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Moa Yngve & Helene Lidström

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Implementation of information and communication technology to facilitate participation in high school occupations for students with neurodevelopmental disorders

Moa Yngve[a,b] and Helene Lidström[a]

[a]Department of Health, Medicine and Caring Sciences, Linköping University, Linköping, Sweden; [b]Department of Women's and Children's Health, Uppsala University, Uppsala, Sweden

ABSTRACT

Purpose: Information and communication technology (ICT) has been proposed to enable an inclusive learning environment and increased participation for students with special educational needs. The aim of this study was to investigate the perceived need for ICT before and after an individualized ICT intervention among high school students with neurodevelopmental disorders and describe how the ICT was used to improve participation in school activities.

Materials and methods: This mixed-method study, with a one-group pre- and post-test design, included 99 high school students with neurodevelopmental disorders. Data from questionnaires and assessments using the School Setting Interview (SSI) were analyzed using descriptive statistics and the Wilcoxon signed-rank test. Deductive content analysis was performed on written notes in the SSI assessment.

Results: The results showed that students' median number of perceived needs for ICT in school activities had decreased from six needs at baseline to one need at follow-up (t16.5 df(98), $p<.001$). There were five SSI items for which over 50% of the students perceived a need for ICT, with most students (95%) needing support in the item *Remember things*. Students received a laptop, tablet or smartphone (95%), software for planning or structure (84%) and ICT for writing and reading (66%). The ICT facilitated participation in multiple school activities, providing reminders and structure, facilitating notetaking and improving spelling. After the ICT intervention, students (61%) experienced improved study results and improved ability to manage difficult school situations (68%).

Conclusion: To conclude, an individualized ICT intervention as support to increase school participation is promising among high school students with neurodevelopmental disorders.

➤ IMPLICATIONS FOR REHABILITATION

- All stakeholders in the school's student health service must be aware of the importance of following the service-delivery process even when it comes to using information and communication technology (ICT) as an assistive technology, in which training and follow-up are important parts.
- It is of great importance to include the students in the service-delivery process for ICT to be effective and useful for the students.
- Because it is easily accessible, mainstream technology has great potential as a cognitive assistive technology to support students with neurodevelopmental disorders.
- Students, as well as teachers, may need to receive knowledge from rehabilitation staff, such as occupational therapists, concerning ICT as an enabler for increased participation in school activities.

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Introduction

Inclusion in general education for children and young people with disabilities has been advocated for years [1], an approach based on the idea that the school environment should suit all students. However, the school's inclusion of students with disabilities is often about placement, i.e., integration, rather than inclusion [2]. A necessity for students' inclusion is access to a supportive learning environment so that students can experience social participation and participation in activities in school, based on their prerequisites [3–5]. Participation in school education includes, among other things, gaining access to school and opportunities to engage in school-related responsibilities and privileges, such as course materials and lectures/teaching, as well as achieving knowledge goals with passing grades [6, 7]. However, restricted participation in school activities among students with disabilities and/or special educational needs (SEN) have often been reported [3, 8–14] indicating a non-inclusive school environment that does not suit all students. In a study by Haug [10], the findings revealed that pupils with SEN experienced a learning environment of lower quality than other pupils. Similar findings have been showed by Coster et al. [12] and Şahin et al. [14], who reported significantly more barriers to participation in the school environment among

CONTACT Moa Yngve Moa.yngve@liu.se Department of Health, Medicine and Caring Sciences, Linköping University, Campus Norrköping, 601 74 Norrköping, Sweden.

pupils with SEN. Limited participation in school activities seems to be even more common among children and adolescents with neurodevelopmental disorders [8, 15–20] including diagnoses such as attention deficit/hyperactivity disorder (ADD/ADHD), and autism spectrum disorder (ASD) [21]. Recently, a prevalence of almost 10% for ADHD and 1% for ASD was reported among 6834 students (5–17 years) in Spain [22], meanwhile the global prevalence of ADHD and ASD is estimated at about 7% and 1%, respectively [21]. There is a documented relationship between these disorders and executive function deficits [23, 24]. Students with neurodevelopmental disorders often struggle in academic areas, due to impaired time management and difficulties with problem solving and starting and completing school assignments, as well as planning and organizing schoolwork [25, 26]. Furthermore, limited social competence can contribute to conflicts in collaborations with classmates and teachers in school [24, 27].

