Videoconferencing as an educational intervention for children with autism

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Videoconferencing as an educational intervention for children with autism

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Summary

Autism is a developmental disorder characterized by impairments in communication, imagination and social interaction. Furthermore autism is often accompanied by an abnormal sensitivity to sensory stimuli. Children with autism often have difficulties attending school, because they need a calm and safe learning environment where the level of social and sensory stimuli is easy to control. It is important to prevent that these children drop out of school and become involuntarily homebound. A conjunction of specialized pedagogical knowledge and modern technological resources could be helpful in improving the quality of education and the prevention of homebound children, therefore Eindhoven University of Technology, the Verschoorschool in Nunspeet, and Webchair B.V. started a joint project.

For this project we worked with the Webchair videoconferencing system that was specifically designed to link hospitalized, homebound or autistic children to their school classrooms. Although the use of videoconferencing as a communication- and educational tool has not enjoyed much scientific attention yet, there are several reasons why such technologies may offer distinct advantages for teaching children with autism. Videoconferencing can be used for distance education of homebound children or as a temporary appliance when a child is suffering from social or stimuli overload in the classroom. This technology permits the development of skills in a predictable and controlled environment, while simultaneously allowing a child to work at his/her own safe place.

In this project we used a combination of qualitative and quantitative research methods (observations, interviews, user experience tests) to gain insight into the acceptance, use and effects of the Webchair system on both students and teachers. Findings showed that the Webchair system can be used to help children who are homebound or have learning difficulties. Children quickly grew familiar with the system and felt connected with their classroom. An analysis of the Webchair lectures (n=20) showed that children were well focused on the lecture. Furthermore, a comparison analysis (n=3) between a Webchair lecture and a lecture in classroom showed that students paid more attention to the lecture and that the periods of disruptions were shorter when working with the Webchair system. However these results must be carefully evaluated. Children with autism generally feel very positive towards technology and for this reason may have given little weight to downsides to and problems with the system. Furthermore, integrating videoconferencing technology in the curriculum takes some effort from both teacher and students. Despite the small sample of this research, promising results were obtained both in terms of user acceptance, as well as academic achievement. In comparison to earlier work, we have demonstrated that video conferencing can have a useful role in educational settings.

Preface

After a period of hard work the moment is finally there… I am writing the preface. And even though it is the first thing you will read, it actually marks the end of this project for me. With this thesis I will complete the master Human-Technology Interaction at the University of Technology in Eindhoven. It has been a period of hard work, but I enjoyed working on every part of it.

This thesis and this experience would not have been the same without the help of many people. First of all, I want to thank Wijnand IJsselsteijn and Yvonne de Kort, my supervisors from the TU Eindhoven, for their support, supervision and useful insights during this project. I also would like to thank the Verschoorschool in Nunspeet for giving me the opportunity to execute this research and for trusting me in this project. They welcomed me with open arms and assisted me in my research wherever they could. Thank you Marie-Louise Courtens, Susanne Bruning & Ton Harms. I greatly enjoyed my stay at the Verschoorschool. Furthermore I would like to thank Graham Smith from Webchair for his guidance during the project and for always being enthusiastic and optimistic about the outcomes of the project.

Besides having a pleasant work environment in Nunspeet, I also enjoyed working at the university where I was in the lucky position of sharing my office with friends. Thanks Joyce, Mirjam and Tom for all the good times, I am sure I am going to miss our pleasant (hard-working) days together. I want to express my gratitude towards Tom for all his love and patience, for cheering me up and giving me all the help and support I needed. Last but definitely not least I want to thank my parents for supporting me in everything I do and for giving me the opportunity to become what I am.

I worked with great pleasure and enthusiasm on this project, hoping to make school life just a little bit easier and fun for children with autism.

I am proud on the work presented in this report, and I hope you will enjoy reading it!

Marlies Wesselink
Eindhoven, September 2012

Contents

1. Introduction

It is very undesirable that children drop out of school. According to last year's research of Ingrado (National Dutch association that secures the right for education) there are on a daily basis approximately 800 to 1100 children at home instead of being at school (Ingrado, 2011). Due to a discrepancy between the pedagogical needs of the child and the pedagogical capacity that a school can offer, this often leads to children who drop out of school and are involuntarily homebound. Behavioural problems (20.8%) and psychological problems (17.6%) are the main reasons for this drop out (Ingrado, 2009). In these studies, there is no specific distinction between the different forms of behavioral and psychological problems, so no clarity can be given about the number of sitting young people at home with autism spectrum disorder. Children with autism deal with many emotional, cognitive and social challenges in their lives and are known to be extremely sensitive to contextual stimuli such as sound, lighting and other people. This makes it harder for them to cope with the normal life, also on an educational level. These students need extra guidance during a normal school day and therefore children with autism often go to schools dedicated to special education.

The inclusion of children with special educational needs in schools has recently received a lot of attention due to proposed cuts in the educational system in the Netherlands. The Dutch government is considering the abolition of the personal budget for children with special educational needs *(Dutch: het zogenoemde rugzakje, een leerlinggebonden financiering).* The increased prevalence of children diagnosed with Autism Spectrum Disorders (ASD) has led to a need for educational interventions that will decrease the current constraints in educating children that are afflicted by ASD. One in five children with autism has at some point been excluded from school, and 67% of them have been excluded more than once (Batten et al. 2006).

A conjunction of specialized pedagogical knowledge and modern technological resources could be helpful in the prevention of homebound children, therefore Eindhoven University of Technology, the Verschoorschool in Nunspeet, and Webchair B.V. started a joint project. The goal is to explore to what extent technological interventions could be helpful in the supervision, rehabilitation and reintegration of these children in their regular classroom.

During this research we worked with the Webchair system. Webchair is a videoconferencing technology designed to link hospitalized, homebound, or autistic children to their school classrooms from a remote site. In this project we used a combination of qualitative and quantitative research methods (observations, interviews, user experience tests) to gain insight into the acceptance, use and effects of the Webchair system on both students and teachers.

2. Theoretical Framework

2.1 Introduction Autism

Autism, also known as autism spectrum disorder (ASD), is characterized by impairments in communication skills and social behaviours (American Psychiatric Association, 2000). Furthermore, autism is often accompanied by an abnormal sensitivity to sensory stimuli. Autism has a neurobiological origin in which hereditary factors play an important role. How often a disorder in the autism spectrum occurs is difficult to say. Different studies are using different definitions and criteria, numbers therefore vary between 40 and 98 per ten thousand (Landelijk Netwerk Autisme, 2003). According to recent research, roughly 1% of the entire population is diagnosed with Autism, whereby there is a gender misbalance of four males to one female (Roelfsema et al. 2011). Moreover some geographical areas are overrepresented, which could be related to specific characteristics of these areas, such as ICT-intensive industry (Roelfsema et al. 2011).

As a spectrum disorder, autism manifests itself in many different ways; the spectrum ranges from children with severe mental disabilities and speech impairments to high functioning children with above-average IQ despite impaired language use and inadequate social skills (Muhle, Trentacoste & Rapin, 2004). Every child is unique and manifestations of the disorder vary greatly depending on the developmental level and age. However, children with ASD have marked impairments in three behavioural domains known as the ‘triad of impairments’: 1. social interaction; 2. language, communication, and imaginative play; and 3. restricted and repetitive interests and activities (American Psychiatric Association, 2000). By autism (the autistic spectrum disorder), we mean the wide spectrum of pervasive developmental disorders. Within the spectrum 5 subtypes can be distinguished: 1. autistic disorder (classic autism), 2. Asperger disorder (language development at the expected age, no mental retardation), 3. disintegrative disorder (behavioral, cognitive, and language regression between ages 2 and 10 years after entirely normal early development, including language), 4. pervasive development disorder not otherwise specified (individuals who have autistic features and do not fit any of the other subtypes), and 5. Rett disorder (a genetic disorder of postnatal brain development, caused by a single-gene defect predominantly affecting girls) (American Psychiatric Association, 2000). Besides the disorder in the autism spectrum often additional related problems occur like dyslexia, Tourette syndrome, mental retardation and neurological problems (e.g. epilepsy) (Landelijk Netwerk Autisme, 2003).

Children with ASD differ in their way of information processing. In addition to the impairments in the interaction, communication and imagination, children with autism often have abnormal stimulus sensitivity. As said, no individual with autism is the same, so neither are their perceptual experiences. However, some perceptual phenomena are very typical. People with autism have difficulties with interpreting a sensation and are vulnerable to sensory overload (Bogdashina, 2003). They have an inability to distinguish between foreground and background information and are often hypersensitive. Hypersensitivity means that the person receives too much stimulation, which the brain cannot handle. Some autistic people seem to be hypersensitive when they are approached directly by other people and

others may actually understand you better when they are not looking directly at you (Bogdashina, 2005). Autistic children often seem to focus their gaze at background items and appear completely absent from the scene, which is an attempt to avoid experiencing visual or auditory stimuli directly. This strategy gives them the ability to take in sensory information with meaning. Avoiding direct perception is an involuntary adaptation they use to help them to function in a sensory-distorted world by avoiding (or at least decreasing) information overload.

Although a high percentage of children diagnosed with Autistic Spectrum Disorders possess above -average intelligence, they are often constrained from participation in traditional learning environments by their inability to communicate directly with others, lack of control of their emotional state, or inappropriate social behaviour (Hertz-Picciotto & Delwiche, 2009). To summarize; the interaction with children with autism can be characterized by having little or no eye contact, absence of speech and the inability to be in control of their own emotions. The increased prevalence of Autism Spectrum Disorders in children aged 3-12 has led to a need for educational interventions which will decrease the current constraints in educating autistic children.

2.2 Autism and Technology

The use of technological interventions for individuals with ASD particularly aimed at the social or communication deficits of the disorder is promising. Individuals with ASD often have relatively strong visual processing skills and a predilection towards electronic media (Shane & Albert, 2008); thus it is likely that technological interventions would be particularly appropriate and motivating for children with ASD. Earlier studies reported that autistic children show a high interest in computer programs and videotapes. A study by Shane & Albert (2008) supports this; they found that children tended to engage in interaction with media instead of other play activities when given more leisure time.

For many years however, the primary role of technology in ASD intervention was limited to the use of videotapes for instructional video modelling (Wainer & Ingersoll, 2010). Though this may be an effective way to teach skills to children with ASD, the current potential of technology extends beyond video modelling to areas such as interactive computer programs, virtual reality and telepresence display technologies. The use of computerized intervention permits the development of skills in a predictable and controlled environment, while simultaneously allowing an individual to work at one's own safe place. This setting might be particularly beneficial for children with ASD because they often experience discomfort with unpredictable social environments (Wainer & Ingersoll, 2010). Moreover, research by Pascualvaca and colleagues (1998) showed that using computerized assessments and feedback can also affect the behavioural performance of children with autism. They used several computerized and non-computerized tasks and found that children with and without autism performed equally well on computerized tasks, children with autism however performed significantly worse on non-computerized task compared to children without autism. The authors suggest that social/motivational factors could be responsible for the

effect, because children with autism might prefer to receive feedback about their performance from a computer rather than the examiner. These findings show that both the format of the task and the nature of the feedback may have an important impact on performance for people with autism.

Recent work of DiGennaro Reed, Hyman & Hirst (2011) explored studies using technology-based social skills intervention to teach children with autism. Their results support the claim that technology can be used as an intervention tool to teach social skills. However, there is a lack of research focusing on the efficacy and efficiency of the use of technology, particularly within schools. It would be interesting to quantify the cost-benefit ratio of technological interventions as a learning tool. In specialized education, there is a trade-off to be made between the advantage of a safe learning (digital) environment and its potential side effects. Too much interaction with technology may limit direct interaction with real persons. However, it is evident today that the use of internet technologies is more and more integrated in our daily lifestyle. Despite the challenges an increasing number of institutions have come to realize the potential impact of using the internet in the classroom as part of the learning environment (Saadé, Nebebe & Tan, 2007).

A model developed specifically for explaining and/or predicting user acceptance of computer technology is the technology acceptance model (TAM; Davis, 1989). The model addresses the issue of how users come to accept and use a technology. Figure 1 shows the TAM. According to the model there are two specific variables; perceived usefulness (PU) and perceived ease of use (PE), which are the primary motivational factors for accepting and using new technologies (Davis, 1989). Perceived usefulness can be explained as the degree to which a person believes that using a particular technology will enhance one's job performance, thus the benefits the system can offer. Perceived ease of use refers to the degree to which a person believes that using a particular technology will be free of effort (Davis et al. 1989). People want to use a system if they believe they can work more accurately and efficiently with it and if these benefits outweigh the costs of using the system. However ease of use in terms of usability are not the only costs of working with a technology, cost in terms of social issues, lack of physical contact etc. are also costs related to perceived ease of use.

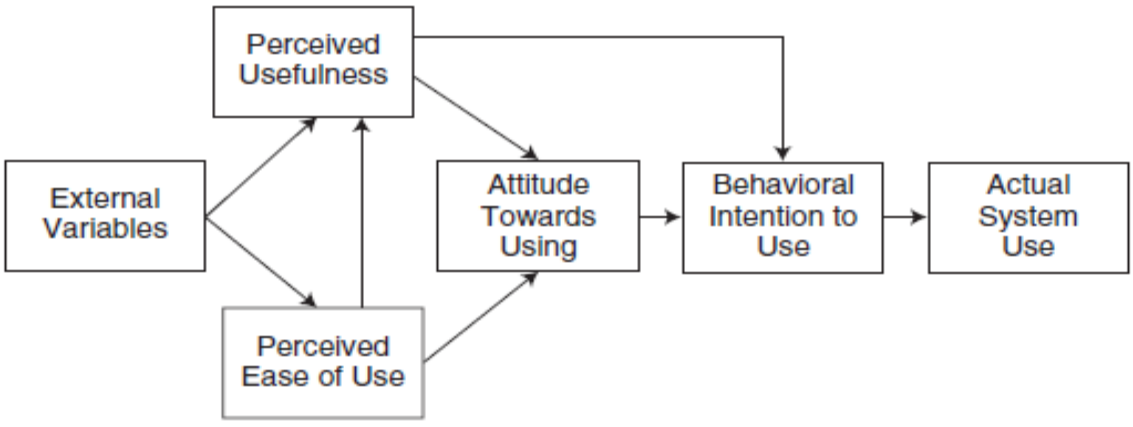


Figure 1 - Technology acceptance model (Davis, 1989)

Furthermore the TAM suggest that the actual use of a system is determined by the users' behavioral intentions to use the system, which is in turn determined by the users' attitudes towards using the system and their perceived usefulness of the system (Saadé, Nebebe & Tan, 2007). Research by Teo, Lee & Chai (2008) suggests that if teachers believe or perceive that computers cannot fulfil their own or their students' needs, they will resist implementing the technology, no matter how sophisticated and powerful the state of technology is. It is therefore important to understand the attitude that teachers hold toward technology and which factors influence these attitudes. Multimedia learning environments and video-mediated instructions offer new possibilities as a synchronous distance education technology.

In this research we focus on special education. Baron-Cohen and colleagues did a lot of research on systemising tendencies in ASD and how this may predict a preference for interacting with, and through, technical systems (Baron-Cohen, Richler, Bisarya, 2003; Golan & Baron-Cohen, 2006). Research of Baron-Cohen showed that individuals with ASD show good and sometimes even superior skills in systemizing (Baron-Cohen et al., 2003). Systemizing is the drive to analyse a system, to construct systems and to derive the underlying rules that govern the behaviour of a system. Systemizing allows one to predict the behaviour of a system and to control it. Individuals with ASD are hyper-attentive to detail and prefer predictable, rule-based environments, features that are intrinsic to systemizing. These characteristics may explain the preference for technical systems. Individuals with ASD favour the computerized environment because it is predictable, consistent and free from social demands which they may find stressful. Furthermore, users can work at their own pace and level of understanding. Understanding the preferences of the potential users may contribute to successful implementation of these technological interventions.

