Teachers’ experiences of using eye gaze-controlled computers for pupils with severe motor impairments and without speech

Patrik Rytterström³, Maria Borgestig¹ and Helena Hemmingsson¹

¹Department of Social and Welfare Studies, Linköping University, Norrköping, Sweden; ²Folke Bernadotte Regional Habilitation Centre and Department of Women’s and Children’s Health, Uppsala University, Uppsala, Sweden

ABSTRACT
The purpose of this study is to explore teachers’ experiences of using eye gaze-controlled computers with pupils with severe disabilities. Technology to control a computer with eye gaze is a fast growing field and has promising implications for people with severe disabilities. This is a new assistive technology and a new learning situation for teachers. Using a reflective lifeworld approach, 11 teachers were interviewed twice. The essence of the phenomenon of teaching pupils who use an eye gaze-controlled computer is to understand what the pupil does with the computer and relate this to what the pupil wants to express through the computer. The pupils have emotions, wishes and knowledge that are trapped in their own bodies. The eye gaze computer creates opportunities to get a glimpse of these thoughts to others, and creates hope concerning the pupil’s future possibilities. The teacher’s responsibility to try to understand what is inside the pupil’s trapped body is a motivating factor to integrate the computer in everyday classroom activities. The results give directions for teaching and for implementation of eye gaze computers in the school system, and also suggest improvements that could be made to computers.

Introduction

The focus of this article is on teachers’ experiences of teaching pupils with severe motor impairments and without speech using eye gaze-controlled computers as assistive technology. The use of eye gaze-controlled computers is related to Swedish laws and school policies which state that children with disabilities should have equal opportunities to participate in all aspects of school life, and schools are responsible for adjusting everyday schoolwork as required to meet each student’s needs and abilities. With this ambition, information and communication technology (ICT) helps both pupils and teachers in the process of inclusive education and is a tool to implement educational practices in better ways (Rodríguez, Nussbaum, and Dombrovskia 2012). This is emphasised by International Telecommunication Union (ITU) which states that by 2015, governments around the world should connect primary schools with ICT to motivate learning (Trucano 2005; United Nations 2012). Interaction
with ICT can open up possibilities to gain knowledge, but can also contribute to the development of agency and influence motivation and activity (Näslund and Gardelli 2013). Although positive effects are described for ICT as a motivation factor for student and teacher, ICT interventions without support and training have limited effectiveness (Archer et al. 2014) and the impact of ICT on student achievement has not been proven (Trucano 2005). A successful implementation of assistive technology depends on various issues such as assessment, training, organisation, environmental factors, motivation and effort (Coleman 2011). Moreover, the use of assistive devices is an interactive process with technology, classmates, teachers and other persons affecting the use of ICT (Näslund and Gardelli 2013).

Teachers have a significant role in implementing and teaching ICT (Brodin 2010). Pupils’ interaction with ICT is related to the teacher’s ability to support and encourage it (Näslund and Gardelli 2013), which influences whether or not students use their AT devices (Hemmingsson, Lidstrom, and Nygard 2009). Although the teacher’s role is important for encouraging students’ use of AT, they are described as having inadequate professional pedagogical training to teach students with disabilities (Grskovic and Trzcinka 2011). The teachers and the school system need to find new ways of implementing assistive devices in education.

The eye gaze computer

Operating a computer can be impossible for children with severe disabilities, without speech and with profound motor impairment since they cannot use a computer mouse, keyboard, joystick, trackball, voice or switches as input methods. For these children, eye-gaze computer might be an option to operate a computer. Eye gaze control allows users to interact with objects on a computer screen by moving their eyes. It is made possible by using an inbuilt camera in the screen that reads where on the screen the person is looking, with a precision of a few millimetres. The gaze replaces the computer mouse and keyboard as the input method (Majaranta and Donegan 2011).

Technology to control a computer by eye gaze is a fast growing field with promising implications for people with severe disabilities. The latest eye gaze systems are commercially available for users and have efficient performance and accuracy (Pfeiffer 2014). There are indications that severely disabled children, despite their serious afflictions, can become more competent at controlling computer with their eye gaze over time (Borgestig, Falkmer, and Hemmingsson 2013). However, it remains unclear how people with disabilities actually use eye gaze-controlled computers in a real day-to-day context. That a technology works does not necessarily mean it is practical in everyday life. The purpose of this study is to explore teachers’ experiences of using eye gaze-assistive computers with pupils with severe disabilities. For teachers, this is a new technology and a new learning situation. It is therefore important to learn from the teachers’ experiences of their life situation, and consider how well the technology is working in the real day-to-day school context.