Graduating from high school may be more challenging for students with disabilities, yet educational attainment is crucial because it gives the students opportunities for further studies and work that will make them economically independent [28–30]. Therefore, the learning environment and the teaching methods may need to be adapted based on the students' individual prerequisites and need for assistive technology [3, 4]. The use of information and communication technology (ICT) can enable students with and without disabilities to participate in education and improve learning [31–34], and thereby contribute to a more inclusive school environment. The term ICT has a broad definition, encompassing computer input interfaces (e.g., alternative keyboards, switches) [35] and mainstream ICT, such as computers, smartphones, tablets and digital smartwatches [36, 37], and is today integrated in technology-based teaching and learning in education [32]. Previous studies indicate that students with ADHD who used ICTs performed better in the task of essay writing than the group who did not use ICT e.g., [38]. In another study, the majority of 300 students with SEN perceived that an ICT adequately supported time management [39]. In addition, ICT can also be utilized as an assistive technology for cognition (ATC) to cater for special needs, such as to assist cognitive function during task performance, e.g., for students with neurodevelopmental disorders [36]. The purpose of ATC is to facilitate an individual's participation, such as initiating, planning, remembering and organizing activities in educational settings – activities that the target group often has difficulty performing [3, 40]. Like ICT, ATC is often a mainstream technology, a commercial product, described as being universally designed for use by a diverse group [41].

In Sweden, extensive efforts have been made to increase the use of ICT in education and today, access to ICT is often standard in high schools [42], and all students have their own smartphone and/or tablet [43]. Unfortunately, several publications have appeared in recent years documenting that the use of assistive technology and ICT in education is far from optimal for students with disabilities [3, 31, 44]. Therefore, one of the questions investigated in this study is: *Do a cohort of students with neurodevelopmental disorders have access to and the opportunity to use ICT as a compensatory device to enable participation in school activities?* To maximize opportunities for students with neurodevelopmental disorders to graduate from high school, it is important to investigate whether a supportive environment, for example individualized use of ICT, can increase students' participation in education. Moreover, very few publications address the issue of which type of ICT students with neurodevelopmental disorders use to facilitate participation in school activities. Since ICT seems to be effective and compensating as support for students with disabilities in higher education [45, 46], it is also of interest to gain more knowledge about the need for ICT and the potential benefit of using it as assistive technology in school activities among students with neurodevelopmental disorders in high school.

Aim

The aim of the study was to investigate the perceived need for ICT before and after an individualized ICT intervention among high school students with neurodevelopmental disorders and describe how the ICT was used to improve participation in education.

The following research questions guided the analyses:

- In which school activities did the largest proportion of students perceive a need for assistive technology and what ICT did the students receive as support?
- How did the students perceive the ICT influenced their study results and ability to manage difficult school situations?

Materials and methods

Study design and ethics

The study was mixed-method, using a quasi-experimental, one-group pre- and post-test, design [47], in which data were retrieved from two national intervention projects initiated by the Swedish government. More details about the projects are presented in the doctoral thesis by Yngve [48].

The Regional Ethics Board in Linköping, study code 2013/409-31, approved the projects and research. Identified students were given verbal and written information about the project before giving written consent to participate, and for the subsequent research study to use the data. For students under eighteen years of age, guardians also gave their approval.

Recruitment and participants

In the two government projects, data were collected between 2011 and 2014 in 12 different high schools in the south of Sweden. The recruitment base was approximately 10,000 students. Staff in the schools included in the projects, such as special education teachers, teachers and occupational therapists, identified students based on low attendance at school, not achieving passing grades or difficulties in the school setting.

In the government projects, 549 students with and without different medical diagnoses gave written consent to be included in research. The inclusion criteria for participants in the present study were: students in regular high school, between 16 and 20 years of age, having a neurodevelopmental disorder, such as ADHD, ADD, or autism spectrum disorder, and having a valid pre- and post-measure with the School Setting Interview (SSI) [49]. Of these 549 students, 107 students had a neurodevelopmental disorder and 99 students had valid SSI measures.

