReadAR did not cause a significant change in the reported difficulty of choosing a book.

This is reflected in the descriptive statistics. The median stayed the same at 3 (‘Normaal’). 53,3% of the participants reported an improvement of the difficulty of finding a book. 20,0% reported that they had more difficulty finding a book with the app, and 26,7% of the participants reported a tie between the two situations.

After each scenario, children were asked to motivate their book choice. This was an open answer. The goal of this information is to see if the reasons why a certain book is chosen are different between the two prototypes. The following codes were created based on the reasons given:

Code	*Description*	*Concrete examples*
Subject/ contents	The subject has chosen the book based on its subject or contents.	'Because it contains jokes', 'It is about Donald [Duck]', 'I like bunnies'
Familiarity (with series)	The subject has chosen the book because they are familiar with it or a series it belongs to.	'I have read it at home', 'I am fan of the Kameleon', 'Suske and Wiske Junior is fun'
Property	The subject describes a property of the book as the reason why they chose it.	'It seems fun and thrilling', 'It is funny', 'It is adventurous', 'It seems interesting'
Type of book	The subject has chosen the book because of the type of book it is.	'It is an informative book' 'It is a funny book [1]', 'The video said it was thrilling'
Seems good / overly general	The reason that was provided contains no reference to the specificities of the book.	'It seems good [2]', 'I could not find another book'

[1] The reason why this is included in 'type of book' as opposed to property, is because the subject specifically described that the type of book is funny, instead of saying they are expecting it to be funny.

[2] Most of the answers in this category are 'Het lijkt me leuk' in Dutch, which can be translated with either 'it seems fun' or 'it seems good'. The latter was chosen as a translation as to not create any confusion with 'funny'

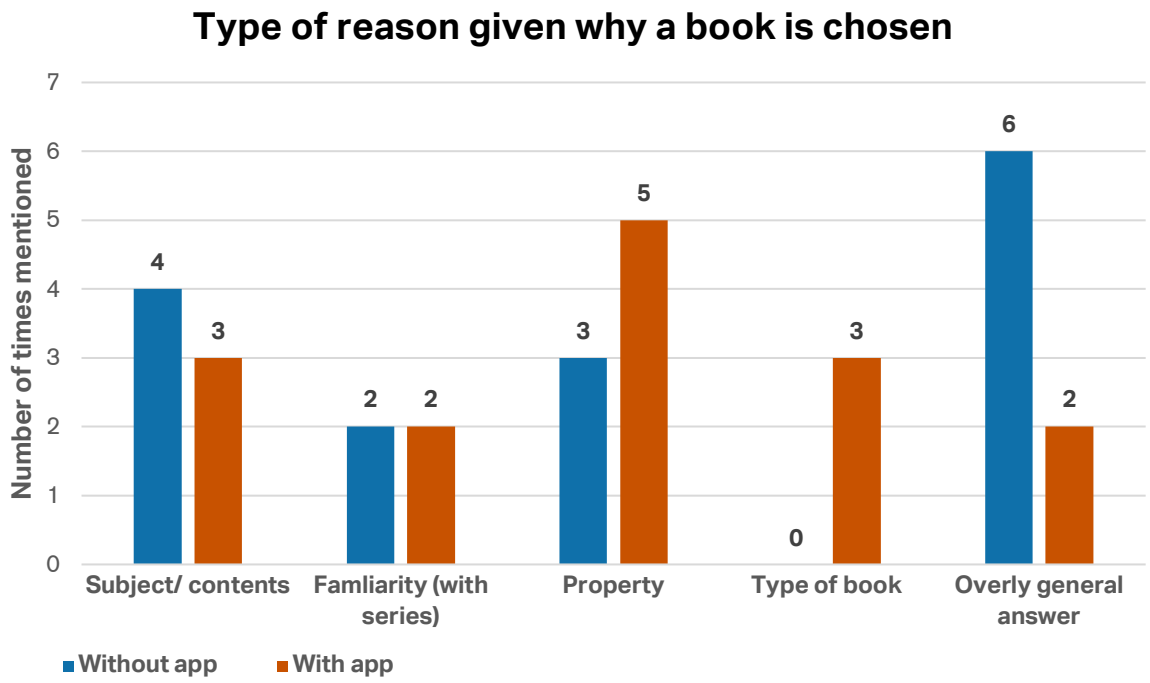


Figure 26, Number of times a certain type of reason is given

In Figure 26, there appear to be some differences in the types of reasons between the two prototypes. It can be seen for the books chosen without the app an overly general answer occurs more often. It can also be observed that with the app, children mention properties and the type of book more often when giving a reason for their choice.

Another interesting observation is that of the 15 reasons given why a book was chosen, 9 reasons included an element that was included as a preference of one of the characters they could choose, or that was mentioned in one of the videos. However, it is hard to say if this can be related to the functioning of the prototype, because the mentioned reason can also be based on an observation by the subject. For example, one of the books that were included in the experience was a book full of jokes. This was included in the title of the book. Therefore, it is possible that the child has simply observed that the book is about jokes, and gave their reasoning based on their observation, instead of basing it on the chosen category of books.

