A Learning Companion for Ben

Concept for a Digital Learning Environment

Zorica Kosztelnik
Industrial Design
Muthesius University of Fine Arts
and Design
Kiel, Germany
zorica.kosztelnik@gmail.com

ABSTRACT

Primary school education is one of the most important investments of a nation. Could advanced technologies increase its success?

Ben is a 6-year-old child who has just finished kindergarten. He is really excited about starting school, choosing his first school bag and meeting his digital learning companion. On what adventures will they embark together? How many new friends will Ben make at school?

The project aims to investigate how the potential of digital learning environments could be used in primary school education. Digital companions encourage children to collaborate and to support each other whilst motivating them by making daily exercises and learning fun.

The author raises the question if we could look at digitality with excitement and curiosity instead of concern. Can we make clear decisions about when digital technologies may actually broaden our horizon and when they have to fade into the background to give space to human to human interactions?

KEYWORDS

artificial intelligence, service design, gamification, digital education, CSCW

1 Introduction

The thesis is a concept for using the potential of digital environments in primary school education. The scope of the project was designing a voice interface-based human-computer interaction and a physical device. Interlinked digital companions encourage children to collaborate and support each other, while

making repetitive everyday exercises playful by gamifying them.

2 Objectives

The context of the project is the primary school, because the first two classes mean a life-changing experience for children. In this period, they have to earn literacy skills, pick up learning methods and understand how to be a productive member of a community (Sylva, K., 2012). For that, it is essential, that they stay motivated and learn to collaborate and bond with each other. If they do not succeed, their chances in life will get limited, being pushed to the periphery of society as all the later subjects and challenges in the education system build on these skills mentioned above. (Ramseger, J., 2018)

3 Methods

3.1 Research Methods

A week-long internship at a primary school allowed a better understanding of the context of the subject. The methods of naturalistic observation and shadowing were chosen in order to avoid any distraction of the people, whose work and interaction has been observed during the research. The findings have been documented in the form of a daily journal, as due to the respect of the privacy of the school personnel and children no recordings or photographs were allowed.

Figure 1: Observing dynamics in the classroom

3.2 Design Methods

The design itself is a holistic concept, which was developed following the human-centered design guidelines. During the evaluation of the current situation of primary school education, the solution has been worked out with the close involvement of teachers. The final product was created in a participatory design process: all concepts of the ideation phase have been reviewed by multiple teachers and iterated in the design phase.

4 Findings

4.1 Peer Groups

A certain dynamic can be observed in the classroom regarding the gender-based distribution of the pupils. The groups show a high adaptation of gender-related social expectations. Also, children with similar skill levels and behavioral patterns tend to seek the company of each other. If they are allowed to decide on their own, they tend to form groups within their own skill level rather than working together within mixed groups. These social constructs are also extended to the breaks between lessons. Interactions between individuals with different profiles would be desirable, as that would enable them to pick up new skills and behavioral patterns. However, the lack of communication between different character types results in homogenic groups, which rarely interact with other groups.

4.2 Group Work

Teachers emphasize the importance of group work because explaining content to each other is an opportunity to stimulate the transference of content from the short-term to the long-term memory of the children. Furthermore, the behavior of peers has a strong shaping effect on a child's actions. Learning new behavioral patterns can easily happen by seeing how others respond to situations, and by observing another person getting a positive reinforcement for his actions.

Facilitating group work can often be challenging, particularly in large classrooms with many groups of pupils working simultaneously. Children often get distracted and carried away by playing games instead of concentrating on the instruction material. In such cases, the role of a moderator remains mostly unfulfilled if a teacher does not interfere.

4.3 Discipline

In order to successfully work together with this age group, supervisors need to impress children with their self-confidence. This requires a proper tone of voice, a certain volume as well as a secure appearance.

4.4 The role of routines

Rituals play an important role in the education of children. Daily routines, such as packing their schoolbag silently while a certain song is played teach them a feeling of schedule and proper behavioral patterns which they should apply in certain situations. Using specific gestures when learning the alphabet helps them to memorize content with the help of their muscle memory.

4.5 Sensorial Experiences

The application of the principles of the Montessori education theory could be observed in the classroom. The usage of instruments as well as other sensorial materials (simple objects, which have a limited number of characteristics) help children in identifying different characteristics of objects and sorting them by characteristic features. Exercises with such material are integrated in the daily life of the pupils. This serves that they learn how they can create an inner order out of their perceptions. These perceptions are: the sense of seeing, sense of touch, sense of taste, sense of smell, sense of balance, sense of hearing and sense of temperature.