Demographic information of the 99 included students is presented in Table 1. The majority of the participants were boys and were studying in a vocational program. The most common diagnosis was ADHD/ADD, but one-third of the 99 students had at least two diagnoses, such ADHD and dyslexia. The students had a mean age of 17.2 years (*Mdn* 17). Half of the participants had special educational support at baseline, most commonly consisting of support from a special education teacher or assistant, and 12% of the students had access to ICT at baseline.

Table 1. Demographics of the 99 included students.

Demographics	n (%)
Gender	
Boy	63 (64)
Girl	36 (36)
Diagnosis	
ADD[1]/ADHD[2]	75 (76)
Autism spectrum disorder	20 (20)
A preliminary neurodevelopmental diagnosis[3]	4 (4)
Native language	
Swedish	91 (95)
Other	5 (5)
Educational program	
Vocational	62 (60)
Preparatory	22 (21)
Introduction[4]	20 (19)
Support in school at baseline	53 (52)
Personnel	41 (38)
ICT	12 (12)

[1]Attention Deficit Disorder.
[2]Attention Deficit Hyperactivity Disorder.
[3]An investigation into a specific neurodevelopmental diagnose is ongoing.
[4]Pre upper secondary school program to support students to gain access to regular programs.

Data collection

Six occupational therapists and one special education teacher (hereafter referred to as professionals) employed in the projects were responsible for collecting data and implementing the ICT intervention. Before project start, the professionals completed a two-day course, held by the project group and the member from the research group (HL), for training in the use and administration of the questionnaires and the assessment instrument SSI [49].

The questionnaires developed by the project group generated demographic information, including students' access to educational support, at baseline (see Table 1). The questionnaire used to evaluate the intervention, 4–6 months after the implementation of ICT, included questions concerning what ICT devices and software students had received and in which school activities these was used as support. It also asked about students' perceptions of the ICT's impact on study results and ability to manage difficult school situations.

To examine students' perceived needs for ICT in the service delivery process, they were interviewed using the student-centered assessment School Setting Interview (SSI), version 3.1 [49], which is focused on the students' subjective experiences of support needed to enable participation in the school environment. The SSI contains 16 items concerning everyday activities in school, such as academic items (e.g., *Write, Read, Take exams, Do mathematics*) and items concerning other school activities both in and outside the classroom (e.g., *Social break activities, Participate in the classroom, Interact with staff*) (see Table 2). To meet the needs of students who have difficulties with attention and concentration, the interviews could be divided into two separate sessions. In connection to the interview, the 16 items were rated by the professional, based on students' perceived needs for support, using the four-step rating scale. A rating of 1 or 2 implies that the student perceived a need for adjustment, while a rating of 3 or 4 implies that the student is not in need of adjustments in the school activity. In addition to the interview and rating of items in the Need for Adjustment Form, the SSI also includes the Planning Intervention Form to facilitate the creation of an implementation plan. The planning was conducted together with the students based on their individual needs, the type of support (such as a laptop with a word processor) and the service-delivery process for implementation. The plan was written down by the professional. Furthermore, the date for the follow-up assessment was decided. In total, the SSI assessment, conducted during scheduled school hours, took between 30 min and one hour to complete.

The ICT intervention

The SSI, with its different administration forms, was used as a guideline in the different phases of the service delivery process. The individualized ICT intervention, implemented in collaboration between the professional and the student, was based on the service-delivery process in assistive technology [50] and included two phases: (1) assessment of the students' needs for an assistive technology, and (2) and identification and implementation of the ICT. Information about the service-delivery process of the ICT intervention was provided to the professionals to ensure intervention fidelity. Consultations with the project director and the member from the research group (HL) were provided regularly to support the implementation work and data collection.

Identification of needs and type of ICT

To improve the student's participation in school activities and to meet each student's individual support needs for assistive technology, identified in the SSI interview, the student and the professional discussed suitable ICT devices. The decided ICT was written down in the Intervention Planning Form under the specific item (school activity), where persons responsible for implementation and the time frame were also stated. For example, a student with a perceived need for ICT in the item *Read* could get access to the ICT text-to-speech software and a student with a perceived need for ICT in the item *Remember things* could get access to a calendar application with active reminders.

