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DIFFERENTIATED TECHNOLOGY-BASED INTERVENTIONS FOR ENHANCING UNDERSTANDING, FLOW AND SELF-EFFICACY BY LEARNERS WITH DEVELOPMENTAL AND ATTENTION DEFICITS

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Abstract

The purpose of this paper is to investigate in which way technologies may be used to increase inclusion and a feeling of flow and self-efficacy in learning processes when it comes to learners with developmental and attention deficits (focus learners) in a mainstream classroom. The paper is an outcome of a wider study on ICT facilitated inclusion and this current piece of research addresses the challenges of enhancing focus learners' comprehension when working with the curriculum. Several technologies have been tried out in a real school context and seven types of interventions are uncovered as valuable for focus learners' capability in learning processes. The paper discusses the findings and concludes that conscious use of technology-based interventions make it possible to provide learning challenges balanced to the learners' individual skills. But a broader understanding and acceptance by all stakeholders for the specific challenges of this group of learners in mainstream educational systems seems needed to fulfil the potential.

Introduction

Inclusion of learners with special educational needs (SEN) in mainstream schools appears an ambitious item in the educational-political agenda in Denmark, where bewilderment and frustration are common phenomena among teachers facing the challenge of teaching SEN learners (Baviskar, 2015). In general, teachers find themselves neither possessing the required specialized pedagogical knowledge and competencies to include youngsters with developmental and attention deficits (Danmarks Evalueringsinstitut, 2011) – nor the sufficient technological skills to utilise the affordances of digital learning resources for this group of learners (Andersen & Sorensen, 2016a). Learners with Developmental and Attention Deficits (in this paper: focus learners) are a broad and inhomogeneous group of children, who are challenged with respect to both life and learning. The term includes learners with Attention Deficit Hyperactivity Disorder (ADHD), Attention Deficit Disorder (ADD) or Autism Spectrum Disorder (ASD). To enable inclusion in terms of increasing presence, participation and achievements for focus learners, it is crucial that teachers have knowledge about the learners' specific challenges and competences: "In order truly to help someone else, I must understand more than he – but certainly first and foremost understand what he understands. If I do not do that, then my greater understanding does not help him at all"

(Kierkegaard, 1859). Likewise, teachers must be able and willing to arrange a learning environment in consideration of this knowledge: "If One Is Truly to Succeed in Leading a person to a Specific Place, One must First and Foremost Take Care to Find Him Where He Is and Begin There" (ibid.).

Children diagnosed with ASD often demonstrate restricted communication and social skills as well as a reduced repertoire of behaviours, interests or activities (Cihak et al., 2012). They might be unable to communicate their needs in an appropriate way or might engage in disruptive behaviours (ibid.), and their learning experiences will often be affected from echolalia, disorganisation, inattentiveness or stereotypic behaviours (Delano, 2007). Learners with ADD or ADHD are affected by the core symptoms of the diagnosis: attention difficulties and/or hyperactivity and impulsivity (Barkley, 2006). The problems include poor attention span, distractibility and difficulty staying on task, which impact their ability to manage time, to keep deadlines, to plan/organize schoolwork or to make friends. The symptoms are very sensitive to situation and context, the situated demands and the level of cognitive complexity in a task (ibid.). Low working memory often pose a barrier as it is necessary for control attention in complex cognitive processes as learning, understanding and reasoning (de la Guía et al., 2015). Focus learners often lack self-regulation, why they master skills at a lower level than their peers. They often experience themselves unable to cope with situations, where skills are demanded and incompetent about their performance. According to (Barkley, 2006) children with ADHD generally have low self-esteem and might easily be frustrated. That is why teachers must be aware to construct learning opportunities, which motivate these learners and encourage them to participate despite their problems.

Theoretical Approach

In Denmark focus learners with low self-esteem and lower skills are included in the mainstream education system without – or with limited – special educational support. They are taught in mainstream classes by mainstream teachers, who are searching for new ways to engage them and help them, and to enhance as well their feeling of flow (Csikszentmihalyi, 2014) in the task solving, and their learning outcome as their self-efficacy (Bandura, 1997). According to the Flow Theory (Csikszentmihalyi, 2014) it is necessary to ensure an appropriate balance between a person's ability and the challenge at hand to attain a feeling of satisfaction and inner motivation in a process. Flow can be experienced in situations, where a task is both challenging and shaped to the focus learner's skills, while an enharmonic balance between challenge and ability triggers anxiety, worry, apathy or boredom. Furthermore, a learner's belief in his or her ability to succeed in a situation or accomplish with a task (self-efficacy), also affects a person's approach to tasks and challenges. Bandura's (1997) social cognitive theory describes how individual's actions and reactions are influenced by actions they have observed in others, and how persons with high self-efficacy are more likely to see challenging tasks as something to be mastered, rather than something to be avoided. In other words, if you are to change focus learners' behaviour, you must change their beliefs. Schaffer (2013) states with his research that flow only appear under following conditions: (a) High