4.6 Motivation

The observed school follows the principles of inclusion, so children with varying needs have to get the best out of their skills. It is essential that they do not lose motivation and for that they must be able to enjoy themselves and experience success while doing the exercises. When learning to write, most children face the difficulty that even holding a pen requires certain fine-motor skills. These skills can be trained over time but require long hours of practice. The investigation showed that children can be easily motivated if they can present something they excel at. Even a child with behavioral disorders would show discipline if he could stand in the spotlight as the main protagonist of the stage play of the theater group. Pupils, who did great in sports but poorly in reading, would avoid latter and invest more energy in improving their running skills.

Figure 2: Different characters of the observed primary school, working out the personas

4.7 Most problematic scenario

The all-day supervision and working on their homework present the children with the highest challenge. In order to learn content and earn skills, repetition and practicing of the content is essential for succeeding at school. However, it is also the least appealing activity for the pupils as they experience it as a lonely and boring activity. If they do not manage to do the obligatory

tasks in this period, they will not acquire the necessary knowledge and skills on which further school content is based.

5 Theoretical Context

Digitality means the condition of living in a digital culture, which refers to a culture that has emerged, or is emerging from the use of computer networks for communication, entertainment and business. For the purposes of this study, the description of digital culture from Allert, Asmussen and Richter (see Allert et al., 2017) was used as a framework for creating a hypothesis for a possible future scenario of primary school education: in public discussions digital culture is mostly referred to as digital media and technology applied in the form of tools. But the concept of Allert, Asmussen and Richter describes digital culture in connection with education as a „profound entanglement of person, digital technology and society. These technologies change our horizon of experience and perspectives, therefore change us and our collective coexistence" (see Allert et al., 2017). As part of the thesis an expert interview took place in May 2018 with Prof. Dr. Heidrun Allert on the topic of a possible concept for a digital learning tool and digital learning environments applied at primary schools. An interesting conclusion of this interview was how computer supported learning environments are mostly pictured as the interaction between a person and a computer where the learning effect comes from their interaction. But the research of Scardamalia and Bereiter has already proven that it is much more effective if the computer is used in the collaboration of the people where the interaction is among all, but the learning effect comes from the collaboration of the persons (see Scardamalia, Bereiter, 1992). This defined the main objective of the thesis: the involvement of the digital component in the collaborative work of the pupils.
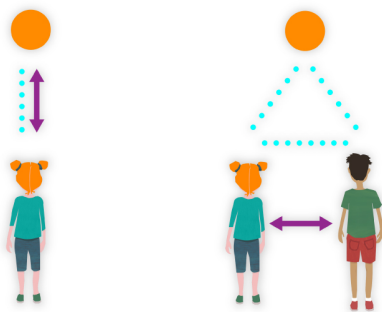

Figure 3: application of AI in working alone and in collaboration: interaction (blue) and learning effect (purple)

6 Design

The concept aims to bring together pupils who have different skills, often children who would not form a group otherwise, so a permanent exchange between varying peer groups is supported in this learning environment. This enables them to gain skills and knowledge through the collaboration with their peers.

6.1 Service Design Concept

The successful initial contact with the learning environment is provided by a ritual which carries pedagogic value. The enrolment has a special meaning for the pupils with the school cone and the choosing of their new school backpack. Therefore, the concept includes a ritual which integrates the learning companion into the everyday life of the children and becomes another event to wait for, which makes school even more exciting and appealing to them.

Figure 4: Introducing a new ritual in the first grade

On the enrolment day all the first-graders arrive to their future classrooms, where they have to do exercises at different stations. These involve using their senses while choosing their preferences, which leads to the selection of a story fitting to their individual character. After they completed the five steps of the selection, a fitting story will be chosen for them and a device in a matching color combination will be handed to them. The first settings of the AI which are the same for every child will be done by the technicians of the school, the individual ones will be done by the teachers. The core idea is, that the device contains a lost creature, which will need the help of the child to discover its identity and story by working through the instruction material. There are approximately fifty stories in the beginning, written by writers of children's books. They will not be available on any other platforms but through the learning sessions with the devices. The learning companions with their stories will accompany the children for two years on their journey to learn literacy language. Every child has a different creature with a different story.
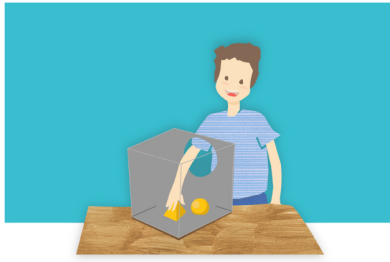
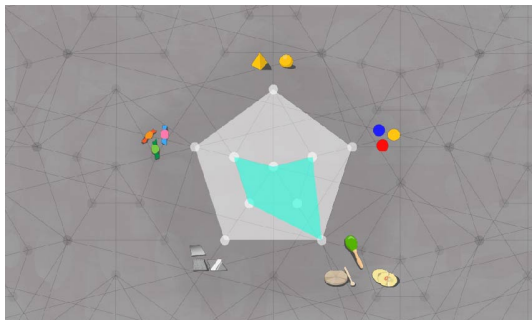**Figure 5: Ben using his senses in the selection process**