8.4 Do children show playful behavior when using the ReadAR app to find a book?

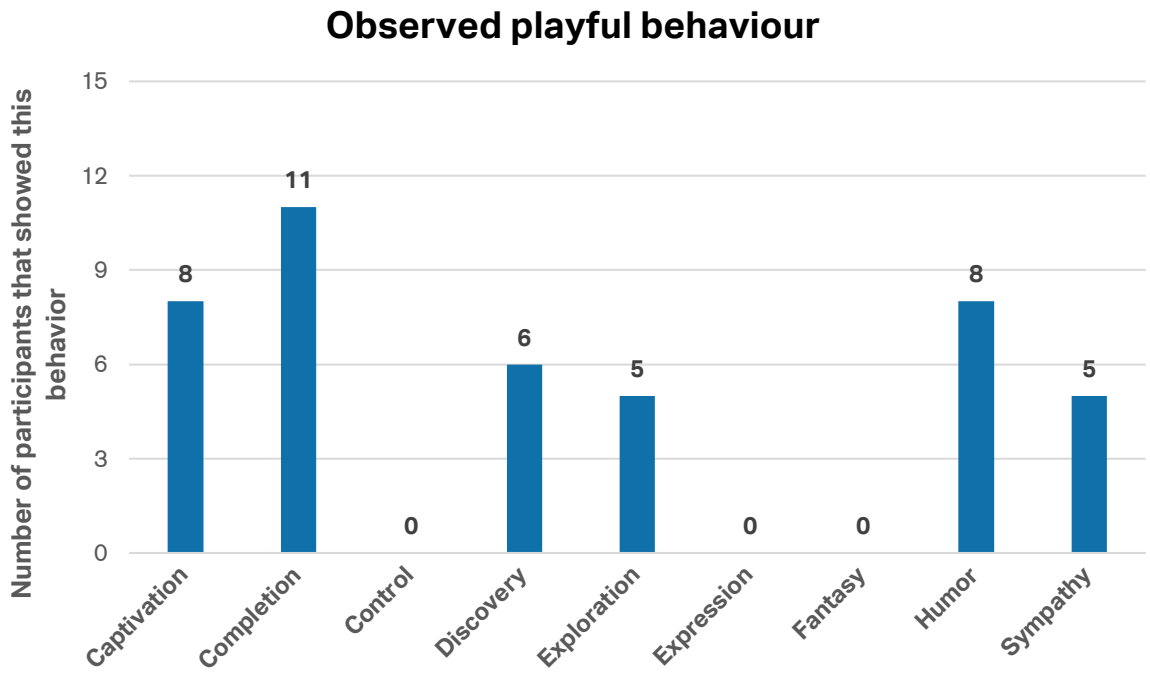


Figure 27, observed playful behaviour (finding book)

During the interactions with the prototype, 11 out of 15 children showed the PLEX element of completion. These children tried out all or most of the available characters to find every available video clip. It seemed to become a challenge for them to find every possible video. 8 children showed humor, mostly in the form of laughter and smiles when seeing their classmates, peers and themselves. Some children found it awkward to see themselves. There were 8 children that showed captivation. This came in the shape of searching for all the videos in a concentrated manner. There were 6 accounts of discovery, and 5 children that showed signs of exploration. The differences in the behavior between these two categories were hard to define, therefore, a general distinction between the two was made during the observation. Discovery was defined by the child trying out new things for them, and exploration meant that the child was trying to find the limits of the experience. 5 children showed signs of sympathy. This came in the shape of recognizing and interaction with their classmates. There were also two accounts of a child saying that a certain book could also be assigned to another character, showing a level of sympathy for the characters.

8.5 Do children experience more fun when using ReadAR to find a book, compared to finding a book without the app?

A Wilcoxon signed-rank test showed to reject H_0, meaning that for $\alpha = 0{,}05$, there is significant difference in the reported amount of fun between choosing a book without the help of the ReadAR app and with the help of the ReadAR app, with $Z = -3{,}219$ and $p = 0{,}001$.

Indeed, it can be seen that the median score of the amount of fun experienced without the prototype is 3 ('Leuk'), with the prototype it increases to 4 ('Heel leuk'). 86,6% of the subjects reported an increase in the amount of fun when subjected to the ReadAR prototype. 13,3% of the subjects reported a tie between the two experiences. None of the subjects preferred choosing a book without the ReadAR prototype. When asked to directly compare the two experiences, 93,3% of the participants preferred the ReadAR app, while one person (6,7%) preferred searching for a book without the app.

The mean overall grade given for finding a book without the app is $\mu = 7{,}76$, whereas the mean grade for finding a book with the app is $\mu = 9{,}51$. From analyzing the overall grade given to each of the two experiences with a paired-samples t-test, it can be concluded that the means of the grades are significantly different, with $t(14) = 4{,}571$ and $p < 0{,}001$.

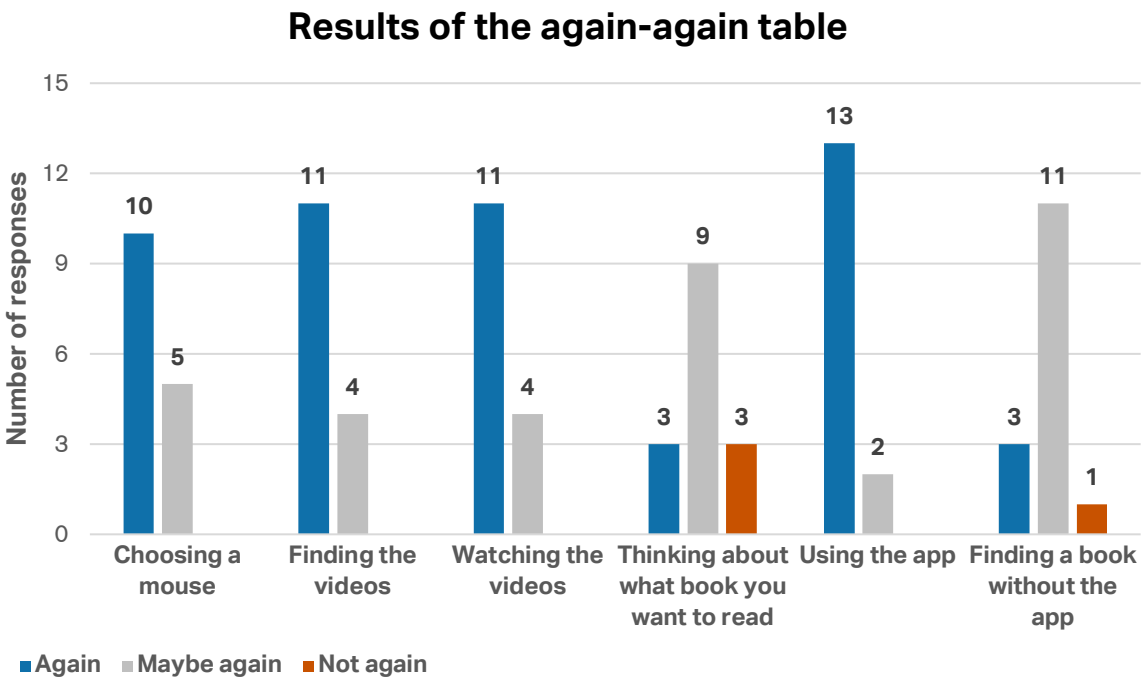


Figure 28, results of the again-again table for session 2

It becomes apparent from the again-again table, that the overall opinion on the elements of the ReadAR app is positive. The majority of the respondents would want to do the distinctive elements again. The respondents are less positive about ‘thinking about what book you want to read’. There are also considerably less subjects that are wanting to choose a book without the app again.

The open questions about the participants’ favorite and least favorite parts of the experiences resulted in a lot of invalid answers. Some children answered the wrong question. For example, some children wrote down what they liked about the book they chose, instead of what they liked about the process. Many children answered ‘nothing’ or ‘everything’ to one of the questions. One third of the answers was deemed to be invalid for any of the beforementioned reasons.