2.3 Videoconferencing as an educational intervention

Earlier research indicated that various modes of interactive distance-learning technologies had a positive effect on instructional and learning processes (Selim, 2005). This research will focus on videoconferencing as an educational intervention. Research of Jung et al. (2006) suggests that videoconferencing technology may provide just the optimal balance between the necessary social and communication skills training through people interaction and the safe environment of a virtual reality absent from the obligations of people interactions. Videoconferencing generally combines video and audio to set up a live connection, so people can see, hear and present as if they were actually in the same room (Selim, 2005). A videoconferencing system must have audio-visual equipment like a monitor, camera, microphone, speakers and a network connection to the internet to transfer the data. Videoconferencing is a synchronous system; this means the system is used at the same time by both teacher and student. In the last few years, more and more institutions have been integrating multimedia learning environments in the classroom. Because of the emerging popularity of this technology there is a need for critical evaluation of videoconferencing education technology in order to (1) justify the existence of videoconferencing technology in distance educational institutions, (2) to improve the videoconferencing mediated instruction performance and (3) to motivate instructors and students to adopt videoconferencing (Selim,

2005). It is important that both teachers and students are willing to adopt this technology, because the use of distance education technology will depend largely on the attitudes of teachers and their willingness to embrace the technology (Teo, Lee & Chai, 2008).

There are some studies that have evaluated videoconferencing as an educational tool (Selim, 2005). However, very little research has been conducted on the use of videoconferencing within the field of autism. There are two studies which used videoconferencing facilities to conduct a functional analysis of challenging behaviour for children with autism (Barretto, Wacker, Harding, Lee, & Berg 2006; Machalicek et al., 2009). They demonstrated that videoconferencing can be used to provide supervision, guidance and provide corrective feedback without being physically present in the assessment setting. However, the videoconferencing system was only used to collect data on challenging behaviour and to instruct the therapist conducting the assessment, but not for the purpose of educating children. Thus, the research proposed in the current project is highly innovative, as it provides a first systematic exploration of the effects of using videoconferencing as an educational tool in autism.

Although the use of videoconferencing as an educational tool hasn't enjoyed much scientific attention yet, there are several reasons why such technologies may offer distinct advantages for teaching children with autism. First of all, children with autism often understand things better if they attend to them indirectly (Bogdashina, 2005); for example, by looking or listening peripherally. Videoconferencing facilitates less threatening visual and social interactions. Gazing directly at people can be too overwhelming for autistic children because eye contact is a strong non-verbal cue to intimacy and emotion. Due to the camera placement on top of the videoconferencing monitor, users will not establish eye contact when looking at the screen. Rather, they will see a downward pointed gaze, as the camera records that face from an elevated position (Figure 2). This feature, which is intrinsic to many videoconferencing systems, is traditionally regarded to be a technical limitation which needs to be overcome (Divorra Escoda et al, 2010). In the case of autistic persons, however, this limitation becomes an advantage and the child's visual and cognitive connectivity to the classroom environment is supported by the effect of a slightly diverted interactive gaze of the teacher as projected through the videoconferencing camera technology.

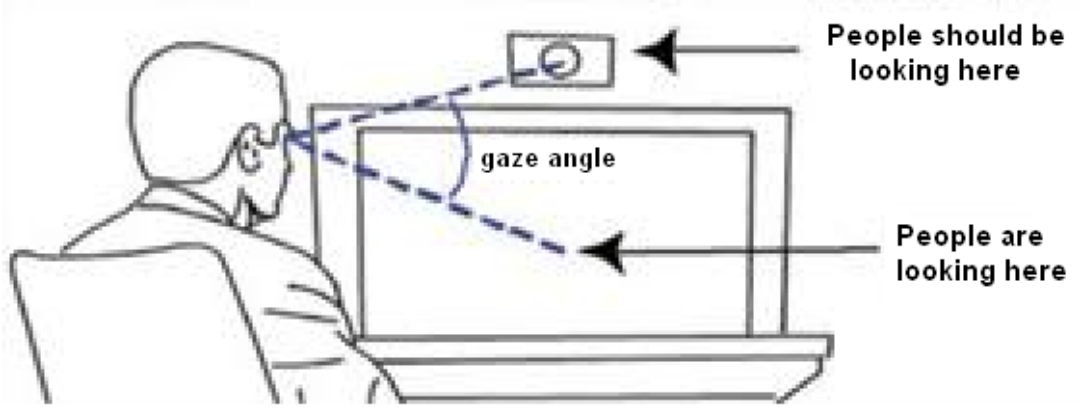


Figure 2 – Lack of direct eye contact in videoconferencing

Furthermore, videoconferencing might be helpful in preventing overstimulation by providing a predictable and controllable environment (Vogel, 2008). When a child can understand his or her environment, emotional security rises and the child feels an increased sense of control. Because children with ASD have specific social challenges, personal space may be more of a priority than for a typically developing child. With the help of a videoconferencing system a child can get used to a social environment without being actually present. The system allows the child to be in control of the situation; he/she can choose were to look, and can for example zoom in on the teacher to prevent overstimulation due to a high stimulus environment in the classroom.

2.4 Study aim

The use of videoconferencing to educate children with autism is a novel field of research. Therefore this study will explore the possibilities, advantages and disadvantages of videoconferencing in teaching children with autism. For this project we worked with the Webchair videoconferencing system which is specifically designed to link hospitalized, homebound or autistic children to their school classrooms. Webchair integrates children with their regular classroom activities by enabling them to function and interact as if actually being in class. This videoconferencing system can be used as a distance education system for children who are homebound, but it could also be a temporarily solution for children who are suffering from stimulus overload in class. The system allows children to learn skills in a predictable and safe environment, while the child is in control of the situation.

The Verschoorschool, a special school for children with ASD, has recently purchased three Webchairs and launched a pilot project together with Webchair B.V. and the Eindhoven University of Technology on the acceptance, use, and effects of the Webchair system for children with autism. The goal of this project is to explore to what extent a videoconferencing system could support the supervision, rehabilitation and reintegration of these children in their regular classroom. The first question is whether video conferencing tools can aid the student in achieving his/her learning objectives while being physically separated from the classroom or even the school. Secondly, can video technology help children to stay connected with their peers and teachers. Thus the focus is twofold; the educational aspect from videoconferencing on the one hand and the social aspect from videoconferencing on the other hand. The aim of this study is to systematically record real-life interactions and experiences with the Webchair system in two phases. The first step will be video observations and small scale in-depth interviews with a small sample of current system users (children, parents, and teachers) in order to arrive at a deeper understanding of the issues at play in using video communication technologies when teaching children with ASD.
The second step will be ‘user experience tests’ whereby a larger sample of autistic students will be asked to work briefly with the Webchair to gain more personal experience regarding the usability and user experience of the system to increase the success ratio of videoconferencing for teaching children with autism.

Research question

The central research question formulated for this study is:

How can videoconferencing tools help to enhance social and educational skills for children with autism?

To answer this central question we formulated several sub-questions:

- How do videoconferencing systems influence student behaviour?
- Will a student perform better / worse when working with videoconferencing?
- How does videoconferencing influence student–classroom interaction?
- What do students and teachers experience when using videoconferencing for educational purposes as strengths & weaknesses?
- Usability: How efficient, satisfying and effective is the use of videoconferencing for educating children with autism?

Research objectives

It is expected that videoconferencing might be a way to educate children who are homebound. Moreover it might provide a more suitable educational setting for specific children by providing a safe, predictable, controllable and attractive environment. However these benefits may not be free of costs; the use of videoconferencing may limit physical and personal interaction and it may take some effort from the teacher as well as the students in the classroom.

In the first study we will investigate whether videoconferencing can be used to help children who are homebound or have learning difficulties. Whether working with the Webchair system might even provide a more suitable learning environment compared to regular classroom education will be answered by the first and second study.

3. Study 1 – Current Experiences

3.1 Introduction

The first study focuses on the current experiences with a videoconferencing tool aimed at providing distance education for children that cannot attend class. For this purpose, the Webchair system was deployed. The aim of this first explorative study is to systematically record experiences with the Webchair. Video observations and interviews will be used to explore for example whether there might be differences in the interaction between teacher and students compared to regular education. Furthermore we will assess the strengths and weaknesses of the use of a videoconferencing system for educational purposes.

3.2 Method

3.2.1 Participants

Two children diagnosed with ASD are currently working with the Webchair at the Verschoorschool. The first boy, Bram[1], is 8 and homebound mainly due to medical reasons. He is diagnosed with classic autism but additionally he is also suffering from epilepsy and haemophilia, which makes it difficult and even dangerous for him to be in an educational setting. He works with the Webchair 3 times a week for 30 minutes. On Monday there are 2 sessions together with the class (math and grammar) and on Wednesday he has a private lesson with the teacher. The second boy who is working with the Webchair is Paul, 10 years old. Paul has difficulties in attending class due to stimulus overload and insecurity and therefore sometimes works with the Webchair from a low-stimulus area somewhere else in school. When he is working with the Webchair he works together with his supervisor *(Dutch: ambulant begeleider)*. Paul attends an hour of geography/world-orientation class on Monday afternoon.
Both boys attend a special school for students with autism. About 12 students with similar disabilities and 2 teachers were present in the classroom during these lectures.

3.2.2 Design

The observational study reported here is a qualitative study. The use of the Webchair was observed for a period of three weeks while the two boys were working with the Webchair. A camera on top of the Webchair recorded the interaction with the Webchair and a camera in the corner of the classroom recorded the total view of the classroom and Webchair. Furthermore, the boys were asked for their opinion by means of a Smileyometer interview. These interviews were carried out by the supervisors of the boys.

[1] Personal traits and characteristics are based on real people, names of the persons are fictive however to ensure privacy of our participants.

3.2.3 Measures

Observations

We used semi-structured observations for the observations. This means we observed using a partly-pre-established coding scheme. The focus of this scheme was primarily on handling and interacting with the Webchair. During the observation the observer coded the direction of the interaction (between teacher and the Webchair student, or from the Webchair student to the other students and vice versa) and the form of interaction (asking questions, listening, being distracted etc.). Furthermore the observation scheme consisted of a description of the behaviour and any examples or effects of the behaviour. The table below shows the coding scheme, with an example from the observations.

Table 1 - Example of observation scheme

Groep: krekels	Les: Taal	Thuis / ~~saferoom~~	Tijd: 11.00
Lesvorm: Klassikaal		Camerapositie: Staat vast, gericht op bord	

Interactie			**Techniek**
leerkracht →	webchair leerling	leerlingen	beeld
			geluid
contact zoeken	vragen stellen	luisteren	problemen
afgeleid worden	actief deelnemen gesprek	anders	cameragedrag ll

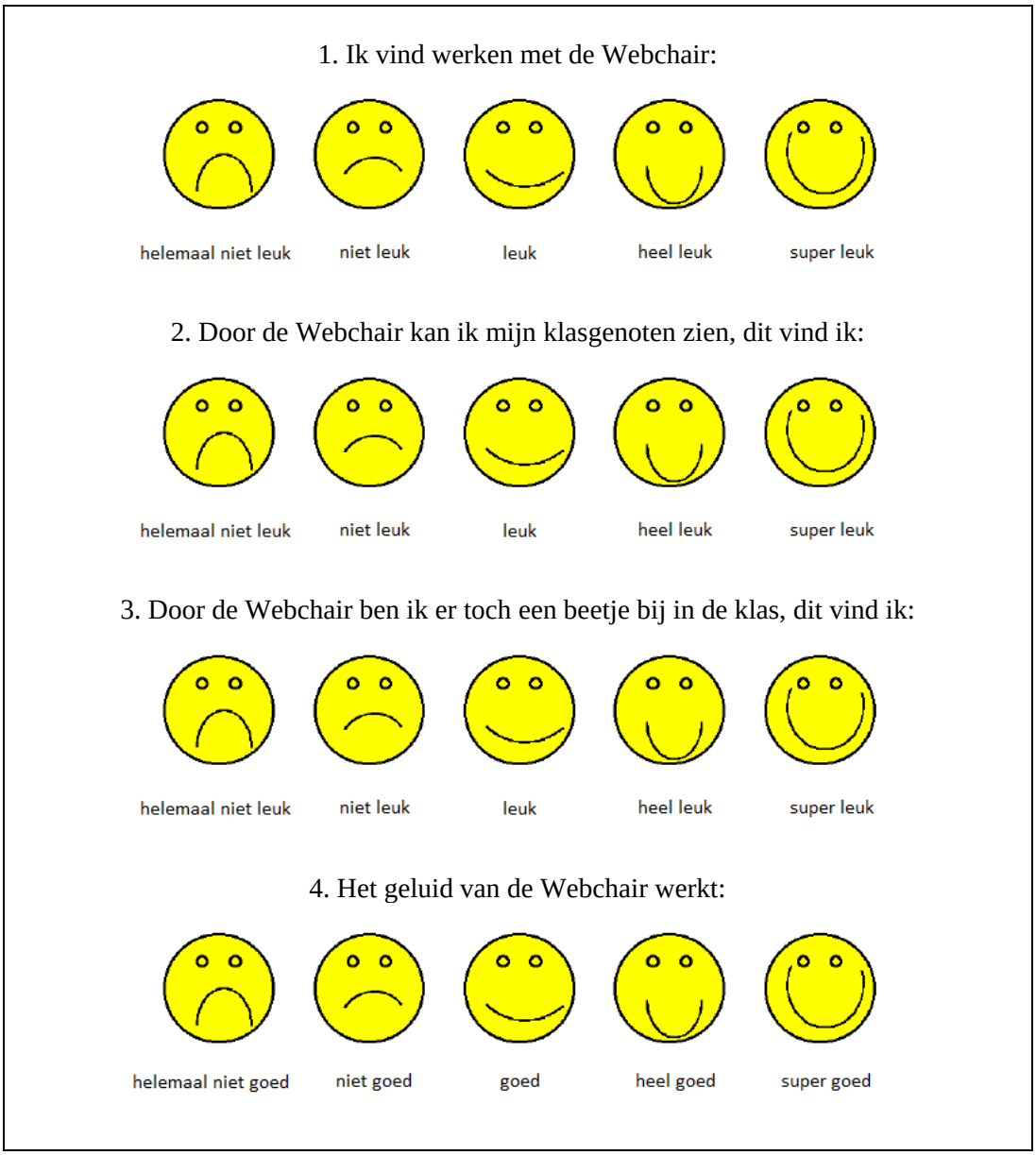
Beschrijving
Leerkracht herhaalt wat leerlingen zeggen voor Bram en vraagt om actief deelnemen van Bram

Voorbeeld / gevolg / effect
“Doe je ook mee Bram?” “Hoorde je dat Bram?”

Opmerkingen
Leerkracht verteld dat Bram erg moe is, omdat hij die dag daarvoor een verjaardag heeft gehad, dit verklaard waardoor jongen veel afwezig is van de les

Interviews

To gain more insight in the experience of the children who have been actually working with the Webchair for 9 months now, we designed an interview in a (autistic) child friendly way. The Smileyometer is an evaluation method that was originally designed with the help of children. Children were asked to make a checkmark on one face to indicate what they thought of a product. This is a very easy tool for children, and it includes textual information to improve the validity (Markopoulos, Read, MacFarlane & Hoysniemi, 2008). In this interview two different Smileyometers were used. See Figure 3 for the interview. The first three questions were about working with the Webchair, and used a like/dislike scale (e.g. When I work with the Webchair I can see my classmates, I find this:). The last three questions were about the technology of the Webchair and used a good/not good scale (e.g., 'The camera of the Webchair works: … '). The interviews were given to the supervisors of the two boys, and they were asked to carry out the interview preferably around the Webchair. This was done because memorability of the system is best immediately after the lecture.