Figure 6: Out of his preferences, the algorithm chooses a fitting story for Ben

6.2   Main Field of Application

The all-day supervision and the doing of homework were chosen as the main field of use for the devices. The aim was to create scenarios where children are not alone but with peers, still in a moderated situation where the AI interacts with them in unexpected ways to keep them alert and concentrated on the tasks. For instance, it directs the attention on the story they have to read by asking questions or expressing curiosity: "What does chocolate cake exactly means?", "Let's read on, I want to know what happens in the story!".

Figure 7: Reading exercise in group work, facilitated by the companions

6.3   Interaction Concept

The device can scan, what the children read and write through its camera as well as project content. It is connected to the server of the school, so it can be controlled by the teachers and the voice interaction is easily provided through a service similar to the Alexa Voice Services: the device records what is being said and sends it to the server where it gets evaluated. The corresponding response will be created by the algorithm on the server and sent back to the device, which communicates with the pupils. A challenge in designing voice interactions is that they are based on the very human and natural interaction of speaking, so they potentially include indeterminacy. Digitalization requires systems which can assign numeric values to analog phenomena and break down processes to a chain of distinguished steps. (Allert et al., 2017) This gets more complicated if one has to deal with such unpredictable processes like voice interaction. One object of the project is to design a digital learning tool that mostly communicates through voice interaction. Algorithms are used to control these processes in a way that an efficient information gathering is matched with a delightful user experience. The concept is based on the assumption that a voice recognition technology is available, with which the construction of such interfaces is possible if proper principles regarding the nature of the interaction are presented.

6.4   Function

A child can switch his/her device on by shaking it, but the periods of the day when it is allowed to be switched on are defined and set by teachers and parents together. The sensors on the case ensure, that the device cannot get switched on in the dark, for example in the backpack. The devices are preferably used in collaboration: two or more children join in a group and work together. This can happen in two scenarios: either some of them have to explain things to the others or they do homework or exercises together in a situation where teachers can or want to give limited supervision, thus enhancing the autonomous learning of pupils. In these cases, the pupils have to stack them on or next to each other by using the pre-defined stacking joints. The devices can detect through near field communication, that a group work with certain participants is going to take place.

6.5   Routines

The companions are included in daily rituals. This manifests in routines which involve sound effects and physical activities, such as connecting two devices by stacking them together or shaking a device to switch it on. These physical gestures are supposed to prepare a certain mood or alert atmosphere when the children start the work with their companions.

6.6   Motivation

The concept uses gamification to restore the motivation of the children: the stories of their companions are waiting to be discovered by them. If they do their daily tasks, they are rewarded with new information about the creatures and unlocking new adventures. It is part of their homework routine,

that in the all-day school supervision they choose a partner to learn with and after finishing the reading tasks, they have to complete a short game where they compete with their AI and with other children. In such examination situations a companion embodies an avatar, so the performance pressure of the child can be reduced, still it can be proven if they understood for instance the content they had to read. The companion makes mistakes, just like the children themselves. Sometimes it asks for help or asks questions, so the owner feels like he can teach it. This aims to boost their confidence, so they stay motivated. While performing writing exercises, the conflict between precision and speed is a frequent problem because pupils try to compete with each other in speed but the precision lacks most of the time as a result. This attitude should be improved with games. For instance, they follow a path on the paper with their pen, so that they guide a certain character through a labyrinth in order to collect items. In the meantime, the AI can give them tips, how they should hold the pen. The winner is not the fastest one, but the one who does it more precisely.
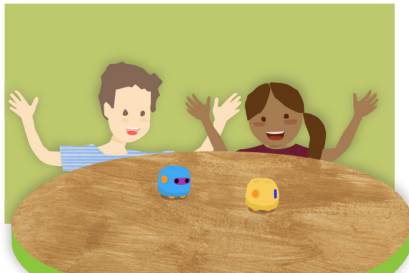

Figure 8: Examination situation

6.7 Improving Group Dynamics

The AI takes a moderating role and helps children to stay focused. It gives hints how to go on with the exercises and expresses disappointment when the pupils lose their self-regulation. The companions encourage children to choose varying partners for the group work and ensure that the groups are mixed through from time to time. Therefore, they will get used to that there is no need for selecting their peers based on gender or skills, as they can all contribute equally to the work, and every person can bring in special skills in different topics.