Method

The study is part of a research project concerning eye gaze control for children with severe motor impairments and without speech with the purpose of optimising the learning, the use and implementation of gaze-based computer in daily activities, in home and in school.
for children. The project includes consideration of how teachers and parents experience eye gaze computers as assistive technology in everyday use at home and in education. For this study, to grasp this everyday use of computers, an empirical research approach conducted from a lifeworld perspective was chosen (Dahlberg, Dahlberg, and Nyström 2008). A lifeworld research describes the world the way it is experienced by humans and to do so in a way that expands our understanding of the experience. This research seeks human’s everyday experiences and meanings, experiences that often is taken for granted or ‘tacit’ (Todres, Galvin, and Dahlberg 2007).

Participants and setting

The study was conducted in Sweden at seven different schools (a preschool, five special schools and one mainstream schools with special class). The seven pupils (Table 1), aged between 5 and 15 years, had cerebral palsy (dyskinesia, spastic diplegia or spastic tetraplegia) with severe motor impairment and were in total need of assistance in all activities in school, as well as in all everyday activities. Four children had unspecified cognitive impairments, one child had a cognitive level related to age, while for two children the cognitive ability was unknown as it was not possible to assess due to the profound disabilities. None of them were capable of speech, and all used eye-pointing and facial expressions as modes of communication. Some children had access to low-tech communication boards or single pictures for eye-pointing, but with limited use. All children were restricted in their ability to express themselves with other people. Other computer input methods, such as head mouse or head switches, had been tried before the gaze-based AT but an eye control device was, in most cases, the only device the children could use to control a computer. The seven pupils were provided with a gaze-based AT, Tobii Technology C12 or P10 (Tobii Technology 2015), with a software program including grids individually adapted with pictures, photos and/or symbols to support each child’s communication, interaction and activities in school. The eye gaze computer was used in school settings for approximately one hour per day.

A total of 11 school staff participated in the study, seven teachers and four teacher assistants, whose experience ranged from 4 to 39 years. Four were male and seven were female. They worked at different schools that had a pupil in class who was provided with a gaze-based assistive technology for use in school activities. The participants, along with their pupils and the parents took part in a gaze-based intervention at a regional paediatric centre in Sweden, to promote the use of eye gaze-controlled computers in school.

Information letters were sent to all pupils and parents who had been referred to the regional paediatric centre. Subsequently, there was an information meeting which provided the chance to ask questions about the study. After written consent to participate in the study was received, the principals and teachers for each pupil’s respective school were contacted. All were given written information about the study.

Data collection

Every teacher and teacher assistant was interviewed twice, first when the eye gaze computer was introduced to the pupil in the classroom, with a follow-up interview seven to 12 months later. The first interview centred on concerns and expectations regarding the use of eye gaze computers in the classroom. The follow-up interview was more focused on the experience
| Participant, sex, and age in years | Diagnosis* | Motor function | Communication | Epilepsy | Cognition‡ | Vision and hearing‡ | School‡ |
|-----------------------------------|------------|----------------|---------------|----------|------------|--------------------|--------|
| 1, c, 5                           | CP dyskinesia | Severely limited, transported | No speech Eye-pointing Clear yes/no Communication board | Yes | N | Hearing loss, no hearing aid | Special preschool |
| 2, c, 6                           | CP dyskinesia | Severely limited, transported | No speech | No | Unknown | Refractive error, bilateral hearing loss, no hearing aid | Mainstream school, special class |
| 3, c, 6                           | CP dyskinesia | Severely limited, transported | No speech Eye-pointing Clear yes/no Single pictures | Yes | UI | N | Special school |
| 4, c, 8                           | CP spastic diplegia | Severely limited, transported | No speech | No | UI | N | Special school |
| 5, c, 8                           | CP spastic diplegia | Most severely limited, transported | No speech Eye-pointing Clear yes/no Single pictures | No | Unknown | Alternating strabismus | Special school |
| 6, c, 13                          | CP spastic tetraplegia | Severely limited, transported | No speech Eye-pointing Clear yes/no Communication board | Yes | UI | Alternating strabismus | Special school |
| 7, q, 15                          | CP spastic tetraplegia | Most severely limited, transported | No speech Eye-pointing Clear yes/no Communication board | No | UI | N | Special school |