With this in mind, it is still possible to look at individual answers to the questions, to get an impression of what elements children liked and disliked. Elements that children liked about finding a book without the app were the browsing, searching and choosing of the book. 2 out of 15 children mentioned they enjoyed reading the summary of the books. 3 children mentioned they dislike the fact that choosing a book takes a long time.

Elements that children stated to enjoy about finding a book with the app were choosing a character, watching the videos, looking for videos. One participant mentioned that they liked the fact they were able to see the books that fit them well. Some negative remarks from the children were that sometimes they get frustrated because expected a video to be present for a certain code, but there was not, since they had not selected the right character. Two users mentioned they liked the part of actually choosing a book after seeing the videos the least.

9. Discussion

9.1 Implications of findings

During the first session, it was not possible to a measure a significant difference in the self-reported fun across the two experiences. It is highly suspected that the main reason why children did not report a higher level of enjoyment, is the recording of a video. Children looked uncomfortable when recording the videos, and also gave it a low score on the domain of fun. A majority of the children mentioned it as their least favorite element of the experience. What the exact cause of this is not clear. It could be that children felt watched when recording the video. It could also be possible that they simply do not like recording themselves. Another explanation could be that the children did not know what to say. The last reason seems unlikely, because when children looked uncomfortable, there were asked to first practice what they want to tell by telling it to the researcher first. They looked less uncomfortable when doing this. This matches the observations that were made during the evaluation of BibPhone [18], which employed a similar mechanic in their prototype.

The observations mostly met the expectations, with a notable exception being expression. It was expected that this experience would facilitate self-expression, but many children were too timed while recording the video to be able to call this self-expression.

For the second session, a significant improvement over the reported amount of fun could be found. The same is true for the overall grade given to the experience. This could be seen in the overall behavior of the children. Half of the children had to wait their turn to use the tablet and had to do the alternative task first. This sometimes led to children not paying as much attention to their alternative task as much, as they were distracted by the other student using the ReadAR prototype. This could have influenced the score they gave to the alternative experience. It also illustrates the attractiveness of the ReadAR app. The application also attracted a lot of onlookers.

A significant difference in the reported amount of difficulty experienced could not be recorded. It seemed that children a lot of attention exploring all the possible videos, but did not pay as much attention to their actual book choice. This could be due to two things. It could be that children knew they were choosing a book only for them to place it back on the shelf afterwards. It could also be that because it is the children's first experience with the application, children wanted to see and explore everything.

Even if it was possible to record a difference in the difficulty experienced, this still would not paint a complete image on the effectiveness of the product. With the current setup, it is not possible to know if the book a child has chosen actually fits them better than the one chosen without the application. For this, a longer-term study would be needed.

The reading stereotypes were found to be popular in both sessions. Children seemed to enjoy the funny design and animations of the characters, and some children actually sympathized with these reading characters. It was also found that every child was able to choose a character, with some children even noticing that some books could be recommended to multiple characters.

Children were also positive about the reading characters in their written answers, with a big majority naming it their favorite element during the first session. However, this could also be due to the fact that children really disliked recording the videos. Still, the reading stereotypes scored well on the again-again table for both sessions.

9.2 Product issues and limitations

The implementation of the prototype had minor issues and limitations that can have an influence of the outcome of the experiment. Firstly, when recording the video, children have to press and hold the recording button. This was done because this was easier to implement than the press of the button, and it was expected that children were familiar with this way of recording video from Instagram and Snapchat. However, it proved that some children had difficulty with figuring this out, often needing multiple attempts to get it right.

Secondly, after a couple of sessions, it was found that the initial recording limit of 30 seconds was too short for one of the participants. Therefore, this time limit was increase to two minutes for the rest of the evaluations.

For the second evaluation session, one of the limitations was that children could not easily select a different reading character when they had chosen one. This was because Unity ARfoundation initializes the library of trackable images at runtime, which could not be changed afterwards. To solve this, the children were instructed to close the app and reopen it to select a new character. This did not seem to prevent them from trying out multiple characters. It is questionable if it is even needed to let children easily switch between characters. Because the experience is new, children wanted to explore every aspect of it. When a child actually uses the application to find a book, the intended use is that a child simply chooses the character that fits them, and chooses a book based on this.

One possible future issue is that every book has a trackable code attached to them. This can clutter the library easily. At the moment the codes were about 5cm by 5cms in size. To make it possible to fit more books with codes on the shelf, it could be considered to make the codes smaller. However, this could create problems with accuracy and unwanted triggers of multiple videos at the same time.

9.3 Evaluation method

9.3.1 Experiment setup

While this project faced some logistical difficulties due to the COVID-19 pandemic, it was still possible to evaluate the project with a respectable number of subjects. However, one limitation is that the evaluation was done with only a subset of the target audience. Children from the Dutch 7th and 8th grade did not participate in the study. It would be interesting to do this evaluation with this group in the future, as the problem of losing reading enjoyment gets worse the older a child becomes [50].

The study was done in sets of two subjects, to make being part less intimidating for children. This could have had an effect over the between-subjects tests. One of the two children was randomly selected to interact with the prototype first, with the other child doing the alternative activity first. It could be observed that the participant that had to start with the alternative activity often paid a lot of attention to what the other participant was doing, instead of paying attention to their own task. This could have influenced the level of fun a child experienced while doing their activity, as they might have subconsciously compared it to what the other child was doing.

9.3.2 Materials

After evaluating the answers to the again-again tables, an interesting pattern became visible. It seems like the simple tasks seems to score better for ‘returnance’, then more complex tasks. When looking at the again-again table of the first session, it can be seen that the easier tasks (choosing a mouse, giving the book a grade), had more positive answers than the more complex ones (recording a video, writing down what the book is about). This seems to suggest that ‘returnance’ is not only a measure of enjoyability, but also an indicator of the effort a certain activity requires.

The open questions concerning the child’s favorite and least favorite elements of an experience seemed to be hard to answer for children during the activity of choosing a book without the app, with many children answering ‘nothing’ or ‘everything’. This was much less of a problem for the three other activities. A possible reason why children had difficulty naming their favorite and least favorite elements, is that children cannot find the distinct elements that go into choosing a book without the app. If this is actually the reason, it would support the theory that children do not employ a clear strategy when choosing a book. To prevent this from happening in the future, it could be considered to make this a multiple-choice question. However, this makes the difference between this question and the again-again table quite small. The open answers are also interesting because these answers are a signal of the remembrance of certain elements of the experience.