Figure 9: Writing exercises with the involvement of the companions

6.8 Hardware

The device is designed for children at the age of 6-8. The housing, carrying the circuit board and the battery, is therefore durable and its visual appearance is suited for the expectations of children of this age, communicating high quality in its look and feel. It fits in the palm of a child, so they can easily take it anywhere with them. It has a camera built in the front which can record in a limited field of vision, therefore avoiding recording sensitive information such as the picture of children. The projector and loudspeaker are also placed on the front, because the device communicates with the children by projecting instruction material and by voice interaction. The shape includes joints on the top, bottom and sides, so the devices can be stacked horizontally and vertically, allowing multiple children to work together.

Figure 10: Horizontally and vertically stackable hardware, which enables group work

6.9 Assistance for Teachers

Monotone and repetitive tasks are completed by the algorithm. A function for providing relief for teachers from paperwork is included in the concept: reports can be produced by the algorithm, as the devices can scan the written content children produce day by day on the lectures. Reports will be made only on the learning progress of the pupils and they will be screened by teachers who can extend, correct or delete them before they get transferred to the records. It is a system similar to the student record files, which earlier existed on paper and lately have been digitalized and moved onto the school's own server.

6.10 Handling of Sensitive Data

The requirements of the networked system were designed to allow a thoughtful integration of a digital environment into primary school education, as the interaction patterns are designed for encouraging collaboration between the children. The required data is stored exclusively on the encrypted school server, which is comparable with the current practice of school catalogues.

6.11 Restrictions

Correction of speech defects is not included in the concept, because it could raise logopedic issues, but the device motivates

children to speak louder and clearer, because if they get used to it in small group sessions, it would act as a confidence booster making reading in front of the class less intimidating.

The possibility of offering mentoring by the digital environment to children with special needs was excluded because it involves psychological and pedagogical aspects which did not fit in the scope of the project.

The function of disciplining is only partly involved in the project. The reason for that is, that there is a tolerance effect, which has been experienced when a new method was introduced to discipline children in the classroom. The authority and presence of a supervising person cannot be replaced by a tool or an environment giving automatic reactions to false behavior of the children, as it can appear as predictable for the pupils. Although the everyday disciplining is not purpose of the project, working against the occurrence of tolerance with a level-based system known from computer games, only applied as positive reinforcement is intended. This means there are always new stages a pupil can try to unlock through completing the actual one. As they do not know, what is waiting for them on the next stage – in the next chapter of the story of the companion – they stay excited about it and get curious which motivates them to go on with the process.

7   Conclusion

Designers have the responsibility to provide concepts and designs which fulfill the needs of the end users. This requires close observation of the context and the persona. It is often challenging to create a research concept which allows to map out every requirements and possibilities. When children are involved in a project, it makes it difficult to define those requirements as testing concepts and ideas with them is different from working with adults. The method of shadowing worked out well in this case and allowed for collecting a large amount of observations which served as guidelines for the design. As a proof of concept teachers gave feedback on the design in different stages, but further testing with simulated digital companions is planned.

As a result of the thesis, principles for designing digital learning environments for children at the age of 6-8 were defined:

1. Encouraging collaboration between children is the most essential benefit which should be aspired. This can happen by providing moderation of group work, allowing the pupils to learn from each other.
2. Digital learning environments unlock new possibilities in creating and restoring motivation of the children as they offer gamifying aspects by including levels which can be unlocked, as well as an alternative to conventional examination situations by providing an avatar for the children. If the avatar shows imperfection, pupils can take the role of a teacher and lecture it, therefore gaining self-confidence while acquiring and enhancing knowledge and skills.

3. Certain restrictions have to be defined in order to create an environment suitable for children: unnecessary distraction should be avoided through controlled usage periods.

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The illustrations were made by the author.

Zorica Kosztelnik is a designer of digital experiences, supporting brands to discover and unfold the potentials of their digital product portfolio. Working in collaborative teams, providing expertise in creating sensational user experiences for the human machine interaction and shaping strategic visions to tackle the challenges of the digitization. She currently works on a range of projects at HID Human Interface Design GmbH in Hamburg.

In 2018 she completed her Bachelor of Arts Degree in Industrial Design with a focus on user experience design and holistic concepts involving user experience, product and service design at the Muthesius University of Fine Arts and Design in Kiel, Germany.

She is fascinated about envisioning digital futures and transforming them into company and institution strategies - always with the focus on people.