*CP, Cerebral palsy, £N – normal; UI – unspecified cognitive impairment; Unknown – not possible to assess.
of using the eye gaze computer. All the participants chose to meet at their working place. The interviews lasted between 60 and 90 min and were recorded with a digital voice recorder. The in-depth open-ended interviews (Brinkmann and Kvale 2015) were conducted as an open dialogue, seeking the informant’s reflections and experiences of using and supporting the pupil with an eye-controlled computer. To get background information on the phenomenon of teaching pupils using eye gaze-controlled computers, all interviews began with the question: ‘Can you tell me about an ordinary day when the pupil uses the eye gaze computer?’ Thereafter, open questions were asked on several sub-areas to get an insight into the informant’s individual experience. Every direct question was followed up by open-ended questions such as: ‘Can you give me an example?’ or ‘Could you please tell me more about that?’ The goal of the follow-up questions was partly to gain richer explanations of the experience and partly to ‘bridle’ the interviewer’s self-understanding, ensuring it was the voice of the informant’s lifeworld that stood out (Dahlberg, Dahlberg, and Nyström 2008). Participants were encouraged to provide concrete examples to avoid thematised descriptions and general arguments. The interviews were transcribed verbatim by the first author.

**Analysis**

The interview text was analysed using the phenomenological reflective lifeworld described by Dahlberg, Dahlberg, and Nyström (2008) to find the essence and meaning structure of teaching pupils with the help of an eye gaze-controlled computer. The approach means that the analysis is descriptive, close to the text and explores the phenomenon without theoretical interpretations and constructions. Although the interviews were focused on the informant’s lifeworld and everyday meaning of teaching how to use an eye-controlled computer, the analysis was carried out with a scientific ‘bridling’ attitude where the interview text all through the analysis was questioned and pondered upon (Dahlberg, Dahlberg, and Nyström 2008). After the interviews were read through several times so researchers could become familiar with the data as a whole, the interview text was divided into meaning units. Each interview was handled separately in the search for various meanings in the data. All meaning units in all interviews were then grouped into different clusters of meaning units. The meaning units and clusters were kept close to the informants’ own words, with no changes of the participants’ statements. These clusters were viewed as ‘temporary patterns’ (Dahlberg, Dahlberg, and Nyström 2008, 244) to get a sense of the essential meanings and structures of the data. After that the text was again regarded as a whole, and the clustered meanings were related to each other, to discover a new whole. The goal was to find the essence of the phenomenon and the meanings that constituted the actual essence. This was done by moving back and forth between the parts and the whole of the text. All meaning units and clusters were connected to the whole text, generating a general structure that consisted of the essence and its constituents. The essence is the most essential, invariant meaning of teaching a pupil with an eye gaze computer. The constituents described nuances and variations between the individual’s experience of the phenomenon. When presenting the general structure, its essence and constituents, the concrete data was formulated into more abstract scientific language.

**Ethical considerations**

The study was approved by the Regional Ethical Review Board, Uppsala.
Results

The results are presented first by exploring the essential meaning of the phenomenon and, following this, the constituents that describe the contextual nuances of the phenomenon. Together, the essential meaning and the constituents comprise the overall phenomenon of teaching using an eye gaze controller.

The essential structure of the phenomenon of teaching pupils using eye gaze-controlled computers is to understand what the pupil does with the computer and relate this to what the pupil wants to express through the computer. Understood as doing, the teacher tries to understand what the pupil sees and is trying to achieve with the eye movements. To understand what the pupil does, the teacher tries to constantly be present and active in the learning situation, balancing between actively supporting the pupil’s gaze and at the same time not taking over control of the computer. Due to the serious communication problems, the teacher looks at the pupil’s eye and facial expressions to understand what the pupil is trying to do on the computer screen.

Understood as expression, the teacher tries to understand what the pupil wants to express through the eye control and by that how to use the computer for learning and development. That the pupils have emotions, wishes and knowledge that is trapped in their own body is mirrored in all the teacher’s stories. The eye gaze computer creates an opportunity to understand these thoughts and feelings for others and creates a hope for the pupil’s future possibilities, a hope that is nurtured by the progress already accomplished. But at the same time, the learning situation also reminds the teachers about the student’s present vulnerable situation and shut-in feeling, and it arouses an awareness of the pupil’s knowledge and thoughts, and a responsibility to understand and bring them out. This responsibility to try to understand what is inside the pupil’s trapped body is a motivating factor to integrate the computer in everyday classroom activities. What the pupil can do in the concrete activities is therefore related to what the pupil can express.