Implementation of the ICT

The implementation phase started when the professional gave the student access to the decided ICT, after which the student's need for training to use the ICT as support in school activities was discussed. The professional tailored the ICT to suit the student's preferences and provided individualized training. Training could e.g., include instructions and practical knowledge and tips on how to manage different devices or software, such as an application on a smartphone, to use it effectively as support in school activities. For example, how to use a calendar with active reminders to plan and initiate studying before an exam. Training could also include testing a smartphone or a tablet in a specific school activity on repeated occasions before deciding if the ICT worked satisfactorily or if another ICT should be tested.

Teachers who taught students who were included in the project and received the ICT intervention were informed about the student's need for support and the use of ICT as support in school activities. This was done to, for example, encourage the teacher to consider adapting their teaching to support the student's use of ICT and to create an understanding of the student's need for access to a smartphone during the lesson. A couple of weeks after implementation, the student was contacted to ensure that the ICT provided sufficient support. A technician was also employed by the government project to provide hands-on help with the ICT when needed, e.g., to install software, adjust settings and solve technical issues. When the ICT intervention ended (after 4–6 months), the students continued to have full access to the ICT they had received as support in school.

Table 2. Perceived need for ICT in the SSI-items at baseline and follow-up among the 99 students.

Item (school activity)	Need for assistive technology (rating of 1 or 2 in the SSI) n (%)		Wilcoxon signed rank test
	Baseline	Follow-up	
Remember things	94 (95)	31 (31)	$T = 8.2$, $p < .001$
Write	82 (83)	18 (18)	$T = 7.5$, $p < .001$
Homework	68 (69)	23 (23)	$T = 6.4$, $p < .001$
Read	60 (61)	18 (18)	$T = 5.9$, $p < .001$
Take exam	54 (55)	20 (20)	$T = 5.6$, $p < .001$
Mathematics	43 (43)	13 (13)	$T = 4.3$, $p < .001$
Participate in the class room	35 (35)	11 (11)	$T = 3.6$, $p < .001$
Get assistance	33 (33)	22 (22)	$T = 1.3$, $p = .196$
Speak	30 (30)	11 (11)	$T = 3.7$, $p < .001$
Sport activities	29 (29)	4 (4)	$T = 3.5$, $p < .001$
Participate in practical break activities	21 (21)	6 (6)	$T = 2.8$, $p = .005$
Interact with staff	16 (16)	11 (11)	$T = 0.5$, $p = .958$
Practical subjects	15 (15)	6 (6)	$T = 2.1$, $p = .033$
Go on fieldtrips	14 (14)	6 (6)	$T = 1.8$, $p = .074$
Participate in social break activities	6 (6)	3 (3)	$T = .9$, $p = .325$
Access the school	5 (5)	1 (1)	$T = 1.3$, $p = .201$

Data analysis

Descriptive statistics, using frequency, percentage and median (*Mdn*), were applied to present questionnaire data (e.g., demographics and type of ICT) and students' need for ICT. To further elaborate students' perceived needs for ICT in the different school activities, the Wilcoxon signed-rank test was used to analyze differences in the participants' perceived needs in each SSI item (ordinal data) between measurement time points [51]. Analyses were performed using IBM SPSS Statistics (version 27) [52]. Overall significance was set at a level of $p < .05$. Data on ICT devices and software the students received were grouped into categories (e.g., "Devices" including laptop and tablet, and "ATC" including calendar and reminders). The ICT categories were linked to the five school activities in which the largest proportion of students perceived adjustment needs; see Table 3. Descriptive statistics of *n* values and percentages were used to present the proportion of students who received each ICT category and its use in school activities. To present how the ICT was used to meet students' needs for support in school activities, a qualitative analysis, based on a content analysis [47] with a deductive approach, was performed [53]. The written notes on the SSI assessment at follow-up, concerning the school activities ($n = 5$) with the largest proportion of students with perceived need for ICT, constituted the unit of analysis. These activities were used as a template to guide the deductive analysis. All written notes of actual use of ICT as support in each specific school activity were collected in matrices and read several times to identify patterns in the text. These patterns, representing similarities of actual use of the ICT, were summarized and a descriptive text was produced.

To evaluate the ICT's impact on study results and students' abilities to manage difficult school situations (research question two), students' self-reported perceptions on these aspects, collected in the questionnaire at follow-up, were analyzed. Students rated their study results and ability to manage difficult school situations after the intervention using five response options, ranging from *much worse* to *much improved*. Students' responses were summarized and presented as percentages.