After every experience, children had to rate the amount of fun they experienced on a smiley-o-meter, and they also had to give the experience a grade. This seemed to produce some interesting

results when looking at specific cases. For some of the answers, there was a big difference in the reported amount of fun experienced, and the grade given. For example, one child gave the experience a 10, but still selected the middle option on the smiley-o-meter. This can say something about the experience, for example that the child was impressed but did not experience a lot of fun. However, it can also say something about the tools used. After discussing one of the cases where this happens with the teacher, it was revealed that this participant was diagnosed on the autism spectrum. This could explain the discrepancy between the grade given and the selected smiley. The reliance on emotions, in the case of the smiley-o-meter, could potentially be a flaw when using this tool with children on the spectrum. When looking at the overall results of the smiley-o-meter and the given grade, they both give similar conclusions for each of the sessions.

Using the PLEX framework for observations was an interesting concept, which has not been widely used in this way before. Using PLEX proved to be useful as a base for the observations, because it gives a complete overview of all elements that can contribute to playfulness. However, using PLEX was not perfect. Some of the elements were too ambiguous, and no indicators are provided by literature. This meant that while observing, a lot of assumptions and interpretations had to be made. Some of these possible interpretations were made in advance, which can be seen in the column ‘cues’ in appendix 11. Because PLEX is based on the type of experience, and not on the actual behavior that is observed, this makes it unfit for observations in its current form. However, it is interesting to reverse-engineer the elements of PLEX to actual observable behavior in a future study to make it suitable for observations of playful behavior.

9.4 Future work

The ReadAR shows potential to truly change the experience of choosing a book for a child. However, it is possible to identify some elements in the product that should be improved. In addition, some suggestions can be made for future evaluation of the product.

It is clear that children did not enjoy recording the videos. It looks like this problem is not unique to this application, as similar problems were observed during the evaluation of BibPhone [18]. Therefore, it could be interesting to look for an alternative way of giving feedback. It would be interesting to know exactly why children disliked recording the video. One alternative to explore could be an avatar that repeats what the child is saying, something like the popular ‘My Talking Tom Cat’ application [51]. Another alternative could be having an AR face filter cover up the face of the users. This might make recording a video less intrusive.

From using the application, it was found that sometimes children did not understand when a video refused to appear for a certain book. Most of the times, this was because they had the wrong character selected. There were some cases where the AR system did not recognize the code correctly,

which could be solved by slightly repositioning the tablet. To make it clearer when a video is not showing up because the wrong character is selected, some more feedback is needed. One option is showing the character for whom the book is recommended on the trackable code. This signals to the user that they have selected the wrong character.

While every child was able to select one of the characters without a problem. In a future version of the application, it should be checked that the reading characters cover all possible books in the library. An interesting future idea could be to vary the contents of the reading stereotypes to explore the combinations of genres that might have different effects on children.

This study was not able to confirm if the ReadAR application has a positive effect on the experienced difficulty when choosing a book. Even if it was possible to record a significant difference, this still would not say anything about the total effectivity of the product. It does not confirm or deny if the book that is chosen, actually is a better fit to the child. This is something that has to be studied over a longer period. For this, the technical implementation would need to be improved, so that children can use the product autonomously and over a longer term.

10. Conclusion

While the results cannot tell a complete picture of how well this application has succeeded in helping children find books in the library, the system definitely shows potential. The reading characters were well-received and understood, and children enjoyed watching the videos that their peers have recorded.

The close collaboration with stakeholders and other experts, both during the research towards the problem, and during the ideation process, lead to an interesting solution that shows a sophisticated approach to solving the issues children experience.

(Note: this was first written for the Creative Technology graduation semester course 'Reflection II')

An argument can be made that ReadAR goes against the trend of Artificial Intelligence and computer algorithms making more and more of our decisions for people. Instead, it uses user-curated categories that children can freely choose. This product is aimed at a generation that has grown up interacting with recommendation algorithms like on YouTube and Netflix. Children are used getting a hyper-customized menu of content that will suit their taste perfectly. At the moment, this is not the case for books. Perhaps this might be one of the reasons why books are losing ground to new types of media.

An ethical paper on recommendation systems mentions a plethora of ethical issues and questions concerning such systems, like problems with *opacity* (black-box algorithms, algorithms that are so complex, only the inputs and outputs are readable), *privacy* (unauthorized inferences), and *social effects* (a lack of exposure to contrasting viewpoints) [52]. While there certainly are solutions to some of these problems, it should be considered that using algorithms to make good recommendations is not the best and only option.

Instead of also implementing these algorithms, this project takes another route, and tries to create a more human and social solution to the problem. The ReadAR project takes the appeal of digital devices with playful interactions and enticing animations and graphics and combines it with human-to-human connection. Not only does this create a more social recommendation system, it is also expected to train children to make their own decisions and learn to reflect about the content they are consuming.

While the recommendations of the ReadAR project probably cannot compete with the algorithms of YouTube and Netflix in the level of personalization, this implementation serves as a more human and sophisticated alternative. By creating balanced reading stereotypes that users curate themselves, children sustain their own recommendation system while actively being challenged to practice and use their reflection skills.

This paper contributes to the field in a multitude of ways. Firstly, it shows the problems that children experience during the book choice process through the eyes of educators, who are close to the problem. This gives a very practical and cased-base view of the problems that children encounter.

Secondly, this study has shown an interesting ideation process, with close involvement of experts during both brainstorming sessions and evaluation of prototypes. The PLEX framework was used in a novel way, with 19 of the 22 elements being used for the first step of the ideation process. The associative brainstorming session resulted in interesting concepts and ideas that could further be elaborated on.

Furthermore, through this collaborative ideation, the design that has been created shows a sophisticated solution, making use of broad reader profiles and engaging 3D animations in the form of the reading stereotypes. It makes use of localized content, supporting children in their book choice through the added context of peer-created videos, building on the concept of the BibPhone [18]. This whole system is supported by children reflecting on the books they return back to the library. This teaches children to reflect on their books and makes the system self-supporting.

This study leaves off with a prototype that shows true potential to transform the book search process of a child. This product does not only address the symptoms of the problem, it also attempts to tackle the underlying cause of the problem.