In the learning situation, there is a tension between the teacher’s future-oriented perspective and the pupil’s more ‘here and now’ experience of the computer, and this can ultimately affect the motivation for the pupil to use the eye gaze-controlled computer. When this learning situation works smoothly, the educational process can be described as follows: the computer is ‘invisible’, intuitively controlled by the pupil, integrated in the school’s everyday life and mediating the pupil’s knowledge, thoughts and feelings to the teacher and other pupils.

To understand the pupil’s gaze

Using an eye gaze computer in education is mostly implemented by controlling educational software or a communication software program. But to support the pupil in using the software is also to help the pupil to gaze-control the computer. The teachers describe how this, in one way, is not possible. It is only the pupil that can control his/her own gaze. Instead, the teacher points at the screen and speaks to the pupil to catch their attention and their gaze. Touching the screen is also accompanied by continually asking questions and making encouraging comments. They also look at the computer screen to see where the pupil is fixing his/her eyes, but to understand what the pupil wants to do, the teacher looks at the pupil’s eyes and observes small facial expressions:
It is important to look at the computer screen but … I always sit down so I can see Emma’s face. It is then that you know what she wants. Is she tired or is she thinking of something?

Sometimes there is uncertainty about how the pupil’s actions should be interpreted. When the pupil pauses and there is no activity on the computer screen, the teacher suspects it could be because the pupil is losing interest in the schoolwork, the instructions are unclear, or the pupil is reflecting on how to perform the schoolwork. The face can reveal what the pupil is focused on, if the pupil is interested and present, or if the pupil is starting to get tired or unable to concentrate.

This means that teachers sit close to the pupil so they can see the screen but also the pupil’s face. The teachers describe the learning situation as a delicate balance between waiting for the pupil to manage to control the computer and helping the pupil by pressing the computer screen or giving new instructions. They do not want to take over tasks the pupil can handle themselves but if these tasks take too long, the teachers become concerned that the pupils will get tired:

It is a balance. If you help him too soon, then he won’t develop … But if you don’t do anything then there is a risk that he will just get tired of this. You have to understand what he is actually thinking in the specific situation.

It is a balance to mediate the just right amount of support to promote the pupils’ development. Too much support will hinder pupils’ development and too less support may result in unwillingness to go further. Trying to understand the pupil’s intention seems to be a key point. By pointing at the screen, looking at the pupil’s facial expressions, talking, helping the pupil to adopt a good body posture, the teachers are active and constantly present in the learning situation. They describe how time is passing and the importance that they are present here and now.

**Getting a glimpse of the pupil’s inner thoughts**

Even though many of the computer’s software programs are related to school subjects and learning activities, the teachers reflect the pupil’s learning progress more often from the possibilities and their desire for the pupils to express their wishes and will. They describe the pupils, due to their disability, as trapped in their own body, with few possibilities to mediate their inner thoughts. With the introduction of eye gaze-controlled computers, there are opportunities to express this inner experience:

There are in Henrik plenty of feelings and stuff like that. We never see that. But now with the computer this becomes visible. Henrik can actually say things that were not possible before. … Who knows what this can mean for him in the future?

For example, with help of the eye-controlled computer, the pupil can express pain and where the pain is situated; can indicate who she/he wants to be with in the schoolyard; or can describe how she/he experiences different activities. What the teacher sees today creates a hope for the future.

But at the same time that the eye-controlled computer creates opportunities to understand the pupil’s inner experience, the teachers experience frustration when the software shows limitations in what is possible to express. The teachers describe how the eye-controlled computer creates a hope of understanding the pupil’s inner thoughts, but when this understanding is within reach, there is an awareness of the software’s limitations:
Sometimes he answers but I don’t believe the answer. Sometimes I think he wants … wants to answer ‘I am so tired of you’ or maybe ‘This is so damned boring’. (laugh)

The pupils can answer questions by choosing different written answers or pictures from a selection on the computer screen. These answers are often prepared in advance by the teachers but they find that the pupils sometimes want to give a different answer. The teachers wish that the programs were more adaptive and more open to the pupil’s situation and needs.

From the teacher’s perspective, the eye gaze-controlled computer opens up possibilities to understand more deeply the pupil’s inner thoughts. But it also reminds the teacher of an underlying unfairness that will never change:

I try to help (by touching the screen) but … You become aware that you can help because you have no disabilities … I mean, William will never be capable of this. It is … In some way this is unfair. I can say what I want … But I doubt William will ever be able to do this.