Results

Students' perceived need for ICT in school activities before and after the individualized ICT intervention

On a group level, the students' median number of perceived needs for ICT in school activities identified in the SSI assessment was six at baseline (range 1–13) and one at follow-up (range 0–10). The decrease in the number of perceived needs for ICT was found to be statistically significant (t16.5 df(98), $p < .001$). At baseline, there were five items (out of the 16 items included in the SSI) for which over 50% of the students stated a perceived need for ICT, as presented in Table 2. Most students (95%) perceived a

Table 3. Received ICT linked to the school activities where the greatest proportion of students perceived need for AT.

ICT	N (%)	SSI ITEMS				
		Remember things n (%)	Write n (%)	Homework n (%)	Read n (%)	Take exams n (%)
Devices	**94 (95)**	72 (73)	81 (82)	32 (32)	51 (52)	13 (13)
Computer/Laptop	44 (44)					
Tablet	55 (56)					
Smartphone	33 (33)					
ATC*	**83 (84)**	82 (83)	8 (8)	35 (35)	5 (5)	14 (14)
Calendar	64 (65)					
Schedule	61 (62)					
Reminders	59 (60)					
Time aids	15 (15)					
Writing and reading	**66 (67)**	2 (2)	75 (75)	6 (6)	55 (56)	2 (2)
Word processor	48 (49)					
Text reader	30 (30)					
Scanner	18 (18)					
Projector	16 (16)					
Audio books	11 (11)					
Other[1]	29 (29)					

*Assistive technology for cognition. [1]Dictaphone/recorder, Keyboard, Dropbox, math application.

need for ICT in the item *Remember things* and 82% of the students perceived a need for ICT in the item *Write*. The school activity in which the students perceived needs for ICT to the lowest extent was *Access the school*, where 5% of the students reported need for support.

A range between 18–31% of the students experienced a remaining need for support at follow-up in the five school activities where 55–95% of the students experienced restricted participation; see Table 2. In all but five items, the proportion of students who perceived a need for ICT was statistically significantly lower at follow-up. The items with no statistically significant difference were primarily located at the lower end of Table 2 and had a low proportion of students with a need for ICT.

What ICTs did the students receive as support in school activities?

The ICTs that the 99 students received in the individualized intervention are presented in Table 3. Furthermore, the received ICT is linked to the five school activities where the greatest proportion of students perceived a need for ICT, in order to visualize where it was used as support. Most students (95%) received some type of device, namely a computer/laptop, tablet or smartphone, or got their private devices tailored. Software and/or applications for planning or structure (ATC) were received and used by 84% of the students. Regarding ICT for writing and reading, received by two-thirds of the participants, students either received software, in which a word processor was the most common (49%), or additional devices, such as a scanner (18%). About one-third of the students ($n = 36$) received additional educational support, such as support from school staff, extra time in written examinations and/or different fidget toys to support concentration during class. As shown in Table 3, received ICT devices and software were used as support in multiple school activities. The devices were to a large extent intended to be used as support in all five school activities, while the ATC was primarily intended to support students in the school activity *Remember things*. Likewise, the ICT categorized as writing and reading was primarily intended to be used as support in the school activities *Write* and *Read*.

How was the ICT used to improve participation in school activities?

The description of how the students used the ICT to facilitate participation in school activities, based on the qualitative analysis, is presented below in three sections, namely *Remember things*, *Write* and *Read,* and *Do homework* and *Take exams*.

Remember things

Two main areas of applications were evident in the notes about how the ICT was used as support in the school activity *Remember things*, namely by reminding and providing structure. Reminding involved setting active alarms and using calendars with notifications. This could be done using the existing calendar in the student's smartphone, tablet, or computer or by adding additional software or applications depending on the needs and preferences of the student. The use of the reminders prompted the student to perform or initiate schoolwork or activities, and to plan schoolwork over the coming week in regard to homework, exams, bringing clothes to the physical education lessons, etc. The other area of application of the ICT, providing structure, was primarily focused on storing school materials in one device. By using an ICT device, such as a laptop or tablet, the student had all schoolwork easily on hand, which reduced the risk of forgetting schoolwork or bringing the wrong materials to class.