Appendix

Appendix 1: Survey questions

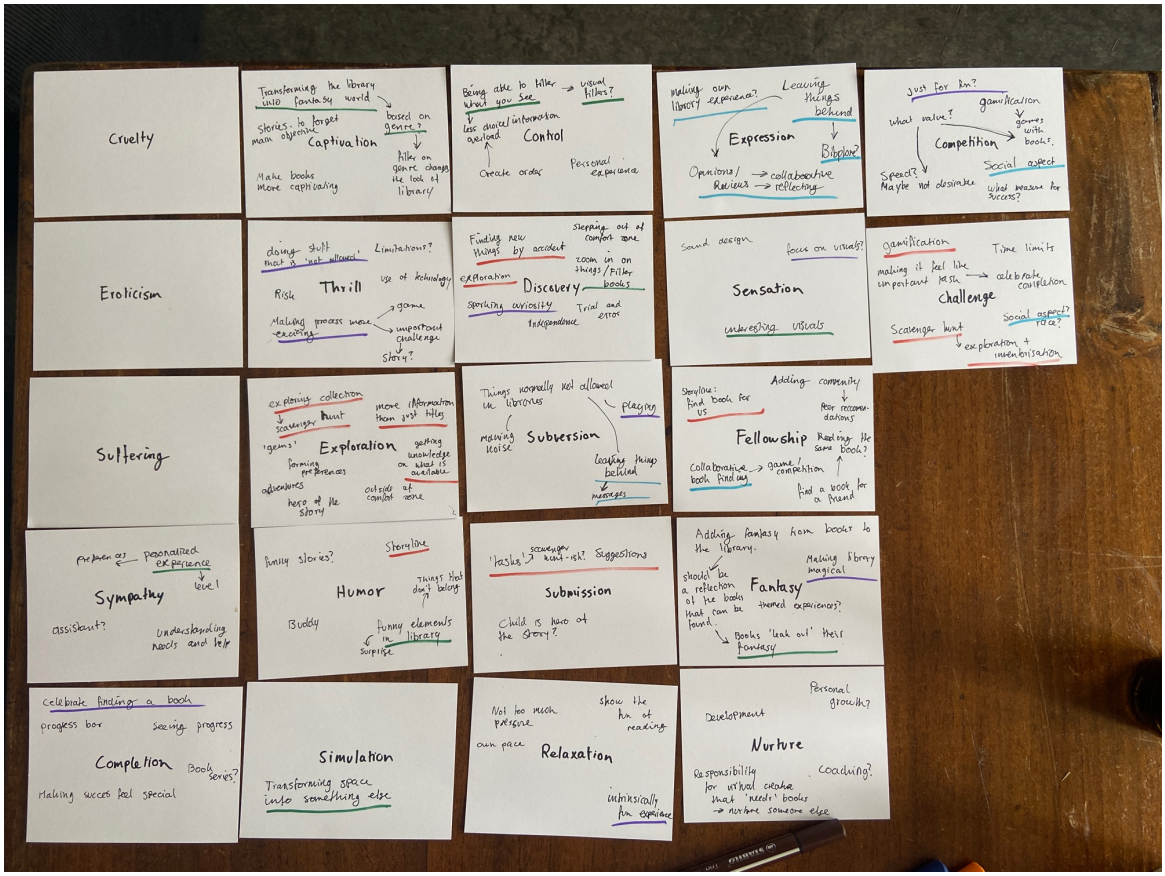
All questions were asked in Dutch, English translations are provided for this paper.

The questions with blue shading covered the construct: ‘the amount of fun experienced while choosing books’. Cells with yellow shading covered the construct ‘ease of finding books’

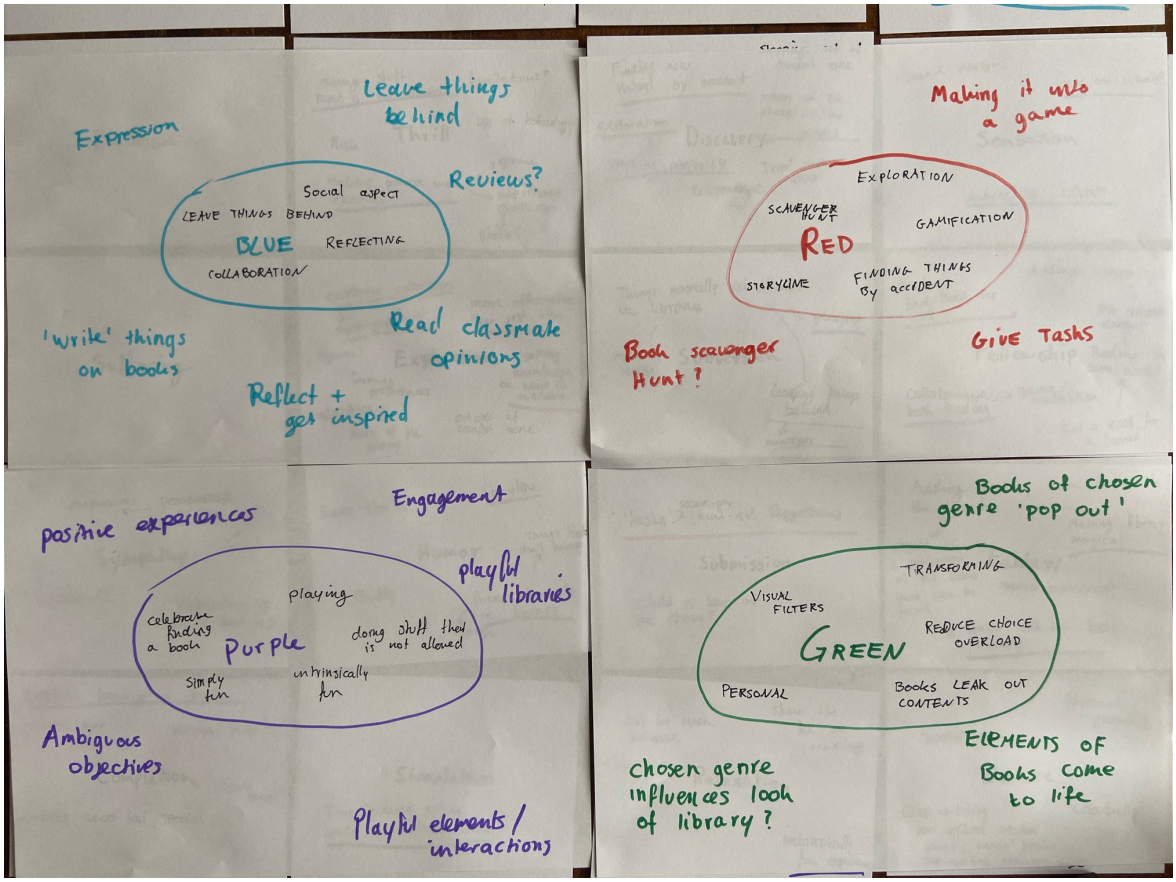
Ik zit in groep:	My year is:	Multiple choice (5, 6, 7 or 8)
Met wie ga je het liefst naar de bibliotheek?	With who would you rather go to the library	Multiple choice (with parent, with teacher, with friend, alone)
Ik vind lezen leuk	I like reading	Likert scale (1-5, 1: Do not agree at all, 5: fully agree)
Ik vind het leuk om naar de bibliotheek te gaan	I like going to the library	
Ik vind het leuk om een boek te kiezen	I like choosing a book	
In de bibliotheek heb ik plezier	I have fun in the library	
Ik zou vaker naar de bibliotheek willen gaan	I would want to go to the library more often	
Ik word blij als ik een boek mag kiezen	I get happy when I get to choose a book	
Ik vind het makkelijk om een leuk boek te kiezen	I find it easy to find a nice book	
Ik weet goed wat voor boeken ik leuk vind	I know which kinds of books I like	
Ik weet altijd goed waar ik moet zoeken voor mijn favoriete boeken	I always know where to look for my favorite books	
Het lukt me altijd om een leuk boek te vinden	I always succeed in finding a nice book	
Ik weet waar ik de boeken die ik leuk vind kan vinden	I know where I can find the books that I enjoy	
Dit boek vind ik het leukst	This is my favorite book	Open question (short)
Waarom vind je dit boek leuk?	Why do you like this book	Open question (long)