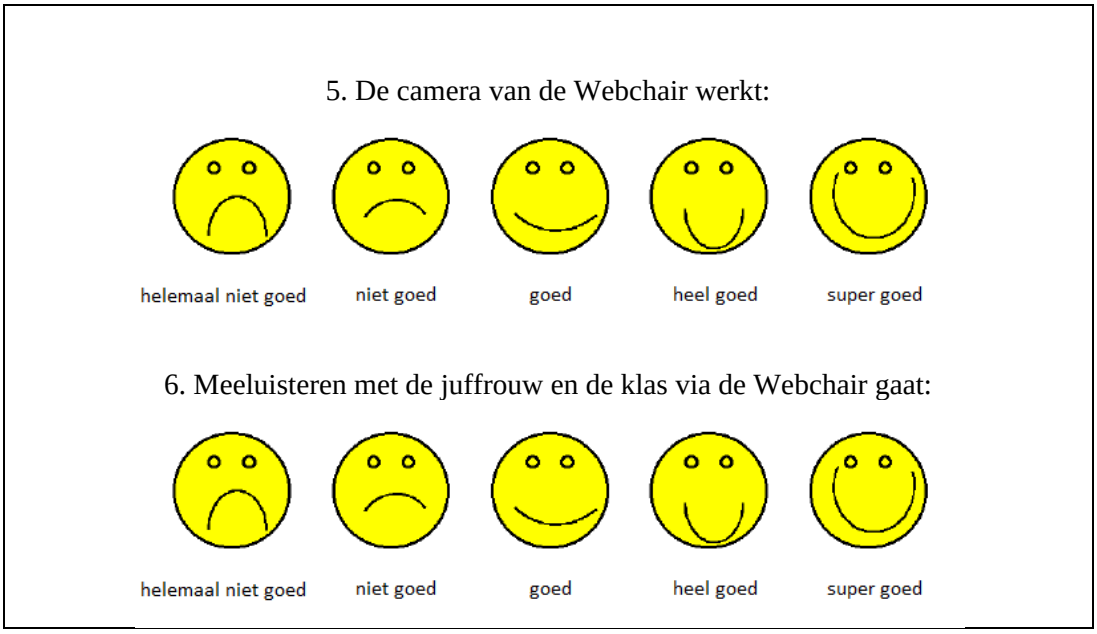


Figure 3 – Smileyometer Interview

3.2.4 Materials and apparatus

For this project we were working with the Webchair videoconferencing system. Controlled by the child at ones remote location (i.e., hospital, home or autism centre), it serves to place the child in virtual actuality of their regular classroom.

The Webchair consisted of two systems; a Webchair laptop at the remote site (L100) and a Webchair portable unit (P300) in the classroom. The Webchair P300 (Figure 4) contained an Apple Mac mini (1.83 Ghz) with Mac OS X operating system, a 19 inch flat screen monitor and a camera. The camera was a Sony (EVI-D100) pan/tilt/zoom colour video camera and is ideal for applications such as videoconferencing, distance learning, conference and training rooms. The EVI-D100 is a high quality CCD camera that combines high-speed, quiet pan/tilt with a wide angle view and 40x zoom (10x optical + 4x digital). Furthermore, it provides features such as auto focus and automatic exposure control which provide fast and stable hands free operation when the camera changes pan/tilt positions. Detailed picture of the Webchair can be found in Appendix B.

The Webchair L100 is a MacBook 13” Intel Core Duo (2.4 Ghz, 2Gb, 250 Gb HD) with Mac OS X operating system. The laptop has a built-in iSight video camera with 640×480-pixel VGA resolution and video capture at 30 frames per second in 24-bit colour.

Figure 4 - Webchair system (left classroom system P300 and right student laptop L100)

Videoconferencing was achieved by using the laptop with internal camera, portable unit with external Sony camera, Skype videoconferencing software and a broadband Internet connection. External microphone (Sennheiser Bodypack Transmitter SK 2 and Sennheiser Wireless Microphone SKM 3) were used to transmit sound from the P300 in the classroom towards the P100 at the remote site. The external camera on the P300 is operated by the L100 via camera control software developed by Webchair (Figure 5). The software allowed the child to change the view of the camera by using the arrow keys on the keyboard and by zooming in (A key) or out (Z key).

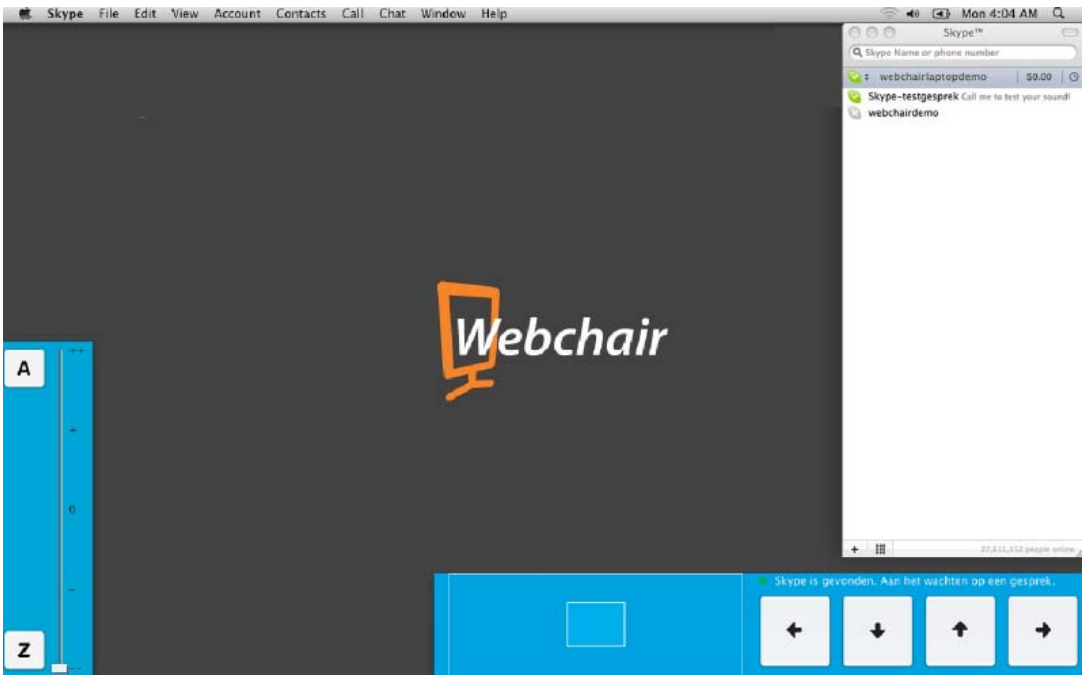


Figure 5 – Desktop Webchair L100

3.2.5 Observation set-up

For the video observations three different measurements were used: First a camera on the Webchair for recording interaction with the Webchair (Figure 6), secondly a camera in the corner of the classroom for observation of the classroom and Webchair (Figure 7), and third the physical presence of the observer in the classroom. Figure 8 shows a schematic overview of the observation set-up of both classrooms. The cameras used for the observations were Sony DCR-SR55E cameras.

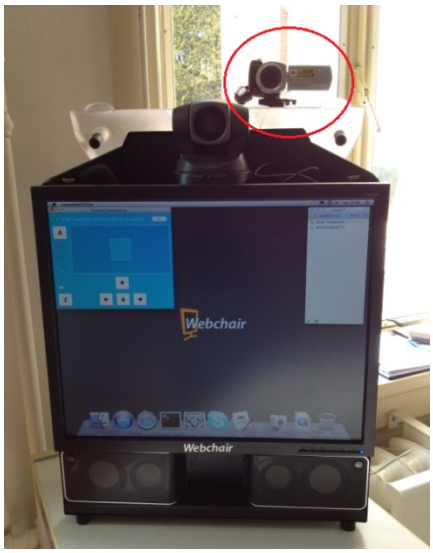


Figure 6 - Webchair view

Figure 7 - Classroom view

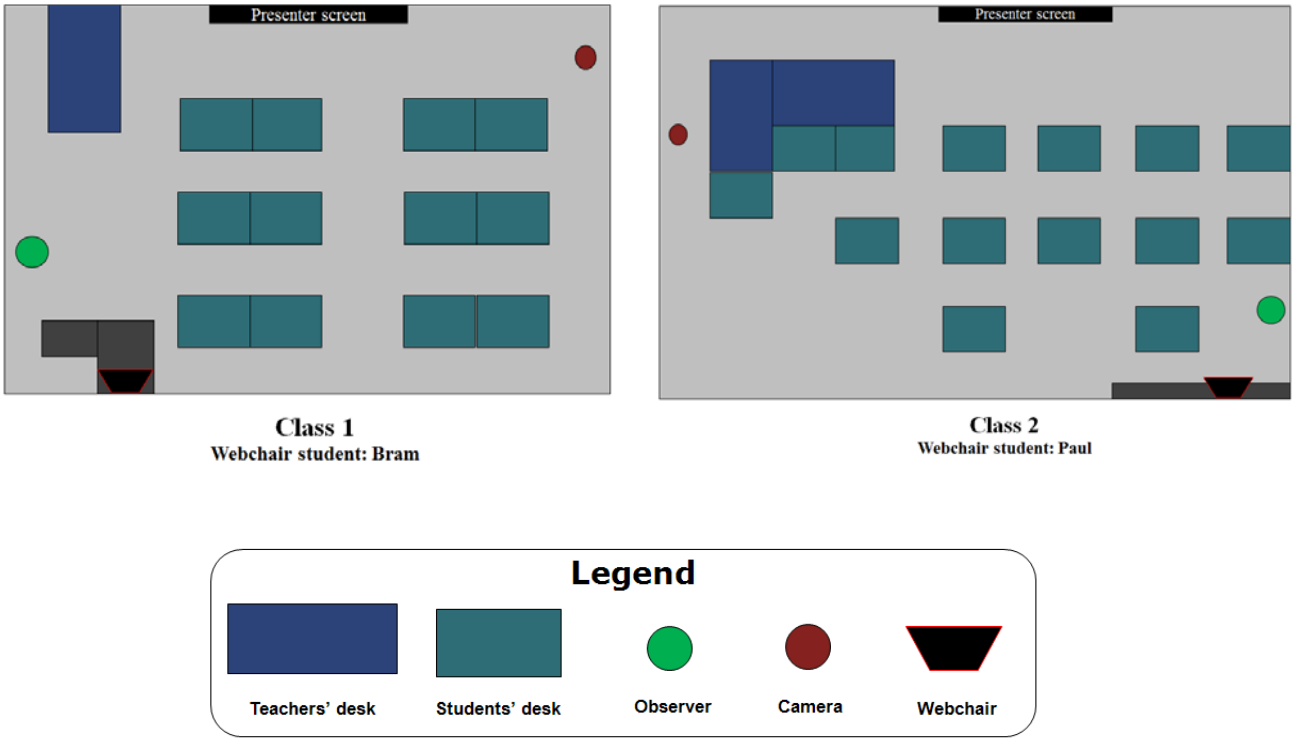


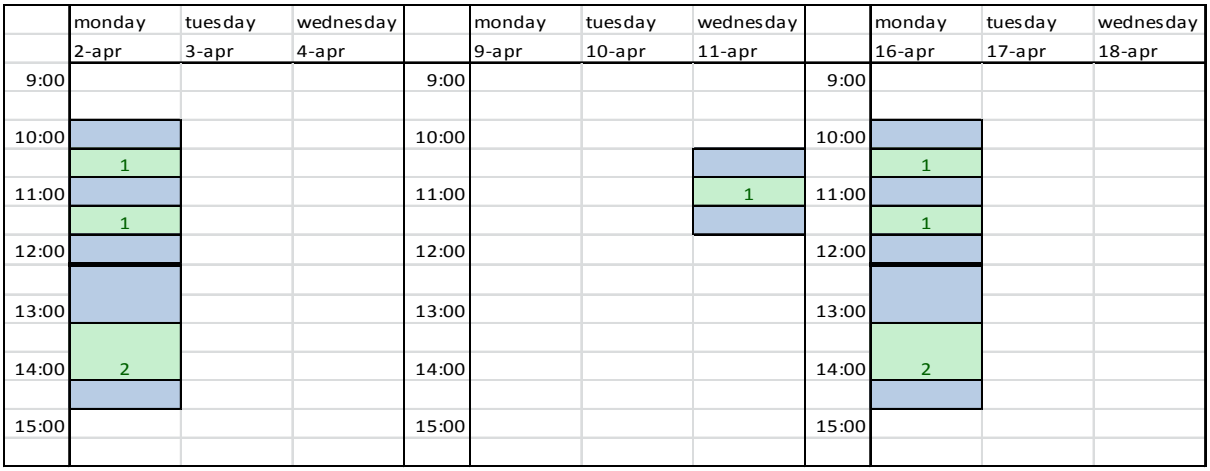
Figure 8 - Schematic overview of observation classes

3.2.6 Procedure

The school board arranged informed consent with the parents to allow video recordings in the classroom. Furthermore the researcher and teacher spoke with the parents of the two boys to inform them about the purpose of the study and the use of the video recordings. Additionally the school board and the University signed a form to declare that all data would be treated anonymously and confidentially.

Both boys attended lectures on prearranged timeslots. During these timeslots the cameras and observer were present. The observer was already introduced the week before, and the children were told the observer was present because of the Webchair. Both teacher and children were told not to pay attention to the camera. The table (Table 2) below shows the observation time schedule, the blue boxes indicate the timeslot of the observations and the green boxes indicate the timeslots during which the Webchair was online.

Table 2 - Observation data



On Monday and Wednesday morning the observer and cameras were present in Classroom 1 where Bram was working with the Webchair. On Monday afternoon the observation took place in Classroom 2 where Paul was working with the Webchair. There were three days of observation with Bram and the Webchair; two of them were together with the class and one individual session. There were two days of observation with Paul, together with his class. During these observations the two cameras recorded the classroom and the observer sat in the room with the observation scheme to write down the proceedings. After the observations the observer talked with the teacher to check whether there were any unusual events. On the last day of the observations the observer gave the supervisors of both boys the Smileyometer interview. Bram's interview was carried out by his teacher after his individual session on Wednesday and Paul's interview was carried out by his supervisor after his Webchair lecture on Monday. Afterwards the interviews were sent back to the observer.

3.2.7 Data analysis

The video recordings of both the Webchair view and classroom view were analyzed together with the observation schemes. Events and additional quotes were reported in chronological order with timestamps.

3.3 Results

Setting

The first class was the class of Bram. Bram was working from home together with his mom. Although there were clear appointments regarding the Webchair lectures, Bram's mother sometimes forgot the lectures. To make sure Bram was online for the observations, the teacher called Bram's mother. Before the children arrived in the morning the teacher turned on the Webchair. On Monday morning the day started with a group session during which the children talked about what they did, ate and played with the day before. On a normal day, the children sat together in a circle. However, when working with the Webchair the children stayed behind their desk. On the first Monday one of the children asked why they have to stay seated behind their desk, and the teacher explained this was done because of Bram. This was due to the fact that from the perspective of the Webchair camera, Bram could not see the other students when they were sitting in a circle in the corner of the class. Furthermore, they were often waiting for Bram to come online before starting with the grammar lecture. In order to minimize disruptions, the children stayed behind their desk so they could easily start with the lecture when Bram was online. Once Bram was online, the teacher interrupted the group talk and turned her attention towards Bram. Meanwhile Bram is sitting at home together with his mother. He is sitting on the couch with the laptop on a side table in front of him. Before the lecture started the children were allowed to greet Bram by waving towards the Webchair. The teacher explained to everyone that the lecture would start and demanded everyone's attention and focus on the lecture.