Write and read

How the ICT was used as support in the school activities *Write* and *Read* are presented in a common description, as the areas of application are closely related. To improve participation and meet students' needs for support in the *Write* activity, the use of word processors facilitated notetaking during class, as well as improved spelling when writing. Furthermore, it eased submitting schoolwork assignments and homework to teachers. Getting access to digital notes was an alternative or complement to using the word processor. Students could take photos, scan the lecture notes, record teacher's lectures or instructions, or get access to the written information *via* email or on virtual platforms, which was possible through the use of ICT devices and software. To cater to students' difficulties in the school activity *Read*, ICT that enabled text to be read out loud was used as support. Different software or ICT devices could be used, such as speech synthesis and scanner pens. Furthermore, digital school materials, such as audiobooks, were made accessible as compensatory devices.

Do homework and take exams

In regard to ICT as support in the school activities *Do homework* and *Take exams*, much is mentioned in relation to ICT in terms of *Remember things*, *Read* and *Write*. Students used new strategies for conducting homework or preparing for exams *via* the use of reminders and enhanced structure through calendars. The ICT was used to remind students to bring home and do homework or study for upcoming exams. Furthermore, having access to instructions, writing, and reading software and the relevant material *via* the ICT device further enhanced the opportunity for students to complete assignments or study for the exam. Another aspect involved modifying exams, in which the actual use of ICT when taking the exam provided support. The use of, for example, a laptop and word processor could provide improved conditions for a student with difficulties in writing when conducting a written exam.

The ICT's impact on students' study results and ability to manage difficult school situations

At follow-up, after 4–6 months of ICT use in school activities, 61% ($n = 57$) of the students reported that they experienced improved study results. About one-third ($n = 31$) of the students perceived that their study results were the same as before the ICT was implemented as support in school activities. Over two-thirds (68%, $n = 64$) of the students perceived that their ability to manage difficult school situations had improved.

Discussion

The main purpose of the paper was to draw attention to students' perceived need for ICT before and after an individualized ICT intervention and how the ICT was used to improve participation in education among high school students with neurodevelopmental disorders. Initially, we asked the question: *Do a cohort of students with neurodevelopmental disorders have access to and the opportunity to use ICT, as a compensatory device to enable participation in school activities*? A question that unfortunately has received a negative answer, as one of our main findings shows that a large number of the students with neurodevelopmental disorders have unmet needs for ICT at baseline, i.e., limited

participation. This finding is very unfortunate and inconsistent with previous research showing that assistive devices can create an inclusive learning environment and be used as an enabler for participation in school activities among students with disabilities [3, 4, 54, 55]. Happily, at follow-up, after the students had been using their individualized ICT in school activities, their perceived need for support had decreased, indicating that their school participation had improved.

Looking at the findings in more detail shows a statistically significant decrease in the proportion of students who experienced a need for support in the item *Write* at follow-up (83% at baseline to 18% post-intervention). In a meta-analysis, Graham, Kiuhara and MacKay [56] described writing as "a vehicle of strengthening, expanding and deepening students' knowledge in e.g., mathematics and science;" thus, an item with impact on many other school activities. In our study, the students seem to be satisfied with the support that ICT has given to improve activity performance in the item *Write*. In line with Graham et al.'s [56], study results, we can assume that students' access to and use of ICT to facilitate writing in this study also affect students' participation in several other school activities. This assumption is based, among other things, on the finding that many of the students with neurodevelopmental disorders experienced improved study results and ability to handle difficult school situations after the ICT intervention.

The same reasoning probably also applies to the item *Remember things*, where 95% of the students had needs for support at baseline, as it is documented that students with neurodevelopmental disorders have a great need for ICT in relation to their executive difficulties [23]. Our research adds knowledge about the benefits of using ICT as a cognitive support (ATC) to enable increased participation in the school's activities, facilitating students' planning, structuring and organizing of their everyday school lives [40]. Lack of educational support, such as ICT, can also reduce the motivation of students with disabilities to attend school, which unfortunately is a common reason for dropping out of school [20, 57]. Thus, further research is needed to evaluate the impact of ICT on students' schooling in relation to attendance and grades.