This knowledge of unfairness has been there all the time, but related to eye-controlling the computer, the pupil’s situation and vulnerability is actualised. The learning situation is therefore also described as one which touches the teacher, allowing him/her to get to know the pupil in greater depth.

**The interplay between the pupil, the eye gaze computer and the surroundings**

In the best learning situations, the pupil and the computer almost become one with each other. In these situations, the teachers express how they do not do anything special other than to ‘be there’. The teachers experience a flow where the skill of eye-controlling the computer or the underlying technology is not highlighted. Instead, the pupil’s communication and integration with other people are emphasised, and the teacher’s role is to more passively observe what is happening. When the eye gaze performance is working in this way and is capable of expressing the pupil’s thoughts, the technology is experienced as invisible:

When does it work best? It is like the computer does not stand in the way. It is not an obstacle, everything just works. … I don’t think about the computer; instead I am focused on what he is trying to do. Things start to move fast on the screen. It is almost that I am not able to keep up.

When ‘everything is working’, the computer is not in focus. Instead, the teacher tries to interpret what the pupil wants to express and convey to the teacher or classmates. The computer strengthens the experience and the teachers describe how the pupil becomes almost one with the computer. The teachers experience how this intuitive way of controlling the computer is related to the pupil becoming better at eye-controlling the computer.

However, the computer could also be experienced as not working as expected. The teacher experiences how the pupil wants to express knowledge or thoughts, but neither the computer nor the pupil’s facial expression can give the teacher a clue about what the pupil wants to express:

Sometimes you just want to throw the computer out of the window. And yes, I believe Michael also wants that (laugh). It could be so when I try to understand what he wants to accomplish with the eye gaze. I have asked a thousand times but when I look at his face, I understand that I have no idea about this.

In these circumstances, the computer becomes ‘visible’ and the interplay between the pupil, teacher and computer ceases.
The interplay between the pupil and computer is also related to the context. The teachers describe how the eye gaze computer needs to be integrated in the school’s ordinary life. It is in ordinary use, in morning meetings, at the schoolyard or when communicating with other pupils that the pupils find motivation to use the eye gaze-controlled computer and appreciate its usefulness:

He always uses it at the morning meeting we have each day. We sit in a circle and say hello to each other. He can say hello to his classmates and describe the weather. Sometimes he shows photos from the weekend.

Although this everyday use of the eye gaze-controlled computer is desirable, there are many obstacles to deal with before achieving this goal. The teachers describe how the everyday use presupposes that the computer is immediately available. Often the computer needs to be started up or fetched from somewhere else, with the result that spontaneity is lost. The computer could, for example, be in a corner of the classroom and the other pupils are in another part of the classroom. The teachers describe how they lose momentum and how the pupil stops participating in the joint work with other pupils. The everyday use of the computer is also made difficult by the fact that the pupil must use technical devices and adjustments to sit in a correct position at the computer. Much time and energy is devoted to getting the pupil prepared for the computer. Sometimes, the computer is too clumsy and not mobile enough to fit new situations. There are also situations when the teacher thinks that the pupil needs to work alone and therefore the computer is placed in a corner of the classroom or in another room. This could help in some situations, but the overall teacher experience is that the computer needs to be integrated into the classroom and used in ordinary school tasks carried out with the classmates.

There is also an interplay between the pupil and classmates. The eye gaze computer attracts other pupils’ interest and the teachers encourage the classmates to try to eye gaze the computer. They do not have the same precision as the disabled pupils have:

It is wonderful to see. They don’t have the same technique. You can see that he has fun when they try to control the computer. He is so proud that he is way better than his classmates at eye-controlling the computer.

The pupil is proud to be better than his classmates and teachers in controlling the computer with his eyes. This could be the only practical situation where the pupil actually is better at something than other people.

To walk at the same pace

The teachers have high hopes that the eye gaze-controlled computer is going to help the pupil in future school work. They have already seen how the pupil can express motions and demonstrate knowledge, both of which were previously hard to do. They also see how the computer could end the isolation and create a possibility to better communicate with those around the pupil. This creates an expectation that the computer, today and in the future, is going to be an important assistive device. Therefore, the teachers experience frustration when the pupil does not want to eye gaze-control the computer. Sometimes there may be periods of weeks or months when the eye gaze-controlled computer is only used occasionally:

It went almost a half year and he never used the computer. Sometimes I tried but I saw how his whole body said ‘No, absolutely not.’ It was just boring.
The teachers say the reason for the dislike among the pupils is often that the teachers are too ambitious and the pupil has lost interest and the enjoyment in controlling the computer. The teacher’s expectations are not shared by the pupil, which makes the teacher disappointed and frustrated. To overcome the negative feelings, the teachers describe how they ‘start over’:

We had tried everything. Nothing was working. But then we restarted …

Restarted?
Yes, started afresh. We restarted and did only the things he enjoyed. Sure, it was games and puzzles and stuff like that … But that was what he liked to do. And in retrospect … We were not where he was.