Likert scale question setup with illustrations

Appendix 2: PLEX associative brainstorm

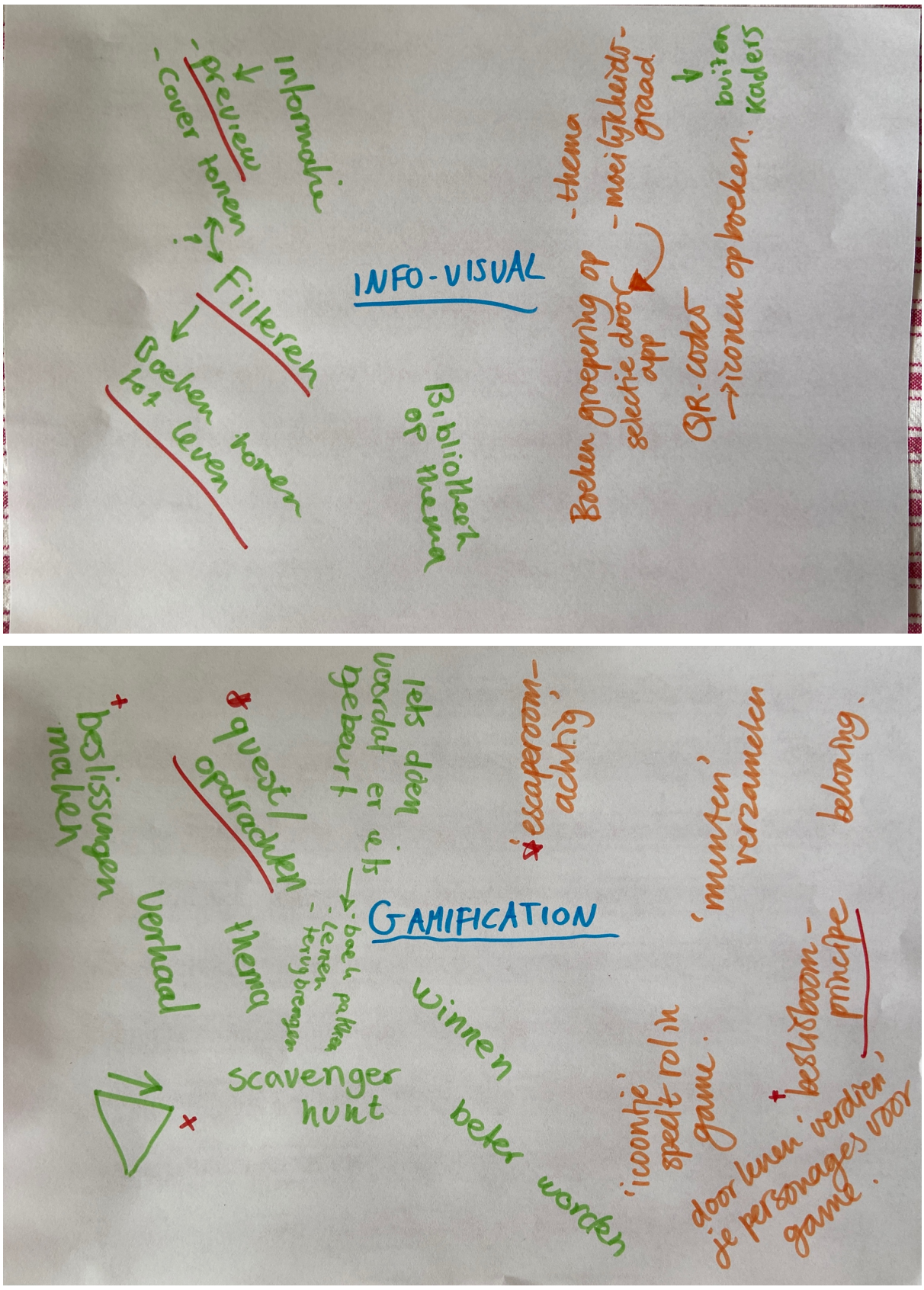


For all but three elements of PLEX, associations to the ReadAR project were made. Ideas or concepts that matched each other were highlighted with the same color. This were further analyzed to create 4 directions.



These 4 directions were further elaborated on in this exercise.