The second class was the class of Paul. Paul was working from another room in school together with his supervisor *(Dutch: ambulant begeleider)*. This room is actually an office for remedial teaching but is solely booked for Paul during his Webchair timeslot. He had difficulties with attending school and the Webchair gave him the opportunity to get used to the classroom in a comfortable and secure way. Before the Webchair lecture started, the teacher asked everyone to raise their hands if they wanted to speak during the lecture. This made sure that the class was quiet for Paul. The teacher turned on the Webchair and her microphone. The microphone of the Webchair laptop of Paul was muted, so he can hear what was happening in the class, but he could not talk with the class. *[In the interviews of Study 2, Paul's teacher told us, this was done by Paul's supervisor, so she could talk with him during the lecture]*

Technical issues

On the first day, the camera control was not working in Classroom 1, so the camera was on a fixed position and Bram had no opportunity to change the position of the camera or to zoom

in or out. This problem occurred more often. Because both the mom and the teacher were unable to fix the problem at that moment the lecture started without camera control. Moreover it would have been too disrupting for the children in the class to postpone the lecture.

In Classroom 2 the sound wasn't working properly on the first Monday. There were a lot of stutters in the sound and eventually the sound stopped working completely. Paul and his supervisor continued working with only the visual output of the camera and no audio. Paul frequently inspected the classroom using the Webchair camera. He was involved in the lecture by for example zooming in on the presenter screen when the teacher showed something on the screen. Although he was working together with his supervisor, he also paid attention to what was happening in the class. On the second day of observation the camera control stopped working. This caused major differences between the observations because from the first observation it was clear that he used the camera a lot. The Webchair is an appliance for Paul to get used to the events and stimuli in a classroom, and the camera control gave him the opportunity to look around.

These technical malfunctions influenced the student's opinion about the Webchair. During the interviews, both boys indicated they liked working with the Webchair, even though the camera or microphone was not always working properly. However, they did indicate that working with the Webchair was less fun when they couldn't zoom or control the camera, or when the sound stuttered. Technical issues were therefore most likely the main cause for a decrease in enjoyability of the system for the boys.

Webchair lecture

During the lecture the teacher of Classroom 1 put a lot of effort in keeping Bram involved. She repeated what the other students just said and she asked whether Bram could understand what was going on and whether he could see what was happening. Furthermore when the teacher asked the class a question, we observed Bram getting the possibility of answering the question first. Just like when Bram would actually be present in class, he raised his hands when he wanted to respond to a question. Moreover when the teacher demanded the children to sit up straight with their arms crossed on the table, Bram also sat upright with his arms crossed. During one of the grammar lectures the class was playing a grammar game where they had to raise their hand if the word was correct. The teacher asked: *"Bram will you actively participate in the game? And just raise your hand if the word is correct!"(teacher Class1).* The teacher rewarded Bram for his active participation by letting him respond more often compared to the other children. When it was clear to the teacher that Bram's attention for the lecture decreased, she quickly reacted by mentioning his name or by asking him questions. For example she asked 'is that right, Bram?' or 'did you hear that, Bram?' to check if he was paying attention. Even though the teacher put a lot of effort in keeping the Webchair-student involved, Bram was still drawn to his mother frequently. When the teacher was asking him a question, he typically looked at his mother before responding to the class. For example, during the private lecture the teacher was explaining grammar to Bram and at the same time Bram's mother was helping him. Eventually the teacher stopped talking

because it was obvious Bram was only listening to his mother. The student lost his attention easily because of the environment he was working in; he was sitting on the couch, with his mother and dog next to him. During the mathematics lecture, Bram's mother started playing with the dog on the couch next to Bram. Bram stopped paying attention to the lecture and started playing with his mother and dog. You could see the mother was helping him a lot, too much even, by answering the questions from the teacher. Again, the teacher monitored this closely by frequently demanding Bram's attention. For example she frequently acknowledged him by saying: *"Well done, I see you're paying attention"(teacher class1).*During the interview Bram indicated he particularly liked the group sessions, when the whole class was working together. He said that mathematics was less fun because he found it difficult to properly participate in the lecture. Bram acknowledged that he had difficulties to stay on track and to respond loud and clear towards the teacher.

The major difference between Classroom 1 and Classroom 2 was that there was little to no interaction with the teacher or other students in Classroom 2. Because Paul's microphone was muted he couldn't interact with the class by asking or responding to questions. In the interview he indicated that even though he couldn't talk with the class, he still felt connected with the class. He regretted however that he couldn't talk with the class, and was only allowed to listen. He would have liked to ask questions to the teacher, but he encountered a lot of support from his personal supervisor with whom he worked together. The lecture in the classroom sometimes went too fast for him, so he indicated that he liked to work in a separate room, where he could work at his own speed and where he had a personal supervisor to explain it to him in a calm and slow way when the lecture was going too fast.

Although there wasn't much interaction between Paul and his class during the lecture, the other students showed concern with Paul and the Webchair. For example during the observation the children noticed immediately when the connection was lost for a while, and told the teacher to wait for a second. The children were not really distracted or looking for contact with the Webchair, but they only seemed to look if everything was okay. So although there was no real interaction, you could see everyone was concerned with the system and took care to make the best of it. The children were accustomed to the Webchair but sometimes forgot that the set-up of the lecture needed some adjustments. For example during one of the observations one of the children in the class asked if she could read some of the lecture instructions aloud. The teacher reminded her that she would have to read the instructions herself because Paul could only hear her talking. *[The teacher explained during her interview in Study 2 that talking with the external microphone is too exciting for most of the children and it causes disruptions during the lecture]*. During the interview both boys indicated that they regretted they were only able to hear the teacher and not their fellow students. Sometimes they were losing track of what was happening during the lecture, because they only heard one side of the interaction.

3.4 Discussion

The goal of this study was to systematically record current experiences with the Webchair system. The question was whether a videoconferencing system could be a helpful tool in providing distance education for children that could not attend class.

The observations showed that Paul and Bram enjoyed working with the system. With the help of the system Bram could follow classes despite being homebound and Paul could work from a safe low stimulus area somewhere else in school.

However these benefits also come with certain costs. The observations showed a lot of interaction between Bram on the remote site with the classroom, but this interaction seemed to require a lot of effort from the teacher. During the lecture she was permanently trying to keep Bram involved with what was happening in class. She often repeated what had just been said in the class, or asked Bram's confirmation for hearing what had been said. Due to the technical issues it might have been that the teacher assumed that the sound was not working properly and Bram couldn't hear what was happening in the class. Another possible explanation might be that it was difficult for Bram to keep track of what is happening in the class. This was something Bram acknowledged in the interview. It might be that the Webchair wasn't helping Bram to focus on the lecture. The observation showed that Bram had difficulties keeping attention due to stimuli in his direct environment. The fact that he was working on a couch together with his dog wasn't contributing to an educational setting. In the second study we will focus on working in an educational setting.

Even though both boys enjoyed working with the Webchair, it is still not widely deployed in educational settings. These observations showed that the Webchair isn't suitable for every child or every situation. The boys were only attending lectures with group sessions and it would be hard to involve students in self-study lectures. Besides the fact that they need the study material at their location, the children often still need a supervisor to coach them. Implementing the system on a larger scale in the curriculum will therefore need a lot of adjustments: the daily schedule should be rearranged and the lectures would need a different set-up.

To sum up, the Webchair gives children the opportunity to work at a remote and safe place, but attention must be paid to create an environment which is beneficial for everyone. Involving a child in the lecture can be a labor intensive task for the teacher. The child in this Study was easily distracted by his domestic environment and required a lot of attention to constantly pull him towards the laptop screen. This in turn influenced the rest of the class, who now received less attention. The Webchair student must be benefiting from the lecture, but not at the expense of the other children in the classroom.

Whether the Webchair can provide a more suitable educational setting for specific children by providing a safe, predictable, controllable and attractive environment will be further investigated in the next study.

4. Study 2 – User Experience Tests

4.1 Introduction

The first study focused on the current experiences with experienced users of the Webchair, the second phase focuses on the usability of the system. This study will explore whether a larger group of children and teachers who are unfamiliar with the system could identify advantages, disadvantages and possible improvements for the videoconferencing system. Furthermore we will take a closer look at the usability to see how efficient, satisfying and effective the use of videoconferencing for educating children with autism is.

4.2 Method

4.2.1 Participants

For this study we looked for children in the age from 6 to 12 years, that is senior classes of primary school. Besides the two classes that were already working with the Webchair, we wanted two classes that were unfamiliar with the Webchair and wanted to participate. The Verschoorschool supported this research by a Webchair expertise group. Together with a team of supervisors and teachers from the Verschoorschool we brainstormed about all matters concerning the Webchair. During one of the meetings we introduced the second study. The two teachers were already working with the Webchair were enthusiastic to participate in the second study. The members of the Webchair team spread the word amongst the teachers of the Verschoorschool to gain another two classes for the research. Two teachers were interested and in a follow-up meeting we explained the purpose of the study and planned a week to carry out the research. In collaboration with the principal from the Verschoorschool we composed an informed consent form that was specifically designed for this research. Hereby we introduced the purpose of the study and indicated that we needed several students to voluntary participate in this research. Furthermore we declared that all data would be processed anonymous and confidential and would only be used for this study. This informed consent was sent out to the parents of the children from the four participating classes. Parents could reply to either the principal or the teacher if their children were not allowed to participate.

In total 27 students participated and attended a lecture with the Webchair system. It was up to the teachers to determine which children were allowed to participate in the study. In every class we chose about 5 children/lectures for the study. Even more children wanted/were allowed to participate but due a lack of time this was not always possible.

Class	Age	# participants
1	5 - 7	6
2	8 - 10	5
3	9 - 11	5
4	11 - 13	11
total		27

4.2.2 Design

Students who participated in the study attended a lecture with the Webchair system from another room in school. During this timeslot which lasted about 20 minutes, we started with some ‘playtime’. Hereby the children could get used to the system and the camera control software. When the lectures started the children were asked to seriously participate in the lesson, but they were free to change the system to match their preference. When the lecture was finished, the children were asked for their opinion by means of the Smileyometer interview. The aim of this study was to analyse the behaviour of the children while working with the Webchair as well the differences with working in the classroom. Besides analysing the Webchair lectures, we made a comparison for 3 students between their behaviour in class and behaviour while using the Webchair. Following the study with the children, an interview with their teachers was planned.

4.2.3 Measures

During these user experience tests we used three measurements. First there was a camera in the classroom to record what was happening in the classroom while the observer was working with the student in the other room. Furthermore we captured the laptop screen of the Webchair student, so we could see exactly what the child was doing with the camera control software and where he was looking at (Figure 9).

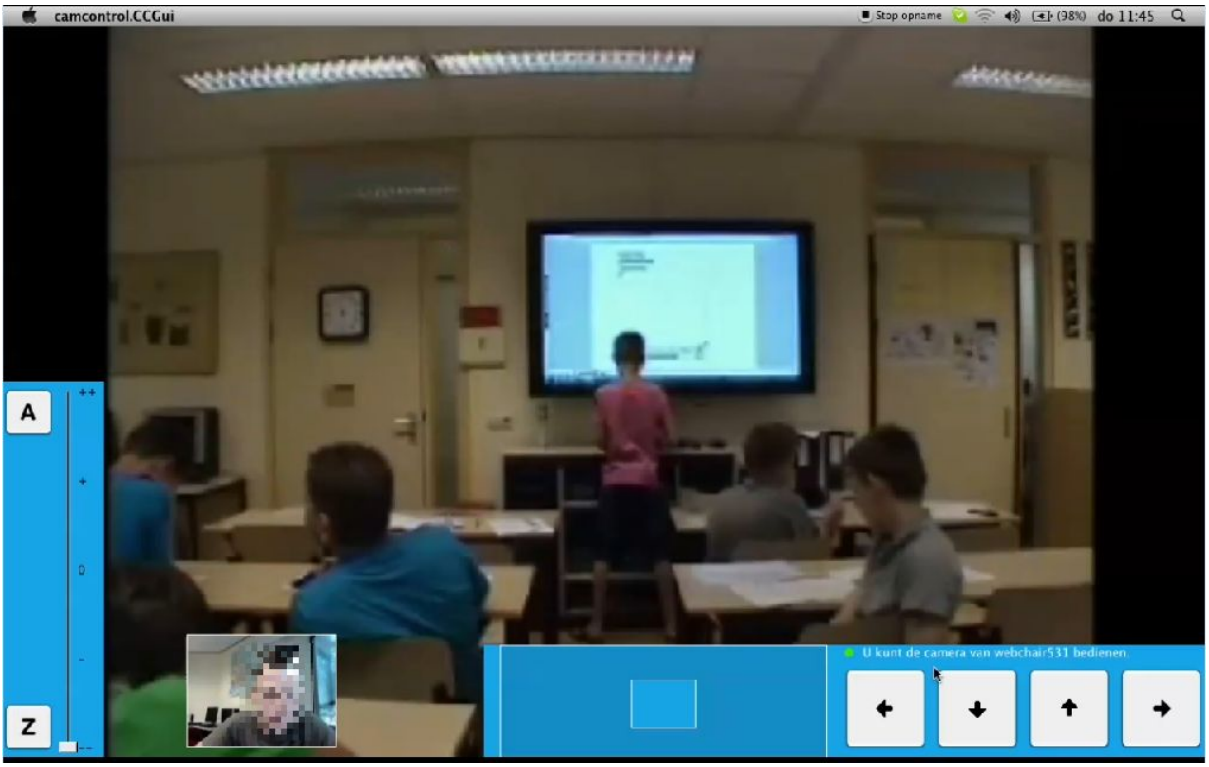


Figure 9 – Screen capture of student laptop

Afterwards we used the Smileyometer interview to gather their opinion about the system. For details on the Smileyometer interview see paragraph 3.4.2. The Smileyometer consisted of three questions about working with the system and three questions about the technology of

the system (same as the interview in paragraph 3.4.2). Furthermore, the interview consisted of three open-ended questions, where we asked the student what went well or wrong with the Webchair, and if they would like to work again with the Webchair. The full version of the interview can be found in Appendix C.

4.2.4 Materials and apparatus

For this study we worked again with the Webchair videoconferencing system, see 3.5 for all the details of the Webchair system. Screen captures of the Webchair L100 system (student laptop) were recorded with QuickTime player for Mac. A Sony DCR-SR55E camera was used for video recordings of the classroom.

4.2.5 Observation set-up

The floor maps below (Figure 10) show the set-up of the Webchair/Camera for each of the classrooms.