The teachers describe how they have hopes for eye gaze-control that are not shared by the pupil. It is only if they understand eye gaze-control from the pupil’s perspective that the urge to control the computer can emerge. It is described as a restart, downplaying the pupil’s expectations and allowing the pupil’s interest and joy to lead the process. This in turn gives the teacher clues about the pupil’s development level and creates a new platform from which teachers could restart. They have to slow down and instead understand how the pupil understands the situation. The future prospects and the hopes associated with them come second to the pupil’s perspective on eye gaze-control.

At the same time, the teachers describe an uncertainty about how much the pupil can improve upon their disabilities. They describe their hopes but they doubt how realistic they are:

You want it so badly. It feels like everything is possible but at the same time you don’t know if he can manage it. I mean, perhaps it doesn’t matter how good at eye gaze-controlling he becomes. What is possible? Nobody knows. I guess time will tell what is possible.

Although eye gaze-controlled computers are available and used in education, the teachers are uncertain about how the pupils can benefit cognitively from teaching. The teachers nevertheless describe how the eye gaze-controlled computer can help them in assessing the pupil’s progress and learning needs. This understanding makes it possible to set up realistic goals and expectations for the pupil’s learning. They describe the importance of understanding the pupil not in terms of what s/he could be in future but what s/he is at present.

**Discussion**

**Results discussion**

The aim of this study was to explore teachers’ experiences of using eye gaze-assistive computers with pupils with severe disabilities. The results showed that teaching pupils using eye gaze-controlled computers entails understanding what the pupil does with the computer and relating this to what the pupil wants to express through the computer. There is an awareness of and a responsibility to understand and bring out the pupil’s knowledge and thoughts, which is a motivating factor for integrating the computer in everyday classroom activities.

These pupils’ severe disabilities have meant that they have had only a limited choice of assistive devices focused on teaching, and therefore the eye gaze computer is ground-breaking. In the best learning situations, the computer is understood as being invisible just works
and the focus is on the result. The computer becomes part of the way the teacher and the pupil relate to the world and the integration between the pupil and the computer becomes embodied (Ihde 1990, 2009). The computer becomes more of a means to have an experience, rather than an experience in itself. For the teacher, the eye gaze computer mediates (Ihde 1990, 2009) the pupil’s knowledge and thoughts and leads to an indirect experience of the pupil’s world. The teachers describe a responsibility to try to understand the pupil’s feelings, wishes and needs and this is what Biesta (2012) formulates as being addressed by the pupil. This is more than just listening to and recognising the pupil. Instead, the pupil is trying to say something and in a sense is asking the teacher to respond. The pupil’s ability to express the thoughts is there when the teachers are addressed by this expression. This means that it is not primarily the pupil’s responsibility to learn and use the computer but the teacher’s to figure out how to help the pupils to better communicate their experience and knowledge through the gaze computer. To be addressed implies that it is possible to view the eye gaze computer as an assistive technology, not just for the pupil, but also for the teacher.

However, this study’s results show that being addressed is sometimes hindered in situations when the software and computer are inflexible, when the pupil struggles to master the computer, or the computer is separated from the normal teaching. While the inner thoughts of the pupil are partly unknown, it is problematic to know beforehand what the software should include. Instead, the software could benefit from being more easily adaptable to what emerges over time. To facilitate integration into the school’s everyday life, the eye gaze-controlled computer needs to be more mobile, easily adaptable to different school situations, and have a faster boot-up time. This is in line with previous research (Asbjørnslett and Hemmingsson 2008; Hemmingsson, Lidstrom, and Nygard 2009; Näslund and Gardelli 2013) on the importance of social participation, and the integration in the school’s everyday life of the use of computers as assistive devices. It takes time to learn to eye-control a computer and find how it is best suited to the individual pupil. This means that implementation of the computer must take place for a longer period of time. It ought to be obvious that learning to eye-control a computer will take an equal amount of time as learning to write. It is also equally normal that the pupils sometimes lost interest in learning to control the computer. This study’s findings indicate that lack of interest occurs when teachers have hopes for future possibilities using the eye gaze-control computer that are not shared by the pupil. This is apparent in the theme labelled ‘Walk at the same pace’ where the teachers have to slow down and instead understand both how the pupil understands the situation and the pupil’s developmental level. For that reason, it is recommended to initially choose activities based on pupils’ motivation and own preferences before they become adept at eye gaze-control. Such activities might be non-educational tasks but may be a necessary step before the eye gaze can be used solely for educational purposes.