Appendix 3: Stakeholder brainstorm



Play
boeken lenen/terugbrengen
wordt beloond met groei
van bv. fictieve wereld.
'gelukken'
personages 'kopen mee'
schuldig/print uit boek
komt tot 'leven'
account koppelen
aan bitbabbo
achterkant/
kaft komt
tot Leven.
Actie
Beurt
Ronde
Verrassing
persoonlijk
privileges
Overlap info-visual
personages delen
werelden met elkaar
koppelen
uit game
stemmen bewaarplaats
Reflection
+ social
schuldig/
leerkracht
'reviews'/filmpjes/
vas-opdrachten.
bij inleveren
tips voor volgende
Samenwerking
voor elkaar
zoeken
Berichten
elkaar
reviews
voor
achterlaten/
reflectie
- Videos/berichten
koppelen aan boeken
- Onderling reviews/berichten

Appendix 4: Content and reviews prototype

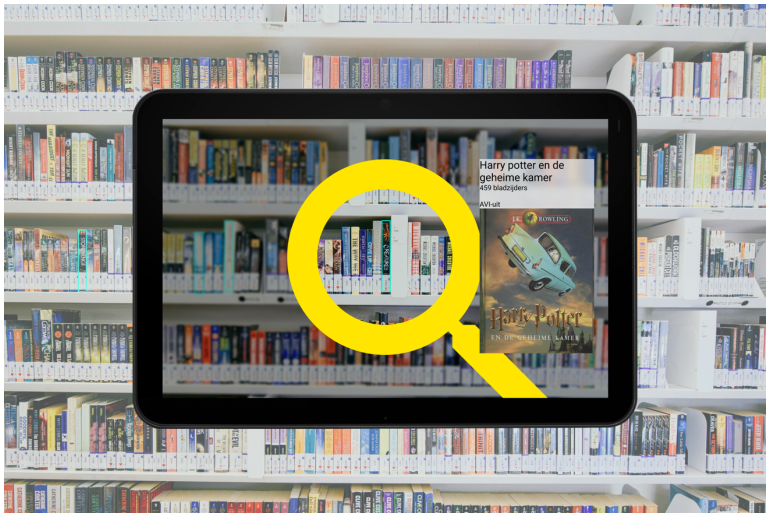
Children can choose the type of additional content they want to see.

The books that have additional content attached show red dots. When they are touched, additional content will be shown.

This is one example of the additional content, a video.

Appendix 5: Magnifier prototype

A small viewfinder in the shape of a magnifying glass is shown

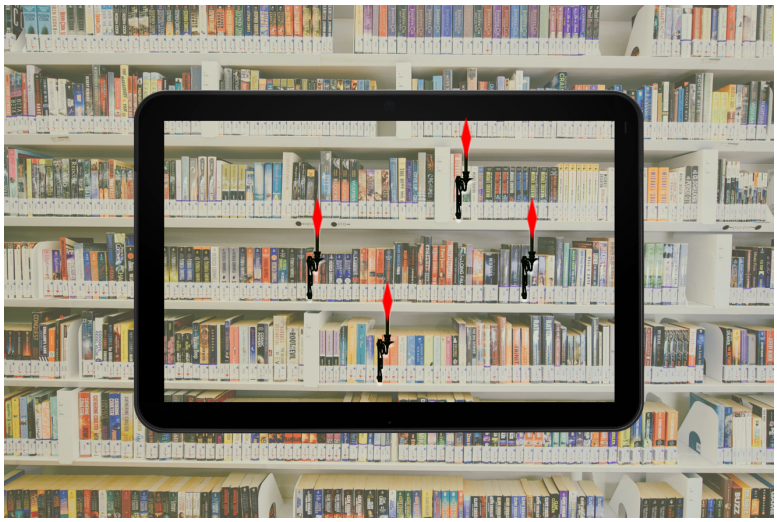


When a book is put into the viewfinder, more information about this book is shown

Appendix 6: Visual filter prototype

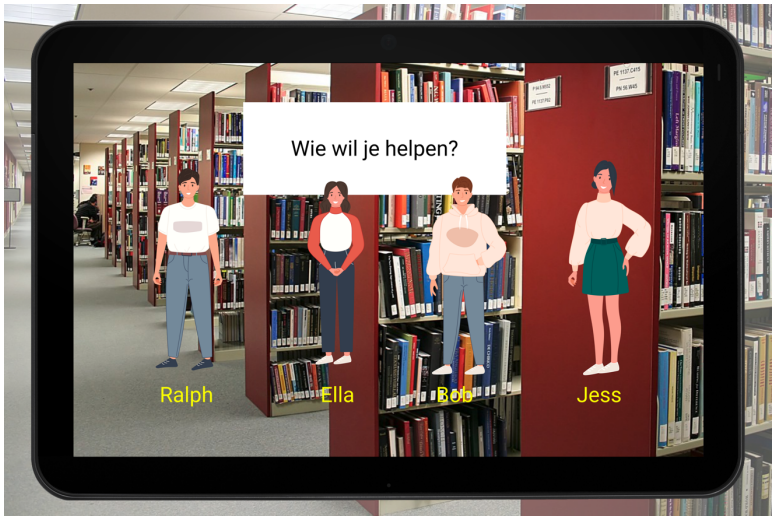
The user starts by selecting what kind of category of books they would want to read

The library transforms to fit the theme that is chosen. A color filter is applied over the viewfinder, and elements are placed in the library.



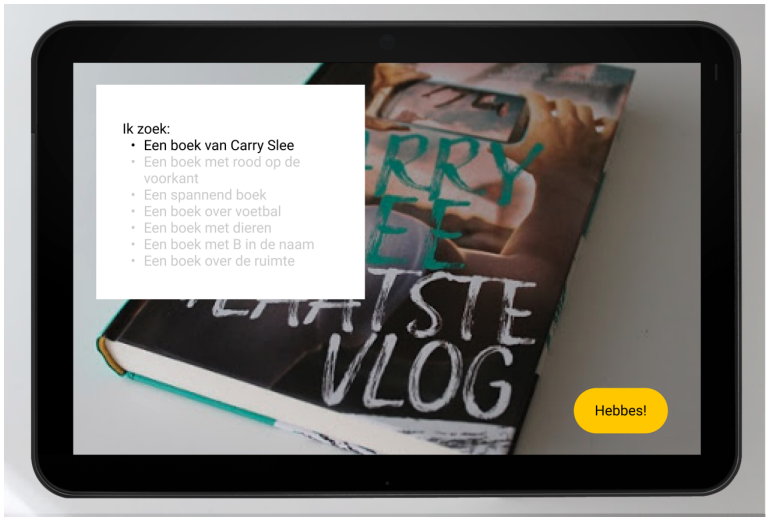
The book that fit the chosen theme are marked with elements to show where these books are.

Appendix 7: Scavenger hunt prototype



The user starts by selecting one of the reading characters to help choose a book. (Characters courtesy of svstudioart)

Children get tasked to find a number of books with certain properties



When the user has found one of the book, they take a picture of it

When the user has found all the books, they are presented with a summary. They are stimulated to choose one of the books presented on the screen.

Appendix 8: Consent form for parents + additional consent

TOESTEMMINGSVERKLARING

Betreft
De Universiteit Twente doet onderzoek naar de inzet van Augmented Reality in de context van de bibliotheek. Meer informatie over dit onderzoek vindt u in de informatiebrochure.