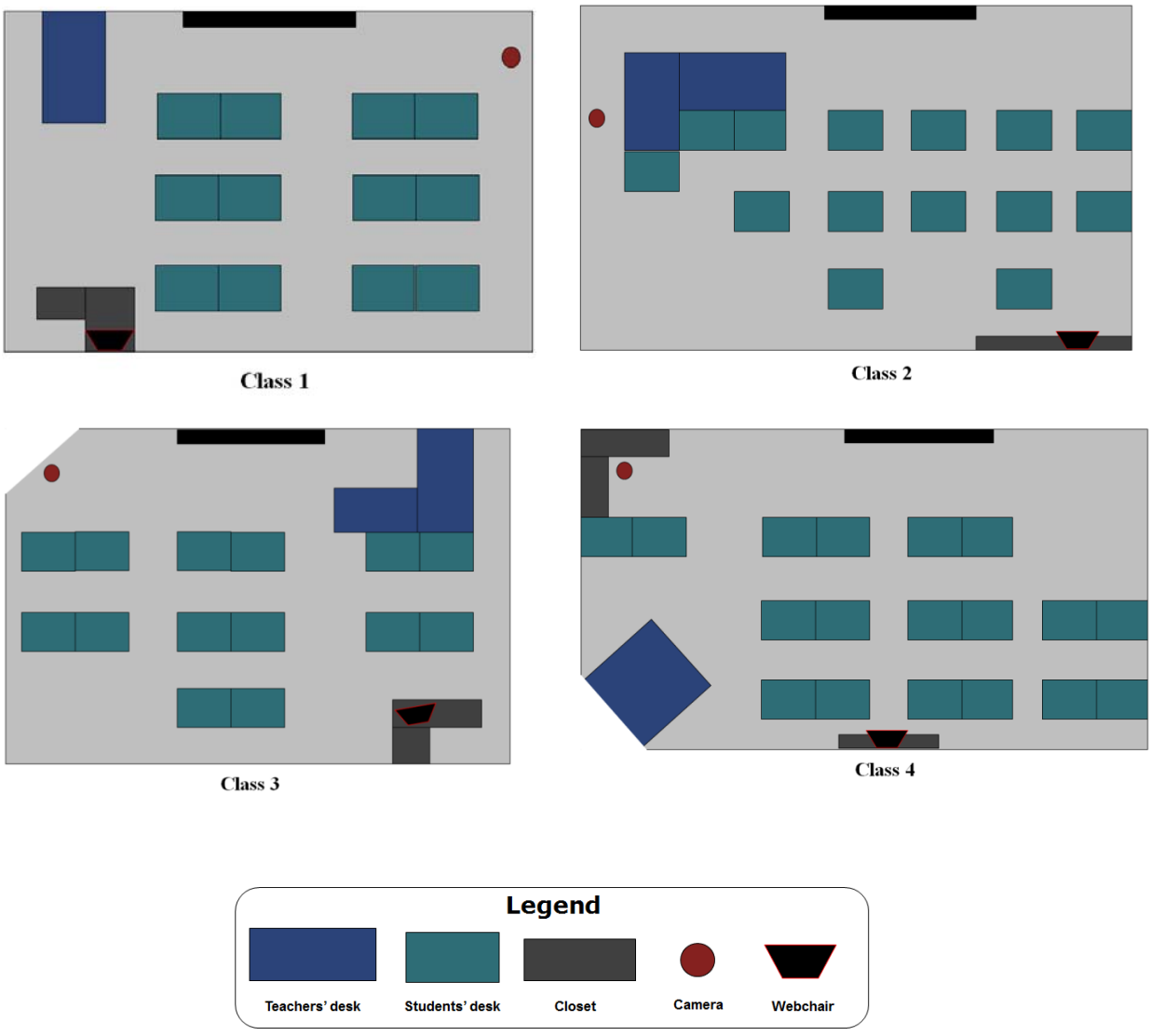


Figure 10 - Floor maps study 2

4.2.6 Procedure

For every class we chose a week to perform the study. Every morning before the lectures started the researcher was present to set-up all the materials. In Classroom 1 and 2 we had to install the camera and set-up the laptop in a nearby room. For Classroom 3 and 4 we also temporarily installed the Webchair at a central location in the class. During the week of the research the teacher decided which students were participating during a particular lecture. The researcher took care everything was set-up before the lecture started and started to introduce the Webchair to the child before the lecture would start in the classroom. The research session started with some playtime to explore the system and to get familiar with the features of the system. Hereafter the lecture started and the student was asked to seriously participate in the lecture. During the lecture the students were free to adjust the system to their preferences. The researcher sat next to the child and offered assistance when needed. After the lecture the students were asked for their opinion through the use of the Smileyometer interview.

To gather the opinion of the teachers an interview was carried out. The interview was semi-structured with two possible designs depending on whether the teacher was familiar or unfamiliar with the Webchair. The questions were divided in two parts with first questions about the Webchair and secondly questions about videoconferencing in general. Questions about the Webchair concerned technical issues with the system, the interaction with the Webchair student and the assessment of the Webchair student. General questions were about the advantages/disadvantages of videoconferencing and whether they could identify possible improvements. The interview questions can be found in Appendix D.

4.2.7 Data analysis

The observer made a coding scheme based on the observations of the first study and several videos from the second study. A second observer was asked to watch several videos shortly to complement the coding scheme. Eventually both observers discussed and agreed on the final coding scheme.

For the coding scheme in both the classroom and web chair observation we looked first whether the student was paying attention to the lecture or whether he was disturbed by the lecture. Because there was no sound in the screen captures we were unable to score the content of the interaction. It was for example impossible to perceive whether a student was talking to the observer or towards the class. Instead we will focus on the visible behaviour of the student, like lifting the hand, showing something to the teacher, or waving towards students in the classroom.

In addition, the videos from the Webchair laptop gave us some more information about the focus of attention of the student. As can be seen in the screen capture (Figure 9), the small portrait in the corner gave us information about the focus of the student on the screen and the large image shows where the student was looking at with the camera. So from the screen captures we can see whether the student was focusing his attention (1) off the screen or (2) on the screen. Furthermore we could identify where the student was focusing his attention on in

the classroom, this might be (1) looking around with the camera (2) focusing on the teacher or the presenter screen or (3) the students or the classroom. Figure 11 shows a schematic overview of the possible areas of focus of the student.

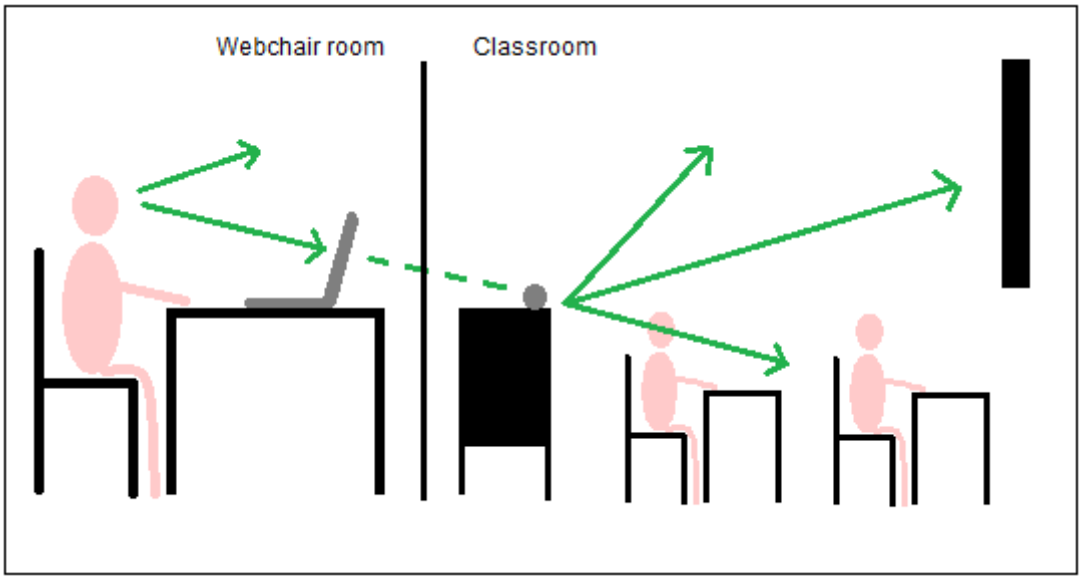


Figure 11 - Focus of attention Webchair student

The final coding schema for both observations is displayed below.

Webchair observation

Paying attention to lecture

- Yes - Focus on lecture (teacher / presenter screen)
- No – Disturbed from lecture (look around etc.)

Behaviour Webchair student

- Lift hand
- Contact with teacher
- Contact with students

Focus of attention – Student laptop

- Focus on screen
- Focus off screen

Focus of attention – Camera

- Focus on lecture (teacher / presenter screen)
- Focus on class (students / classroom)
- Look around

Classroom observation

Paying attention to lecture

- Yes - Focus on lecture (teacher / presenter screen)
- No – Disturbed from lecture (look around etc.)

Behaviour Webchair student

- Lift hand
- Contact with teacher
- Contact with students

Videos were analysed using Noldus Observer XT 10. A second observer was asked to code a video to determine the interobserver reliability. A reliability analysis resulted in a Cohen's Kappa of 0.41 and a Pearson's Rho of 0.96[2]. Because there were quite some disagreements between the two observations, this resulted in a low kappa score. The observer discussed with the second observer about the coding scheme and the corresponding behaviours in the videos. Particularly in the 'paying attention to lecture' scores there were quite different. For example when a child was grabbing his pencils the observer thought this was part of the lecture, because he needed to pack his stuff to participate in the lecture, but the second observer thought he was disturbed from the lecture. Because all the children in the classroom where doing the same thing and the teachers asked the children to get ready for the lecture. Both observers agreed this behaviour was part of the lecture. Eventually both observers coded the same video again. This resulted in an Kappa of 0.73 and a Rho of 1.00, indicating consistent observations between observers. Visualization of these data showed that both observers scored the same things however due to some minimal time differences in the scoring this resulted in a lower Kappa.

4.3 Results

4.3.1 User experience test

Webchair analysis

In a first analysis we focused on the user experience of the Webchair. From the total of 27 participants, the screen captures of 7 participants were excluded from analysis. Their screen captures were found unfit because there were too many technical problems during these sessions. In themselves, such technical failures can be informative as well, in particular in relation to potential design recommendations. The most frequently occurring problems were:

1. The camera control software didn't work at times. When the connection between Webchair and laptop was established one could see the classroom, but the camera was in a fixed position and the user couldn't control the camera. An additionally occurring problem with the camera control software was that the zoom function didn't work, so the user could look around with the camera but couldn't zoom in or out.
2. When starting the Skype connection on the laptop, the camera of the Webchair in the classroom wouldn't start automatically. The only way to fix this was to manually turn on the camera on the Webchair. Normally the laptop had the opportunity of switching on/off the camera in the classroom. Moreover when setting up the Skype connection on the laptop, normally both camera's should turn on automatically.

[2] Cohen's kappa is a measure of agreement that is corrected for agreement by chance. The values of kappa range between 0 and 1, where 0 is non-random full disagreement and 1 is nonrandom full agreement. A Kappa of 0,41 means a efair inter-rater agreement, hoewever, a higher score is preferable. A Kappa of 0,73 is regarded as good. Pearson's Rho is a measure of the strength and direction of the linear relationship. Rho values range between -1.0 and +1.0, where -1.0 is the perfect negative correlation, 0.0 means no correlation at all and +1.0 means a perfect correlation between the two observations

3. The contrast of the camera view could suddenly decrease drastically. The view of the camera turned almost entirely black (see Figure 12). Most of the time the problem could not be fixed without a reset of the system.
4. There were interruptions in the sound or the audio stopped working at all. Switching to another microphone or resetting the system fixed the problem most of the times.

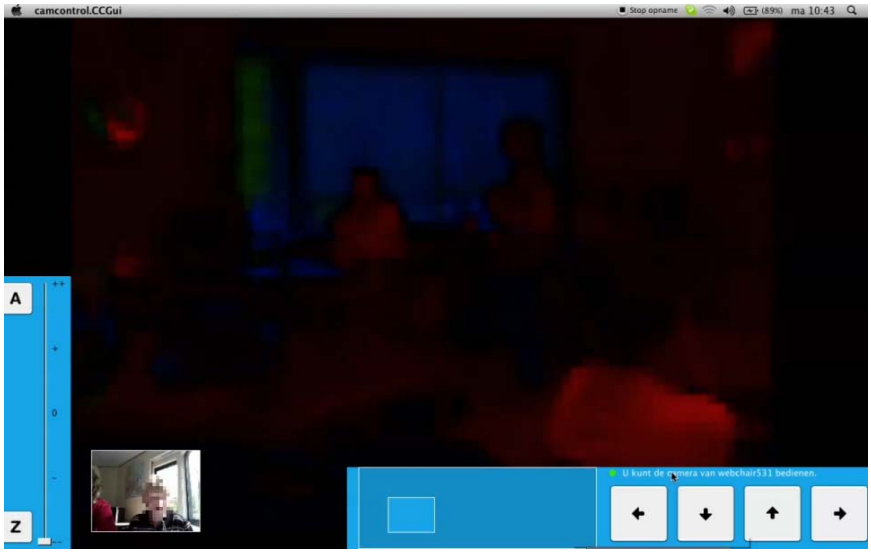


Figure 12 - Technical problem with the camera of the Webchair

Table 3 - Overview participants Webchair analysis

pp	class	lecture	age	time (minutes)
1	4	Grammar test	12	15
2	4	Grammar	11	30
3	4	Grammar	12	18
4	4	Grammar test	12	20
5	4	Grammar test	12	16
6 *	2	Grammar test	9	34
7*	2	Grammar test	10	20
8	3	Grammar test	12	29
9	1	Group talk	6	29
10	1	Writing lecture	7	19
11	1	Math	6	20
12	3	Grammar test	10	6
13	3	Grammar test	10	20
14*	2	Grammar test	9	26
15	3	Grammar	10	27
16	3	Grammar test	9	23
17*	2	Grammar test	9	25
18	1	Group talk	6	23
19	1	Writing lecture	7	16
20	1	Math	7	13

* sound of Webchair laptop was muted

Out of the twenty sessions used for this analysis, there were still five with minor technical problems. Because the problems occurred less than 10% of the lecture time, we included them in the analysis. Table 3 provides an overview of the remaining participants and information regarding their lecture.

Results (see Table 4) showed that participants focused well on the lecture while working with the Webchair. Only five participants were distracted for more than 20% of the time, with a maximum of 29%. However in contrast there were also five participants who were distracted for less than 2% of the time. Students were on average focused on the lecture for 87% of the time (range between 70 and 100).

There were more differences in how they used the Webchair to focus on the lecture (look back at Figure 11 for the different variations in the student's focus of attention). Students were on average looking away from the screen for 41% of the time. However, there were many grammar tests among the participants where participants had to write down a lot, thus an average of 41% is a reasonable amount. The high focus on screen scores were mostly caused by a group talk in the lecture. Hereby students only had to look towards the screen.

When using the Webchair camera, students focused most on the lecture with the camera, which could be either the teacher or the presenter screen. On average the view of the camera was for 70% of the time focused on the lecture. Most participants changed the point of view of the camera during the lecture; only three participants solely focused on the lecture and didn't change the camera view during the lecture (the maximum is not 100% as seen in table 4, because the point of focus started when the lecture started, which was often not at the start time of the observation). The large amount of looking at the lecture with the camera can, at least in part, be explained by the nature of tasks that were being performed. During the Webchair sessions a large number of grammar tests were held among the participants. While correcting the grammar test, participants often zoomed in on the presenter screen so they were able to read the content (Figure 13).

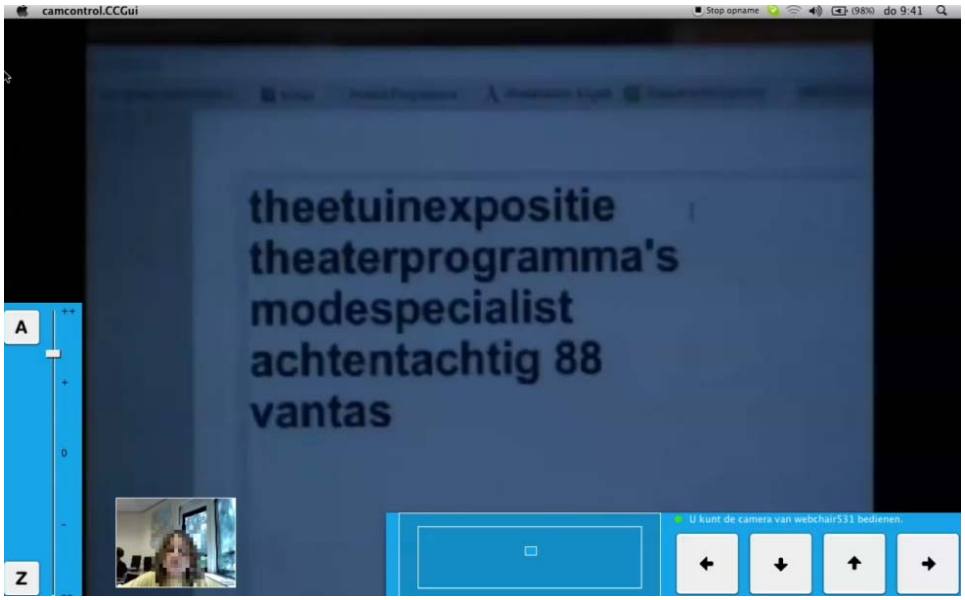


Figure 13 - Focus of attention, camera zoom

Half of the participants (n=10) used all three modes of the Webchair (focus on lecture, focus on class, looking around) during their lecture. There were three participants who were looking around for more than 20% of the time, these participants had also a high percentage on their disrupted from lecture score. The students were on average focused for 27% on the classroom, with a range between 5% and 91%. An often occurring phenomenon was that students were looking at the presenter screen but as soon as this wasn't necessary anymore they zoomed out to see what was happening in the class. Students were struggling because most of them preferred to see the whole classroom, but in order to focus on the lecture they needed the information on the presenter screen.