As mentioned earlier, our results show that students with neurodevelopmental disorders experienced increased participation in school after the intervention, in which individualized access and use of ICT were provided. It seems that access to ICT is not enough for it to be useful as support, since 12% of the students had access to an ICT before the intervention. One way to understand why students' experienced limited participation and need for support in school activities despite access to ICT, is to acknowledge the difference between access to ICT and use of ICT as support. It is difficult to get a complete analysis of the concept of access because it is complex. It would be interesting to investigate if the access to ICT at baseline was based on an existing need for support, or if a lack of training in its use as support caused the non-use of ICT. The data does not allow further elaboration on this matter, but it seems that access to ICT alone is not decisive for use to facilitate participation. Furthermore, the use of a service-delivery process [50, 58] when implementing ICT may increase the use of ICT that students have access to, including their mainstream technology. It may be that ICT, and primarily mainstream ICT, is not seen as an assistive technology and therefore important parts of the service-delivery process, such as training and follow-up, are not applied. The originality of the present individualized ICT intervention lies in using the service-delivery process when implementing ICT in a school context. In addition, it is important to consider that the students and their perspectives are included in the process [59], in this case by using the SSI. A previous literature review showed that the user's participation in the service-delivery process is crucial for the device to be used and useful [58], which may be one reason to students decreased need for support at follow-up in the present study. In Swedish schools, for example, students get access to an individual computer (one-to-one computer) or have their own smartphone, but rarely receive any tailored training in how it can be used to support educational activities based on individual needs, resulting in the potential benefit of using ICT as support being missed. The absence of tailored training may be due to a lack of knowledge regarding the need for support among students with disabilities and/or a lack of competence in how a computer can be used as, for example, assistive technology for cognition. In a study by Widehammar et al. [60], it emerged that there are significant differences in use depending on the type of assistive device (e.g., ATC, prosthesis, or scooter). For instance, ATC users lacked training and strategies for how to use the device to ensure it was as useful as possible, which led to the ATC not being fully utilized in relation to their needs.

Johansson [61] argues that students need different types of learning support, e.g., assistive technology and ICT, depending on which high school program the student attends. In this study, that specific relationship has not been investigated, but the qualitative analysis revealed that the ICT catered to students' needs for support in several different school activities. This finding aligns with McKnight [34], who proposed that the portability and flexibility of ICT is an important benefit. One device, such as a tablet, with different software based on the individual student's needs, could provide the student with an inclusive learning environment in different classes, classrooms, and activities, as well as at home when preparing homework or studying for an exam. Thus, the ICT as support seems to remove a variety of environmental barriers for participation among students with neurodevelopmental disorders.

Methodological considerations

Some methodological considerations should be mentioned. The use of students' subjective experiences when identifying needs for support and evaluating interventions to improve school participation is warranted in literature [11, 62, 63]. In line with this, the present study included students' perceived needs for support in school activities, their perceptions of study results and ability to manage difficult situations as outcome measures when evaluating the individualized ICT intervention. Although the present study findings are promising, the study design does not allow statements on the effectiveness of individualized ICT interventions. Furthermore, self-reported measures may be exposed to bias [47], as participants may overestimate their responses because of the attention they receive by being included in an intervention. Thus, further studies with a control group and objective measures, such as student grades before and after the intervention, are needed to prove the effectiveness of ICT as support to improve school participation among students with neurodevelopmental disorders.

Consideration must also be given to the fact that the data collection was conducted several years ago. As there is still a lack of studies evaluating ICT as support in school, especially concerning students' school participation [37], the benefit of conducting this study was considered to exceed the potential disadvantage of using data from 2014. The results are relevant in teaching today since the activities for which students needed ICT as support for

participation align with both earlier and more recent studies [64]. In addition, findings from a recently published study [13], that also used the SSI, show that the ICTs students preferred to use were largely the same as in the present study, despite data collection taking place in more recent years.

Conclusion

An individualized ICT intervention as support to increase participation in school activities is promising among high school students with neurodevelopmental disorders.

This study shows that the participating students with neurodevelopmental disorders experience an unmet need for ICT at baseline, despite relatively good access to ICT, indicating that students need to be involved in the service-delivery process to gain access to an inclusive learning environment.

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ORCID

Moa Yngve http://orcid.org/0000-0003-1073-1977
Helene Lidström http://orcid.org/0000-0002-1545-3876

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