Some teachers may argue that ideally, pupils should be trained and competent in assistive devices before the device is introduced in the school. However, research shows that using only in-clinic training has a low success rate for becoming competent in using an advanced assistive device in everyday life. Children will start to use a tool such as an assistive device before they are fully competent to use it, and by using it over time and exploring its possibilities, they becomes competent in using it (Cook and Polgar 2015; Salminen, Petrie, and Ryan 2004).

The results show how other classmates were impressed by the technology, which meant the pupil received positive attention. This is also recognised by Murchland and Parkyn (2010),
which describes how it is the assistive technology that provides enhanced status rather than the pupil. But in this study, it is not necessarily just the eye gaze technology itself that has enhanced status. The teachers describe how the pupils are more skilled at eye-controlling the computer than both their classmates and teachers. The positive attention could be related to the skill in controlling the computer just as much the technology itself.

**Method discussion**

Both eye technology in everyday use and teachers’ experiences of teaching pupils with the help of eye-controlled computers are new areas which have not been investigated in depth. To ensure richness of the data, the teachers were interviewed twice to discover both their expectations and experience. The teacher’s experience of having a responsibility to try to understand what is inside the pupil’s trapped body, and the ‘invisible’ aspects of controlling the computer and mediating the pupils’ knowledge, thoughts and feelings were all aspects that came as a surprise to the research team. This could presumably suggest the research team’s open attitude, sensitivity to the phenomenon and a bridling attitude to the researchers’ pre-understanding (Dahlberg, Dahlberg, and Nyström 2008). We also think this was revealed due to the method’s lifeworld approach and could be seen as a strength of this study.

The study’s context and the experience of teaching pupils to eye-control a computer in a northern European society must be considered to transferability to other societies. It would be interesting in further research to include several research methods, such as an observation study, and if possible, to interview pupils using the eye gazing method to consider this learning situation from the pupil’s perspective. The findings of the current study may also have been limited, in that the wide age range of the pupils was not taken into account. It is possible that the teaching experience differs if the pupils are six years or 12 years old. However, it has been shown that the skill to eye-control a computer for severely disabled children is not necessarily related to the child’s age (Borgestig, Falkmer, and Hemmingsson 2013).

In summary, when introduced to an eye-controlled gaze computer, the pupils can, despite their severe disabilities, control the computer and express things that would be very hard, if not impossible without this computer. The pupils go from being able to do almost nothing to doing something. That is a huge step for the pupil, but also for the teacher.

**Disclosure statement**

No potential conflict of interest was reported by the authors.

**Funding**

This work was supported by the Swedish Research Council.

**Notes on contributors**

*Patrik Rytterström* is a registered nurse and senior lecturer at Linköping University, Sweden. His main area of research is care culture in health care and psychiatry. He is also part of the project concerning eye-gaze control for children with severe motor impairments.
Maria Borgestig is a registered occupational therapist with a special interest in how eye gaze can be used by children with severe physical impairments without speaking ability to control a computer. She is working as a postdoc at Linköpings University, Sweden, in the project concerning eye-gaze control for children with severe motor impairments.

Helena Hemmingsson is a (full) professor in occupational therapy at Linköping university, Sweden. Her main area of research is school participation of students with disabilities and how technology and internet influences everyday life of young people with disabilities. She is research lead for the project concerning eye-gaze control for children with severe motor impairments.

References

Archer, K., R. Savage, S. Sanghera-Sidhu, E. Wood, A. Gottardo, and V. Chen. 2014. “Examining the Effectiveness of Technology Use in Classrooms: A Tertiary Meta-analysis.” Computers and Education 78: 140–149.

Asbjørnslett, M., and H. Hemmingsson. 2008. “Participation at School as Experienced by Teenagers with Physical Disabilities.” Scandinavian Journal of Occupational Therapy 15 (3): 153–161.