Furthermore, seven students interacted visually with the teacher, and thirteen students interacted visually with other students. Interaction with the teacher consisted of showing their work in the camera for the teacher, and interaction with the students consisted of waving and looking and giggling towards each other. In addition, 7 students lifted their hand during the lecture. An extended overview of the results can be found in Appendix D.

Table 4 - Results Webchair analysis.

	Minimum	Maximum	Mean	Std. Deviation
Yes – focus on lecture (%)	70,86	100,00	87,97	11,015
No – disturbed from lecture (%)	,32	29,14	13,37	10,802
Focus on laptop screen (%)	24,08	90,16	58,15	18,576
Focus off laptop screen (%)	9,84	75,92	41,85	18,576
Camera view on lecture (%)	18,05	97,97	70,93	20,147
Camera view on class (%)	5,33	91,86	27,92	25,636
Looking around with camera (%)	,06	24,53	9,44	8,481

Comparison analysis

A first analysis showed information about the behaviour of the children when working with the Webchair system. To know whether this actually differed from their regular classroom behaviour we took three children and compared the videos of their Webchair lecture with a video of a comparable lecture in class. This provided us information on which condition resulted in a student paying more attention. Only three participants out of the twenty-seven were suitable for this analysis. Besides the Webchair videos of the participant we needed to have videos of their classroom behaviour and this had to be from a comparable lecture (thus comparing a grammar test with another grammar test from the same classroom). Moreover the children had to be clearly visible in the classroom videos for a similar length of time. This excluded a lot of videos from analysis because only the children who were sitting right in front of the classroom camera were suitable. The first two suitable students (participant 5, class 4, age 12 and participant 14, class 2, age 9) performed a grammar lecture and grammar test, the third student (participant 19, class 1, age 7) attended a writing instruction lecture. Table 5 shows an overview of the participants and the results of the analysis. The lectures ranged between 15 minutes (pp5) and 26 minutes (pp19).

Results showed that the three students were paying more attention to the lecture when working with the Webchair, as can be seen in the highlighted areas in the table below. During the Webchair lectures the students were on average focused on the lecture for 88% of the time, while during the lecture in the classroom they were on average focused for 67% of the lecture time.

Table 5 - Results comparison analysis.

	Webchair				Classroom			
	Focus on lecture		Total (s) lecture	% focused	Focus on lecture		Total (s) lecture	% focused
	Yes	No			Yes	No		
pp5	741,64	157,34	898,98	82	649,48	246,84	896,32	72
pp14	1337,88	239,79	1577,67	85	920,04	529,44	1449,48	63
pp19	959,42	31,74	991,16	97	691,89	358,88	1050,77	66

Besides paying more attention to the lecture, the periods of disruptions were shorter during the Webchair lecture. In the classroom they were more easily distracted and it took longer before they got back to work. Student 2 for example, was quietly working on his worksheet without disruptions during the Webchair lecture. However in class, he was more distracted and asked for confirmation of the teacher during his work. This was also the case with student 1, who demanded a lot of attention during the lecture by talking to the teacher, but was silent when working with the Webchair. Especially student 3 (participant 19) wasn't paying attention to what was happening in the class when working with the Webchair, and was for 97% focused on the lecture. In the class there were more disruptions which resulted in a focus percentage of 66%. To give an indication what these data look like, the figure below shows the results of both the classroom and Webchair observation of participant 19. In Figure 14 you can see that there were more disruptions and the periods of disruptions were longer in the classroom condition.

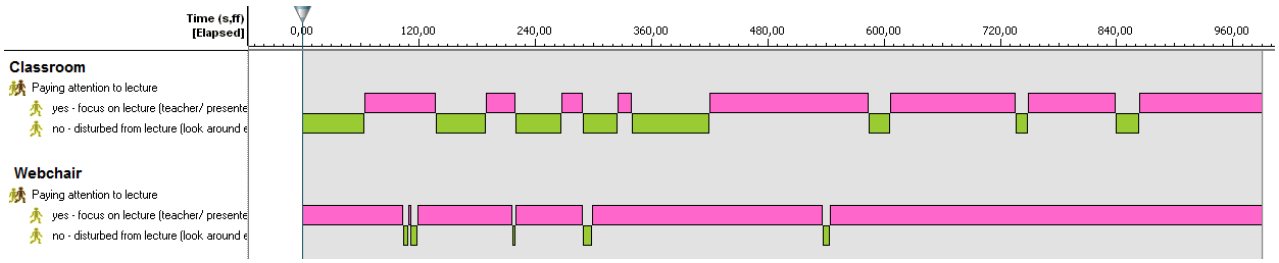


Figure 14 - Observation results participant 19

4.3.2 Survey students

In total 27 students, aged 6 to 12, participated in the study. Four children had difficulties with the Smileyometer questions and didn't answer all of the questions. When asked if they liked working with the Webchair (question one, Smileyometer) answers ranged between 3 (nice) and 5 (super nice), with an average of 4.04 (SD = 0.854).

When evaluating the sound of the Webchair system (question 4 and 6), students sometimes made a distinction between the teacher and the rest of the class. Hearing the teacher was not really a problem (3=good) but it was difficult to hear the students in the class (2=not good). The sound was rated with a mean of 3.4 with a range of 2 (not good) to 5 (very good). The camera was also rated between 2 and 5, but with a mean of 3.8.

Five students worked without a microphone (they could hear the class, but they couldn't talk with the class). Out of these 5 children, two of them indicated that they didn't feel connected with the classroom. None of the other participants mentioned they didn't feel connected. In the open-end questions these children indicated they felt uncomfortable not being able to talk. One of the students was afraid she could not ask the teacher for help when something was unclear.

All of the students reacted short and enthusiastic when asked if they wanted to work with the Webchair again: "Yes, of course! It is super cool!" Some mentioned it was fun just because they were able to look around in class without making the teacher mad. Only a few of them mentioned it was actually nice to work with the Webchair because it was a nice and quiet environment and they were not disturbed by other students. When asked what they liked about the system they mainly responded with: "Everything". Students indicated it was easy to work with and easy to control the camera. Where some of the students mentioned the bars of the camera control software were disturbing and unnecessary, others mentioned that the bar was clarifying and not disturbing at all. What they disliked about the system were the technical failures. Some of them mentioned it would be especially annoying when you would work from home, because you wouldn't have a clue then what was happening. Some of the students mentioned it was annoying you need to zoom in on the lecture to understand the lecture, but meanwhile you cannot have a look at the classroom to see what was happening.

4.3.3 Interviews teachers

Introduction

The Webchair was welcomed with interest and curiosity, especially amongst students. However, after a short period of time both teachers and students got accustomed to the presence of the Webchair. When asked about their experience of working with the Webchair, the teacher of class 4 answered: *"Nowadays we are so accustomed to multimedia like Skype and that kind of thing. I don't have to think about it as a new technology, in my opinion it is already totally accepted" (teacher class 4).* At the Verschoorschool they use video recordings to analyse a child's behaviour or to improve the lectures, so having a camera in the class therefore wasn't a special occasion. The teachers were easily adjusted about the system in the class. The system however did make a huge impression on the children in the classrooms, who were all really curious about the system. That the children have an affinity with technology was confirmed by the teachers. The teacher of Classroom 2 explained that she had some real computer nerds in her class and she knew for sure they would be enthusiastic about working with the Webchair. However she could imagine it would be different in a class with children that were really suffering from their disorder: "*I think you*

really need to prepare them individually so they know exactly what the procedure will be" (teacher class 3). Having a Webchair in the classroom was a little bit strange at the start, but after an introduction about the purpose of the system the children became more comfortable with the system in the classroom.

Working with the Webchair

Even though all of the teachers were easily accustomed and the lectures proceeded very naturally, they were definitely aware of the Webchair, both in the preparation and during the lectures. When asked if they changed their lecture for the Webchair, it became clear the Webchair lecture needed a special set-up: *"It's a different way of teaching; normally there is more interaction with the children in the classroom. Now you are busy with repeating what the children said, or when they ask a question I need to repeat the question. You always have to be aware that someone is watching you, and that he will only hear me" (teacher class 1).* The teacher of class 1 told that she already started thinking about the Webchair lecture on Sunday, because it is a different set-up and it needs some thorough preparation. The teachers who were new with the Webchair didn't prepare a different lecture because they were unfamiliar about the goings-on with Webchair lectures. However they choose interactive lectures for the Webchair sessions, where the Webchair child could participate in the lecture.

Even though the teachers felt that the student was part of the class, the physical distance was sometimes still difficult. *"In fact, he was there, but actually, he was not" (teacher class 4).* According to class four's teacher, the teacher has an important role in involving the child in the lecture. If you do this right, it will feel like he was really part of the lecture. The teacher of class 1 thinks the distance is very much a limitation, both to herself and the student. *"It is an advantage that a child can participate in lectures when this isn't possible in a regular setting for whatever reason. This is really a plus. But the disadvantage is that it is a remote education system. It remains at a distance; it is a child in a black box" (teacher class 1).*In the eyes of the teachers, there are both advantages as well as disadvantages to the use of the Webchair. *"I prefer having him in class, but I understand that he prefers to look around in class from a safe and pleasant room. Simple things like lifting your hand in class if you have a question may be very difficult for him. He feels a lot of pressure to get back in class. Now he can observe from a safe distance that it was actually quite comfortable in class, without feeling that pressure. So I think that's nice for him" (teacher class 2).*

Although the teachers agreed on the advantages of the system, they all hope that the Webchair is a temporary appliance. *"It remains something remote. I think you should only use the system if there is no other option. I don't necessarily think that it is suitable for every setting. I think it is better to have direct physical contact" (teacher class 1).* The teacher of Classroom 2 said that she also hoped that the use of the Webchair will soon no longer be needed. *"It would be nice if he can stay in the classroom and feel comfortable with it. The goal of the Webchair was to see what is going on in the classroom. I hope that using the Webchair will eventually result in the student's re-integration in the classroom" (teacher class 2).*Most teachers see the Webchair as a temporary appliance to help a child to reintegrate in the classroom.

Added value of the Webchair

From study 1 it was already clear that there were differences between Classroom 1 and 2. The moments with the Webchair that can be of added value are very dependent on the situation of the child it seemed. The teacher of class 1 was under the impression that the educational value of the system is scarce. This opinion is based on her experience with the Webchair, which was quite negative because of the student she worked with. Bram is a boy with classic autism and he needed a clear distinction between home and school. Working with the Webchair was difficult for Bram since he was working in a domestic setting containing lots of distractions and unnecessary stimuli. A calmer environment would possibly have worked better for him. Nevertheless she thought that the Webchair could be a useful tool; *"for example for a child who is suffering from overstimulation in class and can now work with the Webchair from a low stimuli area somewhere else in school "(teacher class 1).* Furthermore the Webchair could be helpful for children in the hospital or who are homebound for medical reasons, especially when it is only for a few months. This would make it easier for children to re-integrate in class.

Class 2 holds a completely different attitude towards the Webchair; the teacher is convinced of the added value that the Webchair system could have in the educational setting. In her opinion the Webchair student (Paul) benefitted a lot from working with the system. *"I think he would have never made it this far without the Webchair. He really had the opportunity to watch what was happening in the class in a safe and pleasurable way. Although it was a huge step for him to take, it was the right one to take" (teacher class 2).* According to the teacher of Classroom 2 not only the Webchair student, but also the other students were benefiting from the Webchair. Children in special education normally are resistant to change in their direct environment. Having a Webchair in the class was a really big change for them. It learned them to accept that different children have different needs. The teachers of Classroom 1 and 2 never thought about showing the remote site of the Webchair in order to increase acceptability. However after observing the remote site the acceptance towards the Webchair (student) grew amongst the children. They noted that the Webchair was helping Paul, and they learned to support his needs. *"At one moment during the Webchair lecture, I was talking and Paul was gone, to the toilet perhaps. One of the students in class noticed Paul was gone and asked me to wait for a while because Paul was gone. At that moment I realized that they really see Paul as their classmate, and I think that's great!" (teacher class 2).*

The teacher of Classroom 3 agrees on the added value of the Webchair and thinks that certain children will perform better when working with the system. For example for children who are easily distracted in the classroom. A videoconferencing system gives them the opportunity to work in a quiet and separate room, with instructions from the classroom. The teacher really thinks that the system could be beneficial for certain students.

Contact with the Webchair student

The teachers that were unfamiliar with the Webchair were easily accustomed to the Webchair and worked just like they would normally do. *"When a student was online with the Webchair, it was just like he was actually in class. The Webchair was in the right place so it was just as*

if he was sitting in the back of the class. When I looked around in class I saw him just as I saw the other kids" (teacher class 4). The fact that the location of the Webchair was an important aspect for making natural contact was confirmed by the other teachers too. The teacher of Classroom 3 told that she experienced it to be easy to make eye contact with the Webchair student: *"Because the Webchair was on a closet and in a central place in class I could easily look at him, and he can see me. It is just as if there is a student in the back of the class, but now you see him by means of a screen" (teacher class 3).*

Teacher 2 also had the feeling she made eye contact with the Webchair student. However she rarely used this because normally Paul is working together with his supervisor and his microphone is muted, so it is hard to interact with Paul. Paul's microphone is muted in order for his supervisor to be able to talk to him and coach him during a lecture without disturbing the class. Not only the teacher but also Paul and the other students regret this. *"They found it difficult that Paul couldn't talk, and also Paul himself founds this difficult. And I agree it is difficult, because now he is not totally involved in the lecture, so that's unfortunate." (teacher class 2).* She thought it would be better if Paul could talk with the class. Then he would be even more part of the group. *"Now he is only looking at what we are doing and he can only hear me talking. This is also difficult for me, because I needed to repeat all of the question and answers of the children. Normally the children are reading aloud during the lecture, but now I have to read everything otherwise Paul won't hear it" (teacher class 2).*

Possible improvements

The teachers mentioned they had difficulties working with the microphone. Because the teacher's microphone and the external microphone can't be used at the same time, they are mostly working with the pocket microphone. *"It would be nice if the Webchair student could hear the whole class without using a microphone. I think that's something that could be improved in order to increase the usability of the system" (teacher class 2).* Ideally they would like to have a microphone in the ceiling so everyone can talk at the same time.

Besides having trouble with the microphone there were a lot of technical problems with the Webchair, especially in Classroom 4. According to the teacher this caused a lot of agitation in the classroom. The system should be working well; otherwise he would have stopped working with the system. Furthermore the teacher of Classroom 4 would like to have a remote control for the camera, to make sure the student is paying attention to the lecture.

Although the teachers of Classroom 1 and 2 have already been working with the Webchair for almost a year, they still have technical difficulties with the Webchair. The teacher of Classroom 2 would like to know more about the system: *"The technical part is a disadvantage for me, because when it stopped working I often don't know what to do. Most of the time a reset will do the job, but this will cost you ten minutes every time" (teacher class 2).* The teacher of class 1 also would like to have a more simplified system: *"Both me and the mother don't know much about the technology. When the system wasn't working it was hard for us to diagnose the problem" (teacher class 1).*The observer took care of the technical issues in Classroom 3 and 4, so therefore they don't have a clear opinion about the technical part of the system.