Hoofdonderzoekers:
Lars Wintermans (Afstudeerbegeleider: Robby van Delden)

Contactinformatie
Mocht u vragen hebben over dit onderzoek, dan kunt u contact opnemen met Lars Wintermans (l.j.wintermans@student.utwente.nl) de onderzoeker ter plaatse of bij de secretaris van de Ethische Commissie (ethics-comm-ewi@utwente.nl). De Ethische Commissie bestaat uit onafhankelijk deskundigen van de universiteit en is beschikbaar voor eventuele vragen en klachten rondom het onderzoek.

Onderzoek: ReadAR

☐ Ik verklaar hierbij dat ik volledig geïnformeerd ben over het onderzoek. Het doel van het onderzoek en de methodes zijn mij uitgelegd, waarbij ik de ruimte heb gehad om vragen te stellen.

☐ Ik begrijp dat mijn kind op ieder moment, zonder opgaaf van reden, mag stoppen met het interview zonder dat hieraan enige consequenties verbonden zijn.

☐ Ik geef hierbij vooraf toestemming voor deelname van mijn kind aan het onderzoek.

☐ Ik geef toestemming voor anoniem, schriftelijk gebruik van de uitspraken tijdens het interview voor onderzoeksdoeleinden.

☐ Ik geef toestemming voor het maken van audio-opnames van het interview ter naslag van gedane uitspraken.

Audiomateriaal wordt enkel door betrokken onderzoekers geluisterd en zal nooit openbaar gemaakt worden en/of vertoond worden aan derden voor demonstratie of rapportage. Al het onderzoeksmateriaal zal verwerkt en opgeslagen worden conform de regels en richtlijnen van de AVG. Alle data wordt voor een minimum van 10 jaar opgeslagen maar waar realistisch voor onbepaalde tijd passende bij de huidige richtlijnen van de Vereniging van Universiteiten (VSNU).

Datum: Plaats:

Naam kind: Handtekening ouder/verzorger A :

Handtekening ouder/verzorger B :

Dag ouders/verzorgers van groep 5/6,

Een tijdje geleden hebben jullie voor mij een toestemmingsformulier ingevuld voor medewerking van uw kind aan een onderzoek wat ik aan het doen ben over het kiezen van boeken. Hiervoor heeft uw kind destijds een korte vragenlijst ingevuld in de klas. De resultaten hiervan heb ik verwerkt en ik heb een app ontwikkeld waarvan ik denk dat het kinderen kan helpen met het kiezen van een geschikt boek. Deze app wil ik binnenkort in de klas gaan uittesten. Hier heeft u in principe al toestemming voor gegeven door middel van het formulier.

Ik stuur deze mail om u te informeren wat voor app het zal zijn, en om toestemming te vragen voor het gebruiken van videobeelden. De app werkt namelijk als volgt: wanneer kinderen een boek hebben gelezen, wordt er door de app aan gevraagd of ze een video-recensie willen opnemen voor hun klasgenoten. Deze recensie wordt vervolgens aan het boek gekoppeld. Wanneer een kind met de app een boek zoekt in de schoolbibliotheek, kan dat kind de recensies die de klasgenoten hebben opgenomen zien, gekoppeld aan dat boek.

Ik heb in het originele toestemmingsformulier geen toestemming gevraagd om videobeelden te gebruiken, via deze mail wil ik dat alsnog doen. De video's worden alleen door klasgenoten en mij bekeken, en zullen niet openbaar zijn. Na het onderzoek worden deze direct verwijderd.

Een korte reactie op deze mail met een simpele ‘Ja’ of ‘nee’ zou heel fijn zijn. Voor meer vragen kan u een mail sturen naar l.j.wintermans@student.utwente.nl

Alvast heel erg bedankt,

Met vriendelijke groet,

Lars Wintermans

Appendix 9a: Fun assessment form

Hoe leuk was ……?

Hoe leuk vond je het? (kruis aan)

				
Helemaal niet leuk	Niet zo leuk	Leuk	Heel leuk	Fantastisch
☐	☐	☐	☐	☐

Wat voor cijfer geef je het? ……

Wat vond je het leukst?

……

Wat vond je het minst leuk?

……

Appendix 9b: Additions to fun assessment form for session 2

Waarom heb je dit boek gekozen?

……

Hoe moeilijk was het om een leuk boek te vinden?

				
Heel moeilijk	Beetje moeilijk	Normaal	Makkelijk	Heel makkelijk
☐	☐	☐	☐	☐

Appendix 10a: Comparison form session 1

We vergelijken …….. met …….

Wat vond je het leukst? (kruis aan)

…….. ☐ …….. ☐

Wat zou je nog een keer willen doen?

	Nog een keer	Misschien nog een keer	Niet nog een keer
Een muis kiezen	☐	☐	☐
Een filmpje maken	☐	☐	☐
Opschrijven waar het boek over gaat	☐	☐	☐
Het boek een cijfer geven	☐	☐	☐
De app op de iPad gebruiken	☐	☐	☐
Het boekverslag invullen	☐	☐	☐

Appendix 10b: Comparison form session 2

We vergelijken …….. met …….

Wat vond je het leukst? (kruis aan)

…….. ☐ …….. ☐

Wat zou je nog een keer willen doen?

	Nog een keer	Misschien nog een keer	Niet nog een keer
Een muis kiezen	☐	☐	☐
De filmpjes zoeken	☐	☐	☐
De filmpjes bekijken	☐	☐	☐
Bedenken welk boek je wil lezen (zonder iPad)	☐	☐	☐
De app op de iPad gebruiken	☐	☐	☐
Een boek zoeken (zonder iPad)	☐	☐	☐

Appendix 11: Observation form

Experience category	Cues	Occurance
Captivation	Forgetting surroundings, concentrated looks, confidence	
Completion	Wanting to do/ see everything	
Control	Doing things that were unexpected, telling the character something else then mentioned	
Discovery	Trying out new things	
Exploration	Trying to find limits	
Expression	Expressing themselves	
Fantasy	Using an imagined situation, going along with a story	
Humor	Showing smiles, laughs, making jokes	
Sympathy	Being able to emphasize with the character	

Appendix 12: Modified book report

Boekverslag

Waar gaat het boek over?

Wat is het voor een boek?
O stripboek
O voorleesboek
O sprookje
O zoekboek
O informatieboek
O prentenboek
O anders.....

Wat vind je van dit boek?
O leuk
O niet leuk
O te makkelijk
O te moeilijk
O spannend
O saai
O anders .....

Welk cijfer geef je het boek?

Waarom geef je dit cijfer?

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