Biesta, Gert 2012. “No Education without Hesitation. Thinking Differently about Educational Relations.” In Philosophy of Education 2012, edited by Claudia W. Ruitenberg, 1–13. Urbana-Champaign, IL: PES.

Borgestig, M., T. Falkmer, and H. Hemmingsson. 2013. “Improving Computer Usage for Students with Physical Disabilities through a Collaborative Approach: A Pilot Study.” Scandinavian Journal of Occupational Therapy 20 (6): 463–470.

Brinkmann, Svend, and Steinar Kvale. 2015. Interviews: Learning the Craft of Qualitative Research Interviewing. 3rd ed. Los Angeles, CA: Sage.

Brodin, Jane. 2010. “Can ICT Give Children with Disabilities Equal Opportunities in School?” Improving Schools 13 (1): 99–112. doi:http://dx.doi.org/10.1177/1365480209353483.

Coleman, Mari Beth. 2011. “Successful Implementation of Assistive Technology to Promote Access to Curriculum and Instruction for Students with Physical Disabilities.” Physical Disabilities: Education and Related Services 30 (2): 2–22.

Cook, Albert M., and Janice Miller Polgar. 2015. Assistive Technologies: Principles and Practice. St. Louis, MO: Elsevier.

Dahlberg, Karin, Helena Dahlberg, and Maria Nyström. 2008. Reflective Lifeworld Research. 2nd ed. Lund: Student literature.

Grskovic, Janice A., and Sheila M. Trzcinka. 2011. “Essential Standards for Preparing Secondary Content Teachers to Effectively Teach Students with Mild Disabilities in Included Settings.” American Secondary Education 39 (2): 94–106.

Hemmingsson, H., H. Lidstrom, and L. Nygard. 2009. “Use of Assistive Technology Devices in Mainstream Schools: Students’ Perspective.” American Journal of Occupational Therapy 63 (4): 463–472.

Ihde, Don. 1990. Technology and the Lifeworld: From Garden to Earth. Bloomington, IN: Indiana University Press.

Ihde, Don. 2009. Postphenomenology and Technoscience: The Peking University Lectures. Albany, NY: SUNY Press.

Majaranta, P., and M. Donegan. 2011. “Introduction to Gaze Interaction.” In Gaze Interaction and Applications of Eye Tracking: Advances in Assistive Technologies, edited by P. Majaranta, H. Aoki, M. Donegan, D. W. Hansen, J. P. Hansen, A. Hyrskykari, and K. J. Räihä, 1–9. Hershey, PA: IGI Global.

Murchland, S., and H. Parkyn. 2010. “Using Assistive Technology for Schoolwork: The Experience of Children with Physical Disabilities.” Disability and Rehabilitation: Assistive Technology 5 (6): 438–447.

Näslund, R., and Å. Gardelli. 2013. “I Know, I Can, I Will Try: Youths and Adults with Intellectual Disabilities in Sweden Using Information and Communication Technology in Their Everyday Life.” Disability and Society 28 (1): 28–40.

Pfeiffer, Thies. 2014. “Gaze-based Assistive Technologies.” In Assistive Technologies and Computer Access for Motor Disabilities, edited by Georgios Kouroupetroglou, 90–109. Hershey, PA: IGI Global.
Rodríguez, Patricio, Miguel Nussbaum, and Lioubov Dombrovskaia. 2012. “ICT for Education: A Conceptual Framework for the Sustainable Adoption of Technology-enhanced Learning Environments in Schools.” *Technology, Pedagogy and Education* 21 (3): 291–315.

Salminen, A., H. Petrie, and S. Ryan. 2004. “Impact of Computer Augmented Communication on the Daily Lives of Speech-impaired Children. Part I: Daily Communication and Activities.” *Technology & Disability* 16 (3): 157–167.

Tobii Technology. 2015. “Tobii Dynavox Devices.” Accessed December 18, 2015. http://www.tobiidynavox.com/devices/

Todres, L., K. Galvin, and K. Dahlberg. 2007. “Lifeworld-led Healthcare: Revisiting a Humanising Philosophy That Integrates Emerging Trends.” *Medicine, Health Care and Philosophy* 10 (1): 53–63.

Trucano, M. 2005. *Knowledge Maps: ICT in Education*. Washington, DC: info Dev publication.

United Nations. 2012. United Nations Expert Group Meeting on Building Inclusive Society and Development through Promoting ICT Accessibility: Emerging Issues and Trends. Tokyo, Japan, 19–21 April 2012. United Nations Information Center.