To summarize; even though the teachers experienced problems when working with the system, they still think the Webchair can be a helpful appliance. The system can be easily used for children with medical problems. It can also be applied for children who have learning or social disabilities even though this may take some extra effort. Working with the Webchair was received positively amongst all of the teachers and children. Especially in the classes who were already working with the system they were curious to work with the system so they could experience the Webchair from the remote site. Unfortunate the teachers had difficulties working with the system. When the system wasn't working properly the teachers of class 1 and 2 tried to reset the system. They would like to know more about the technology to identify the cause of the failure. Furthermore all of the teachers would recommend improving the audio. It would be a big plus if the Webchair student could hear both the teacher and students in the class. A decent microphone system would be beneficial for everyone.

4.4 Discussion

Because only two students were working with the Webchair at the start of Study 1, we needed a more extensive study to generalize our findings. In the second Study we increased the number of participants for the purpose of increasing the external validity.

In study one's discussion we speculated why the student in Class 2 was only able to hear the class but couldn't talk with the class. Paul's teacher told in the interview that this was done by Paul's supervisor so she could talk with him during the lecture. However Paul, the teacher and the students in the class found this unfortunate. Moreover 2 of the 5 participants from Classroom 2 indicated they didn't feel connected with the class. These findings show that talking and interacting with the class is an important feature of connectedness.

Technical problems with the system, especially in Classroom 4, caused sub-optimal research conditions. This may have resulted in a negative experience with the system for both teacher and students. However, even though technical problems with the system, the mean scores in the Smileyometer interview were al rated above average. Several reasons could be given that lead to the positive assessments of the system. First, students generally feel very positive towards technology. This may be related to their systemizing needs (Baron-Cohen et al. 2006) as discussed earlier in the literature. Second, the research situation may have prompted some socially desirable responses, as the students may have been eager to please the research and/or teacher. Third, the failures of the system were not give a lot of weight in their assessments. The students may be blinded by technology causing them to refrain from critical feedback. The experience of working with a fancy laptop induced so much enthusiasm that they didn't cared about the technical failure of the system. When asked if they wanted to work again with the system they all responded positive, even the children who could impossibly keep track on the lecture due to technical failure. Even though it is important to critically examine the Smileyometer interview, we should not neglect the positive results that we found. These positive results suggest the system is easy to work with and the children were easily accustomed to the system.

We also found promising results on the video analyses. The findings showed that children were well focused on the lecture. Moreover a comparison analysis showed they were even more focused during the Webchair lecture in comparison to their regular lecture in classroom. However we should handle the results with care. First of all, the observer asked the children to seriously participate at the start of the lecture. Moreover the observer was sitting next to the children during the lecture. The fact that the observer was constantly paying attention to them might be very intriguing for the children. Secondly, not only the observer encouraged them to pay attention, she also offered them help when needed. This may have resulted in minimal periods of disruptions, because the observer could intervene more rapidly than a teacher in class who need to take care of twelve children. Thirdly, just as with the Smileyometer interview they may want to please the observer and teacher. The children who were participating in the study were chosen by the teacher, and because of this special position they wanted to show the teacher they were the right one to be chosen. The children were told they were part of a research and therefore they might want to be on their best

behaviour. But despite the critical notes we should not forget the promising results of this study both in terms of user acceptance, as well as academic achievement.

The interviews with the teachers provided us with information on the teachers' point of view of the Webchair. For example the adaptations teachers are required to implement to their standard classroom procedures in order for the Webchair to work. It helps if they have a clear view of how Webchair could potentially help the student. This is for example the case with the teacher of Classroom 2, who could clearly see the student is benefiting from working with the Webchair. Even though there were problems during the session, they still think the Webchair can be a helpful appliance. Moreover the teachers gave some useful recommendations to help improving the system.

Overall both the students and teachers were positive about using the Webchair. Children liked working with the Webchair and even performed better when working with the system. Teachers were easily adjusted to the system in the classroom, and work just like they would normally do. Using the system is definitely not free from efforts for teacher and students, but everyone is willing to work with the system when the Webchair child would benefit from ones Webchair moments.

5. General Discussion

The development of instructional technologies like multimedia learning environments have seen rapid growth. However, there is a lack of research that investigates how these instructional technologies can be used more efficiently and effectively to improve teaching and enhance learning. Especially in the field of autism there is a need for critical evaluation of instructional technologies. For children with autism, the use of technology to provide intervention, particularly aimed at the social or communication deficits of the disorder is promising. Children with autism are known to be extremely sensitive to contextual stimuli, such as sound, lighting and other people and therefore often have difficulties with attending school. They need a calm and safe learning environment where the level of social and sensory stimuli is easy to control. In this research we focused on videoconferencing technology as an educational tool. Videoconferencing technology permits the development of skills in a predictable and controlled environment, while simultaneously allowing a child to work in his/her own safe place. This technology could be used for distance education of homebound children, or as a temporary solution when a child is suffering from social or stimuli overload in the classroom.

This research was the first systematic exploration of the effects of using videoconferencing as an educational tool in autism. We explored how videoconferencing tools can help to enhance social and educational skills for children with autism. In an explorative study we recorded real-life interaction and experiences with the Webchair system in two phases. In the first phase of the research we focused on experiences with current system users to explore whether videoconferencing might be a way to educate children. The first study showed that the Webchair was evaluated positively from the users' perspective. In this light, the relatively low uptake (very infrequent use by two users only) at this educational facility is puzzling. Simply liking the system does not appear to be sufficient to implement the system in an educational setting. This has already been shown in the TAM model of Davis and colleagues (1989) according to which users will formulate a positive attitude towards the technology when they perceive the technology to be useful and easy to use. The system may be perceived as useful but it also has to be perceived as low effort. In other words, the benefits of using the system should outweigh the costs of using it. Moreover, not only the attitude from the child who is working with the system, but also the attitude of the teacher is important to determine the actual system use (Teo, Lee & Chai, 2008). Results of the first study showed that working with the system is not free of effort. Involving the child in the lecture can be a labor intensive task for the teacher. The child is easily distracted by his domestic environment and requires a lot of attention to constantly pull him towards the laptop screen. This in turn influenced the rest of the class, who now received less attention. This also poses the question of the scalability of the Webchair system (or any other videoconferencing solution). Should more than one child need such a system in any one class, the effort required for one teacher to coordinate interactions with multiple remotely located children, while at the same time keeping the rest of the class engaged, does not scale easily. Having two or even more Webchairs in a classroom may be too chaotic for both the students and teacher. On a small

scale the Webchair child can attend the most important lectures, the other children get the attention they need during the other lectures and the teacher is able to manage it.

The second study was a user experience test whereby a larger sample of novel users was asked to work with the Webchair to gain more insight into the usability and user experience of the system. Results showed that students were quickly familiar with the system and liked working with the system. Moreover the students were well focused on the lecture and a comparison analysis (n=3) showed students were even more focused working with the Webchair system compared to working in the classroom. This is a promising result that deserves further research in order to substantiate the results through a larger set of students, and longer duration of Webchair interactions. However, during this study we experienced substantial technical issues with the Webchair system. To be usable, stability of the system is key. Nevertheless the children had a positive attitude towards the system. This could be due to their generally positive attitude towards technology or it might indicate a positive response bias. The teachers were more critical during the interviews. Especially the two teachers who have already been working with the Webchair for almost a year clearly see both the costs and benefits of working with the system. Where the system was very beneficial for one of the boys, effects of the system on the other boy were marginal. Both teachers agreed that using the system is not free from costs and attention must be paid to create an environment which is beneficial for everyone (teachers, Webchair students, students in classroom).

This study has several limitations. First, the exploration of current experiences with the system was very limited. Because they hardly used the system at the moment there were only two students with a total of three observations days in a period of three weeks. More students using the system would have given us a broader view. Especially the results of the comparison analysis in the second study were we looked at behavioural differences between Webchair- and classroom lectures, were promising. However because of the low number of participants (n=3) there is a lack of external validity. In the second study there were a lot of technical problems, which caused sub-optimal research conditions. Moreover participants were excluded from the analysis because technical problems caused too many disruptions during the lecture.

Besides limitations regarding the sample size, there were also limitations in the method we used. First, we were unable to measure the verbal communication between the Webchair student and the class because the screen captures only captured the screen and not the audio. This would have provided us with more information because now it was sometimes hard to keep track on what was happening in the classroom. Furthermore we only used self-report measures with students, which may be fairly unreliable. For further research it may be useful to measure more performance measures as the scholastic performance.

Furthermore the majority of lectures in Study 2 were grammar lessons. A more diverse range of lectures would have been more interesting. Moreover, the participating students were all from the same school and worked only for a short period of time with the Webchair (range from 6 to 34 minutes). For further research it may be interesting to design a longitudinal

study. Further research could also include a larger comparison study, different types of classes, different schools. The results of this study showed a very high focus rate, which is a promising result. However, effects on the long term may be different. Maybe the students were focused because they didn't want to ruin their one-time opportunity of working with the system. A longitudinal study must reveal whether these high focus scores sustain over time. Moreover the presence of the observer might have influenced the focus scores. For further research it might be interesting to see whether the children are able to work with the system independently. If the Webchair system will be implemented on a larger scale it is important to know whether the children will be able to solely work with the system without a supervisor. This is also important for the teachers. During this study the new teachers were supervised by the researcher who took care of the technical aspects of the system. The teachers therefore didn't experience the demands and stress involved in the use of the system in a real-life school setting. When the system wasn't working properly they knew the supervisor would fix the system and the student could return to class in order to finish the lecture. For further research it might be interesting to train the teachers to work solely with the system.

Although we performed this research solely on children aged between 6 and 12, it might be useful to extend this research on children aged 12 and over. Older children may have different needs and are probably able to work more independent. Further research must identify the most optimal settings and additional technology requirements for the Webchair system in order to optimize its use in this particular setting. Every child is unique, and research must identify the profile of students who may benefit most from working with the Webchair system. In a follow-up study it might be valuable to identify the social impact of the system, in relation to autistic children's social needs and reintegration within the classroom setting.

Implications for design

As said before; people want to use a system if they can work more accurately and efficiently with it and if these benefits outweigh the costs of using the system. Currently the users are struggling with a lot of obstacles when using the system and improvements could be made to improve the usability of the system. From this study a number of recommendations emerge which will be helpful when implementing videoconferencing for educational purposes. These are not only technological implications regarding the system, but also helpful tools to efficiently work with the system in en educational setting.

First of all, the position of the Webchair in the classroom is important for both the student who is working from the remote site as well as for the students and teacher in the class. Install the Webchair at a central location and at the right height will enhance natural gaze direction. Gaze direction can give people hints as to who is paying attention to what/whom, and helps in establishing common ground in communication. It is, however, less emotionally confronting that direct eye contact. The right location supports everyone to interact as if actually being there; the student is able to look around in a natural way, and for the teacher and students in the class it will feel like a student sitting in the back of the class.

Not only the place in the classroom is important, attention must also be paid to the location at the remote site. When a student is working from a safe room in school, this really should be a safe, quiet and low stimulus place. During this research there was a lack of suitable, low stimuli places where a student could go to utilise the Webchair. Because the Webchair is not widely used at the Verschoorschool yet, there is no room solely for the Webchair. Therefore the students worked with the Webchair from an office or storage room. This wasn't contributing to a low stimulus working environment. It is important to arrange a room suited solely for the Webchair.

When a student is working from home it is essential to make clear arrangements about the set-up. During this study we saw a child working from the couch together with his dog. This makes it hard for a child to focus on the lecture. Children with autism need a clear structure and attention must be paid to make a distinction between school and home. Sitting on a couch isn't contributing to a learning environment. Children should be working at a desk, just like in class. Moreover, distractions from the domestic environment should be minimized.

During the study we had technical difficulties with the Webchair system. When a problem occurred it was hard to diagnose the cause of the failure. For example when the camera stopped working it was difficult to determine whether it was a problem on the laptop, Webchair or the connection between the two. The teachers already indicate they want to know more about the technology so they can try to restore the system. To improve the usability of the Webchair system, the teachers should either get training by Webchair or Webchair should supply instant support. Teachers are too busy with the students in the class, especially in special education, to spend much time on diagnosing the problem. Webchair should provide quick support, to prevent that Webchair lectures will be cancelled because of technical failure.

Improvements could be made regarding the audio and microphones. The major problem is that only the person who is speaking with the microphone can be heard at the remote site. Both teacher and students experienced this as a disadvantage of the system. The external microphone cannot be used at the same time with the teacher's microphone. Moreover the big external microphone caused agitation amongst the children. Therefore the Webchair student will solely hear the teacher talking with the teacher's microphone. The teacher should constantly be aware of this and repeat everything what the children ask or tell. It would be a big surplus if the Webchair student could hear everyone talking without the complex microphone system. This will unburden the teacher from constantly repeating and it gives the children the opportunity to actively participate in the lecture. This will make the lecture more fun and interactive for both the students in the class and for the Webchair student.

Finally a recommendation to the teachers. How can teachers in the classroom best redesign their lecture to incorporate the remote site, without too much disturbance to the lecture itself and attention to the others in class? At the introduction of the Webchair you should introduce all of the children to both sides of the Webchair. This will increase acceptance amongst the children and prevents prying eyes towards the Webchair during the lectures. To prevent disruptions during the lecture, make sure everything is set up properly before the lecture

starts. Moreover it is important to make clear appointments with all of the involved parties to create a calm environment. Children with autism need a lot of structure. When working with the Webchair from another place it might be more difficult to guide them during the lecture. Give the children clear instructions and inform them about the structure of the lecture and the time left. Moreover check regularly if they understand what's going on during the lecture, and if they are able to keep up with the lecture. Support the Webchair student to actively participate in the classroom to enhance a feeling of presence. The most important advice is that involving a Webchair student in the lecture might take more effort compared to the children in the classroom, but make sure you create an environment which is beneficial for everyone. The Webchair student must be benefiting from the lecture, but not at the expense of the other children in the classroom. At the Verschoorschool they set up a team of teachers and supervisors in an expert group. Hereby we discussed often occurring problems and design strategies for the lectures. This might be helpful to improve the form and content of the Webchair lectures.

Conclusion

Technological interventions may have a particular appeal to autistic students, as they resonate with some of their visual processing preferences and systemizing tendencies. Whereas video modeling of behavior and computer-assisted educational tasks have shown clear potential in the past for addressing needs for autistic children, remote education through videoconferencing technology has not yet received systematic attention. The rationale for using such technologies is clear: it can enhance earlier access to appropriate educational curricula, prevent the negative effects of being away from the classroom, and may offer a safe and controllable environment for students to work from, while still being engaged with the goings-on in class.

This research explored a completely new field of research; using videoconferencing to teach children with autism. Despite the small sample of this research, promising results were obtained both in terms of user acceptance, as well as academic achievement. At the beginning of this research we wondered whether a student would perform better/worse when working with a videoconferencing system and how working with the system would influence their behaviour. We found that students were enthusiastic about working with the system and performed better when working with the Webchair. The interaction between student and teacher (sub-question three) was more intensive compared to classroom interaction. The teacher gave the Webchair student more attention to make sure the student felt involved with the goings-on in class. The Webchair has both strengths and weakness (sub question four), also referred to as benefits and costs during this research. For students it can be beneficial to work from a comfortable and predictable environment, on the other hand too much comfort can result in unnecessary distractions. Teachers are willing to help the student on the remote site, but the physical distance was sometimes still difficult. It takes more effort for teachers to actively involve the student during the lecture. To answer sub-question five about the usability of the system: The system was easy to work with for the children, however the system itself suffered from technical failures. For teachers it was hard to fix the system when

problems occurred. At the introduction of the Webchair it is important to train both students and teachers how to use the system.

Recalling our main research question; how can videoconferencing tools help to enhance social and educational skills for children with autism? In comparison to earlier work, we have demonstrated that video conferencing can have a useful role in social and educational settings. Further tests and experiments need to be conducted in order to identify key parameters that must be adjusted for the needs of autistic children. In our opinion the valuable quote below shows exactly what this research was all about; helping children with autism to find a suitable and safe way to enhance their social and educational skills.

> "*I think he would have never made it this far without the Webchair. He really had the opportunity to watch what was happening in the class in a safe and pleasurable way. Although it was a huge step for him to take, it was the right one to take"*
> *(teacher class 2).*

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Appendices

Appendix A - Observation Scheme

Groep:	Les:	Thuis / saferoom	Tijd:
Lesvorm:		Camerapositie:	

interactie			**techniek**
leerkracht	webchair leerling	leerlingen	beeld
			geluid
contact zoeken	vragen stellen	luisteren	problemen
afgeleid worden	actief deelnemen gesprek	anders	cameragedrag ll

Beschrijving

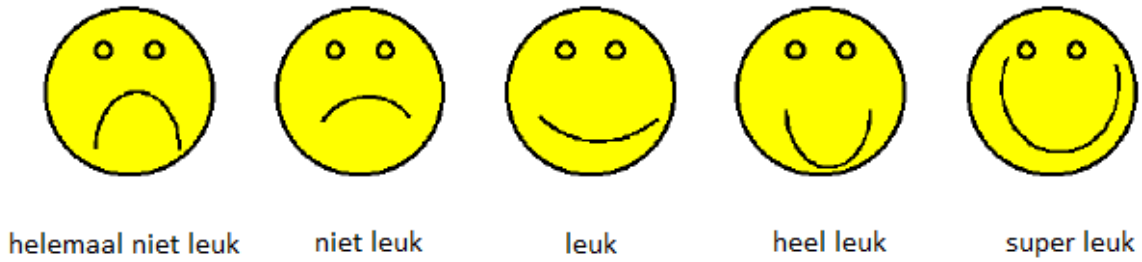
Voorbeeld / gevolg / effect

Opmerkingen

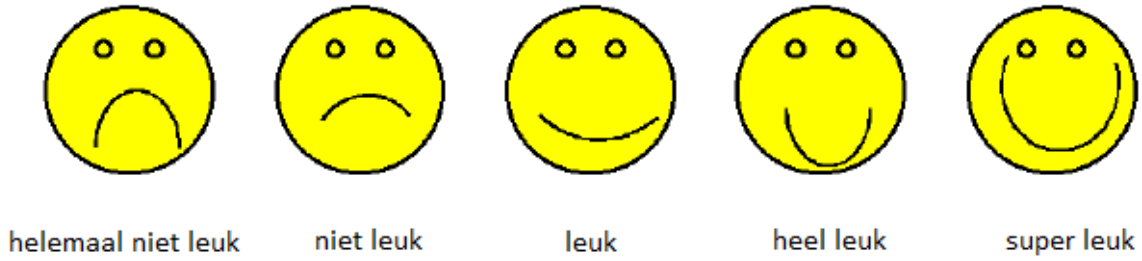
Appendix B – Webchair

Appendix C – Smileyometer interview

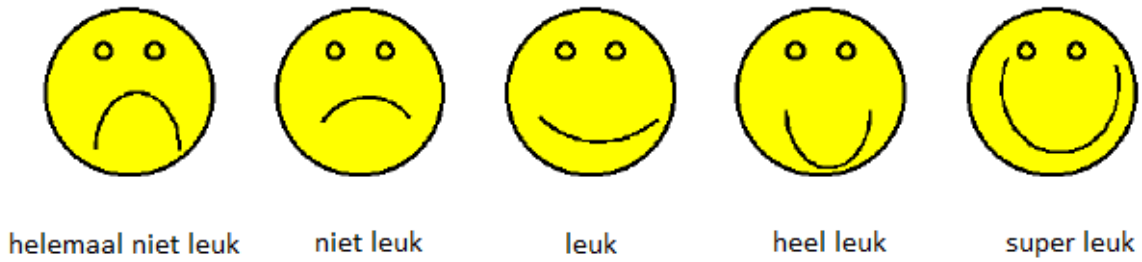
1. Ik vind werken met de Webchair:



2. Door de Webchair kan ik mijn klasgenoten zien, dit vind ik:



3. Door de Webchair is het net alsof ik gewoon in de klas ben, dit vind ik



4. Het geluid van de Webchair werkt:

helemaal niet goed | niet goed | goed | heel goed | super goed

5. De camera van de Webchair werkt:

helemaal niet goed | niet goed | goed | heel goed | super goed

6. Meeluisteren met de juffrouw en de klas via de Webchair gaat:

helemaal niet goed | niet goed | goed | heel goed | super goed

7. Dit gaat goed met de Webchair

……..……
……..……
……..……
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8. Dit vind ik moeilijk met de Webchair

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……..……
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……

9. Zou je nog een keer met de Webchair willen werken? Kun je vertellen waarom?

……
……..……
……..……
……..……
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……
……

Appendix D –Interviews Teachers

Interview with teacher who is familiar with the Webchair system.

- Wat is uw ervaring met de Webchair?
    - Hoelang werkt u al met de Webchair?
    - Hoe heeft u de Webchair geïntroduceerd bij de klas
    - Kunt u mij het proces vertellen hoe het er aan toe gaat in de klas met de Webchair, dus van opstarten tot uitzetten?
    - Hoe betrekt u de leerling achter de Webchair bij de klas
    - Voelt het werken met leerling op afstand natuurlijk/onnatuurlijk (dus via scherm achter in de klas) en waarom?.
- Techniek:
    - Kunt u de Webchair en dus de leerling goed zien op afstand (last van lichtinval o.i.d.)
    - Welke problemen betreft de techniek ervaart u met de Webchair
    - Wat vindt u van het geluid/de microfoons?
- Interactie: is de interactie tussen leerlingen anders wanneer deze bij u in de klas zouden zitten als dat zij via de Webchair meewerken?
    - Kost het voor u meer aandacht wanneer er met de Webchair gewerkt wordt
    - spreekt u ze anders aan, behandelt u ze anders,etc.?
    - Is de vorm/inhoud van de lessen anders wanneer er met de Webchair gewerkt word?
- 1 van mijn onderzoeksvragen gaat over assessment, de prestatie van de Webchair leerlingen: Zijn de prestaties van Webchair leerlingen anders wanneer zij in de klas werken of via de Webchair ? Bent u in staat leerlingen beter te beoordelen doordat ze anders presteren wanneer zij met de Webchair werken?
- 1 van mijn hypotheses is dat kinderen de Webchair fijn zouden kunnen vinden omdat het oogcontact minder direct is.
    - Heeft u het gevoel dat u oogcontact kunt maken met de leerling via de Webchair ? en hoe reageert de leerling hierop?
    - Denkt u zelf dat minder direct contact 1 van de waardevolle punten van een Webchair systeem zouden kunnen zijn.
- Tot slot, reflectie: Wat kan volgens u de rol van de Webchair zijn in het didactisch proces. Dus wat zijn de belangrijkste momenten met de Webchair die van meerwaarde kunnen zijn.

- Welke voor en nadelen ziet u in het gebruik van een videoconferenties ysteem zoals de Webchair
- Denkt u dat kinderen met autisme anders reageren op /omgaan met een videoconferentie systeem ten opzichte van kinderen zonder autisme?
- Denkt u dat videoconferentie technologie een hulpmiddel kan zijn voor kinderen met autisme? Kan videoconferentie technologie bijdragen aan het verbeteren van sociale en educatieve vaardigheden voor kinderen met autisme? Dus kan een leerling toch zijn leerdoelen bereiken ook al is deze fysiek niet in de klas of op school, en blijft deze leerling verbonden met zijn klasgenootjes en de leeromgeving van de klas.
- Welke mogelijke verbeteringen heeft u voor het gebruik van videoconferentie systemen / Webchair

Interview with teacher who is unfamiliar with the Webchair system.

- Allereerst, hoe heb je het ervaren zo met de Webchair in de klas?
    - Hoe heeft u de Webchair geïntroduceerd bij de klas
    - Hoe betrekt u de leerling achter de Webchair bij de klas
    - Voelt het werken met leerling op afstand natuurlijk/onnatuurlijk (dus via scherm achter in de klas) en waarom?
- Techniek:
    - Kunt u de Webchair en dus de leerling goed zien op afstand (last van lichtinval o.i.d.)
    - Welke problemen betreft de techniek ervaart u met de Webchair?
    - Wat vindt u van het geluid/de microfoons?
- De Webchair was nieuw voor u: waren er dingen die u moeilijk/onduidelijk vond aan de Webchair
- Interactie: is de interactie tussen leerlingen anders wanneer deze bij u in de klas zouden zitten als dat zij via de Webchair meewerken?
    - Kost het voor u meer aandacht wanneer er met de Webchair gewerkt wordt
    - spreekt u ze anders aan, behandelt u ze anders,etc.?
    - Is de vorm/inhoud van de lessen anders wanneer er met de Webchair gewerkt word?
- 1 van mijn hypotheses is dat kinderen de Webchair fijn zouden kunnen vinden omdat het oogcontact minder direct is.
    - Heeft u het gevoel dat u oogcontact kunt maken met de leerling via de Webchair ? en hoe reageert de leerling hierop?
    - Denkt u zelf dat minder direct contact 1 van de waardevolle punten van een Webchair systeem zouden kunnen zijn.
- Tot slot, reflectie: Wat kan volgens u de rol van de Webchair zijn in het didactisch proces. Dus wat zijn de belangrijkste momenten met de Webchair die van meerwaarde kunnen zijn.

- Welke voor en nadelen ziet u in het gebruik van een videoconferentie systeem zoals de Webchair
- Denkt u dat kinderen met autisme anders reageren op /omgaan met een videoconferentie systeem ten opzichte van kinderen zonder autisme?
- Denkt u dat videoconferentie technologie een hulpmiddel kan zijn voor kinderen met autisme? Kan videoconferentie technologie bijdragen aan het verbeteren van sociale en educatieve vaardigheden voor kinderen met autisme? Dus kan een leerling toch zijn leerdoelen bereiken ook al is deze fysiek niet in de klas of op school, en blijft deze leerling verbonden met zijn klasgenootjes en de leeromgeving van de klas.
- Welke mogelijke verbeteringen heeft u voor het gebruik van videoconferentie systemen / Webchair

Appendix D – Results Webchair Analysis

	Duration	looking at screen			Not looking at screen			Focus on lecture			Focus on class			looking around		
		duration	# events	% of total	duration	# events	% of total	duration	# events	% of total	duration	# events	% of total	duration	# events	% of total
ppn1	864,04	553,11	71	64,01	310,93	70	35,99	753,09	4	87,16	67,58	2	7,82	23,26	2	2,69
ppn2	1713,99	1082,57	91	63,16	631,41	88	36,84	1132,41	14	66,07	154,88	2	9,04	352,6	15	20,57
ppn3	920,69	643,97	59	69,94	276,72	58	30,06	722,99	2	78,53	74,91	1	8,14	-	-	-
ppn4	983,61	565,35	62	57,48	418,26	61	42,52	734,9	2	74,71	121,18	1	12,32	40,01	2	4,07
ppn5	898,99	810,54	22	90,16	88,44	21	9,84	471,83	6	52,48	99,41	5	11,06	181,88	4	20,23
ppn6	1086,93	470,17	51	43,26	616,77	51	56,74	946,01	1	87,03	-	-	-	-	-	-
ppn7	1148,48	629,23	55	54,79	519,25	54	45,21	838,81	2	73,04	242,71	1	21,13	-	-	-
ppn8	1403,72	753,08	118	53,65	650,63	117	46,35	820,69	5	58,47	522,24	4	37,2	53,31	4	3,8
ppn9	1720,32	1489,2	50	86,57	231,12	50	13,43	849,46	4	49,38	652,96	7	37,96	199,72	4	11,61
ppn10	1068,21	751,12	50	70,32	317,09	48	29,68	643,01	6	60,2	151,31	6	14,17	262,06	9	24,53
ppn11	1145,89	641,94	54	56,02	503,95	54	43,98	851,71	10	74,33	61,05	3	5,33	198,39	8	17,31
ppn12	342,86	254,33	19	74,18	88,53	18	25,82	335,89	1	97,97	-	-	-	3,73	1	1,09
ppn13	1212,53	564,62	50	46,56	647,92	50	53,44	1173,82	1	96,81	-	-	-	-	-	-
ppn14	1577,67	452,77	56	28,7	1124,9	56	71,3	284,77	3	18,05	1217,42	4	77,17	-	-	-
ppn15	1457,96	788,15	52	54,06	669,81	52	45,94	1093,23	4	74,98	314,99	3	21,61	0,83	1	0,06
ppn16	1109,52	540,49	80	48,71	569,03	79	51,29	950,65	4	85,68	-	-	-	85,27	4	7,68
ppn17	1433,29	413,64	88	28,86	1019,64	88	71,14	957,87	1	66,83	473,71	2	33,05	-	-	-
ppn18	1365,94	1156,91	42	84,7	209,03	41	15,3	-	-	-	1254,73	5	91,86	96,71	5	7,08
ppn19	991,15	238,64	29	24,08	752,51	29	75,92	960,57	1	96,91	-	-	-	-	-	-
ppn20	791,21	504,48	37	63,76	286,73	37	36,24	388,95	2	49,16	244,92	2	30,96	15,53	1	1,96

	Duration	lift hand	Contact teacher	Contact students	Technical problems		yes - focus on lecture (teacher/ presenter screen)			no - disturbed from lecture (look around etc.)		
		# events	# events	# events	duration	% of total	duration	# events	% of total	duration	# events	% of total
ppn1	864,04	-	-	1	-	-	832,86	5	96,39	31,19	4	3,61
ppn2	1713,99	-	-	5	64,56	3,77	1214,58	26	70,86	499,4	25	29,14
ppn3	920,69	-	-	2	-	-	815,91	2	88,62	104,78	2	11,38
ppn4	983,61	-	1	-	-	-	777,95	15	79,09	205,66	15	20,91
ppn5	898,99	-	-	6	68,24	7,59	741,64	3	82,5	157,34	2	17,5
ppn6	1086,93	-	-	-	-	-	1082,77	2	99,62	4,16	1	0,38
ppn7	1148,48	-	-	-	-	-	1148,48	1	100	-	-	-
ppn8	1403,72	1	-	1	-	-	1360,6	4	96,93	43,12	3	3,07
ppn9	1720,32	13	2	7	20,64	1,2	1225,26	18	71,22	495,06	18	28,78
ppn10	1068,21	-	4	2	-	-	778,51	10	72,88	289,7	10	27,12
ppn11	1145,89	2	5	1	-	-	873,16	13	76,2	272,73	12	23,8
ppn12	342,86	-	-	-	-	-	342,86	1	100	-	-	-
ppn13	1212,53	-	-	1	28,15	2,32	1208,69	2	99,68	3,85	1	0,32
ppn14	1577,67	-	-	1	-	-	1337,88	20	84,8	239,79	18	15,2
ppn15	1457,96	2	1	-	-	-	1433,68	5	98,33	24,28	4	1,67
ppn16	1109,52	-	-	1	69,81	6,29	924,47	7	83,32	185,05	6	16,68
ppn17	1433,29	-	-	-	-	-	1410,5	4	98,41	22,79	3	1,59
ppn18	1365,94	1	1	7	-	-	1002,87	12	73,42	363,06	11	26,58
ppn19	991,15	2	3	-	-	-	959,42	6	96,8	31,74	5	3,2
ppn20	791,21	1	-	3	-	-	714,27	9	90,28	76,94	8	9,72