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perceived skills; (b) Knowing what to do; (c) Knowing how to do it; (d) Knowing how well you are doing; (e) Knowing where to go (if navigation is involved); (f) Freedom from distractions and (g) High perceived challenges.

Technology today is a natural part of people's life and impact many aspects of education, training and development. Education is a human right and disabled people should be provided appropriate support. Assistive technology (AT) is seen as a solution for providing this support and remove barriers in education (McKnight & Davies, 2012). They are internationally recognised as "a particular valuable tool for people with disabilities… [in order to] … improve their quality of life, reduce social inclusion and increase participation" (Waller & Watkins, 2013). A large number of assistive learning technologies have been investigated (ibid.), but "there is perhaps a tendency for research to focus on the technology rather than its uses" (McKnight & Davies, 2012) as e.g. development of technological tools (Bul et al., 2015), comparing tools (Hill & Flores, 2014) or evaluating the value of a function under specific circumstances (Kang et al., 2007). Furthermore, most literature on AT for the focus learners examines technologies used in therapy by psychologists (de la Guía et al., 2015) or by special education teachers (Cihak et al., 2012). Therefore, the authors of this paper call for investigations of the use of AT in the classroom. This paper examines how teachers have used AT to help focus learners to a more constructive confrontation with the learning content and experience a feeling of flow and self-efficacy in learning activities in mainstream classes.

Research Contexts and Design

This paper is an outcome from a wider research design, ididakt (Sorensen et al., 2013); an iterative and explorative qualitative research project, where data is collected in a real school context at public schools in Denmark. It is a case study in the frame of Educational Design Research (EDR) (McKenney & Reeves, 2012) with a hermeneutical, phenomenological interpretation of data. The authors/researchers have been professional dialog partners and facilitators in transformations processes at 11 schools, where they, in collaboration with 46 teachers, have examined the impacts of using ICT based interventions in 26 classes. More than 500 learners from 1st to 10th grade (age 6-16 years) were included in the project – among them 56 focus learners with extensive developmental or attention deficit disorders. The empirical data set consists of teachers' statements at seminars, in interviews or at a research blog, from surveys, interviews with school leaders or students and from classroom observations. A five-types-model of including, ICT based interventions are recognized and described in earlier iterations of the project (Sorensen & Andersen, 2016a; Sorensen & Andersen, 2016b; Andersen & Sorensen, 2016b; Andersen & Sorensen, 2015; Andersen, 2015), where this paper frames and examines ICT based interventions to enable and enhance *Differentiation & Comprehension*.

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Analysis and Findings

Several technologies have been used to facilitate differentiation and increase learners' comprehension in learning activities among the 26 classes. By categorising, analysing and interpreting data seven valuable ICT-based interventions which addresses this challenges are identified:

Digital Textbooks

Digital textbooks provide learners opportunities for using Reading Technologies (Text-to-speech) and listening to written text. Access to libraries of digital textbooks enable focus learners to choose books of interest and appropriate intellectual challenge AND get necessary reading support, which facilitate a balance between challenge and ability (flow) and enable independently reading (self-efficacy). They know what to do, how to do and are able to monitor their own progression in reading statistic and control questions. Digital texts make it easier as well to use digital writing support tools with impact on flow and self-efficacy:

> *"A couple of boys are now able to deliver a readable product, why they now get response as well" (Teacher G).*

Accessibility from any platform in school or at home has been helpful for learners with poor memory or planning skills:

> *"Now books are not forgotten at home or disappeared in school. Reading support is at hand both in school and at home" (Teacher G).*

Digital Course Portals

Publishers Digital Course Portals provide access to the full curriculum for a subject and contains texts, information, tasks, models etc. Learners find content at different levels of complexity with digital reading support at hand, supplemented with materials in various modalities as e.g. pictures, videos, graphics, sound clips, links or interactive features. It enables enhanced perspectives at, comprehension of and motivation for the topic in a sound balance between challenge and skills (flow). Focus learners have access to Digital Course Portals in both schools and at home; they know what to do and how to use the resources:

> *"The focus learners get started really focused. They are looking for information for answering an assignment. They read and make a quiz about what is learned. They choose between easy or difficult texts. They follow different media links and watch different kind of movies" (4th grade).*

Focus learners monitor their own progression at the site:

> *"The reading log has been helpful to N (boy, 10th grade) to keep track of his answers – it offers him an overview and simplify his options" (Teacher K).*

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Video Content

Video has been used to support differentiation and comprehension at the schools, but differently with learners as either *consumers* or *producers* of videos. When videos are provided as a part of the academic dissemination to all learners a more equally access to information are given:

> *"All learners must benefit from them. The instructions must be brief and clear" (Teacher B).*

The videos are either produced by teachers or derived from Youtube.com, digital learning resources or an online video resource. Some videos inform learners about procedures (e.g. how to navigate at Google Drive), other videos are used for enhancing learners' preliminary understanding, as explanations according to homework or instead of/as supplement to instructions in the classroom:

> *"Video has been used in Danish language, social studies and history. It is very good for learners with reading difficulties. All learners watch the videos, but some of them have in addition something to read. J (boy, 8th grade) can be concentrated in 20 minutes with a video" (Teacher J).*

Some focus learners do not at first benefit from videos:

> *"The impact is higher for learners with academically surplus energy. It is challenging, that the learners not are able to ask questions. I must still give them oral explanations and they can afterward use the videos to remember, what to do. That makes in return many learners self-sufficient" (Teacher F).*

But videos offer many focus learners a fine balance between challenge and skills:

> *"M (boy, 10th grade) can be concentrated very long time by them. He understands the Pythagoras after watching explanations and gives right answers afterwards." (Teacher K).*

Learners have easier access to knowledge, they can replay if needed and receive information in their own speed. Focus learners interact autonomously with the content and express self-efficacy:

> *"I am learning better with the computer because there are more options. I can e.g. watch video – and look at both video and text. It is easy for me to make notes because I can pause the video. It is much easier to use a video than to ask my teacher all the time" (girl, 8th grade).*

When classes are watching video at the classroom board, many focus learners take a break and drop out of activities. Videos seem to be more useful for individuals or peers where the focus learners can interact with or dialog about the content. Videos have also been used to sustain

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and visualise, what is learned – as an externalised memory or an alternative to classroom presentations. Such videos help focus learners to remember and guide them when shifting from one activity to another, and illustrate progression as well:

> *"I would continue with this method, because my focus learner (boy, 6th grade) had so much drive when creating the video. Normally he would not take part in such activities" (Teacher B).*

Video presentations are made by vulnerable learners, where the production of a video has prompted a feeling of confidence about their skills (self-efficacy):

> *"Presentation via video for B (boy, 4th grade). It was a good idea. He really liked that option. But when he saw his peers present, he wanted to do the same. So he did not use his video… He has so much non-attendance and it is very difficult for him to get into flow. Video presentation is a good idea as a backup. It would be fine, if everybody have this opportunity, and just chose in the moment, if they would like to present via video or in real life. Then it would be less stigmatising" (Teacher F).*

Digital Training resources

Digital Training Resources provide learners rehearsing specific skills and possibilities for choosing challenges that fits their capability. The program scaffolds them to know what to do, how to do and how well they are doing. They work in their own speed with a minimum of distractions and often feel both flow and self-efficacy when they find the programs interesting. Many focus learners express, that they like these predictable resources and teachers observe learners more focused and active in learning activities, where task solving is guided and response or help is available:

> *"M (boy, 10th grade) uses matematikfessor.dk. He follows explanations using good, closed, headphones and is able to stay at the tasks even with some noise around him. Normally he would do nothing" (Teacher K).*

Learning Games

The learning games scaffold – like the Digital Training Resources – learners and tell them what to do, how to do and monitor how well they are doing. They can work in their own speed with minimal distractions and obtain a feeling of flow. Several schools have tested learning games and the teachers' judgement is clear. Focus learners were more motivated and engaged when playing learning games and the tasks in the game were appropriate to their skills:

> *"A (boy, 4th grade) was very focused at the game. He wanted to continue at home, which is totally new for him. He should also continue in the school, but*

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> *unfortunately it is finished in few hours. It should have been more extensive – they are finishing the game to fast" (Teacher C).*

When it comes to learning games, some focus learners got a new role in the classroom:

> *"We used a learning game. N (boy, 6th grade) was really in play here and able to help his peers" (Teacher B).*

The learner states that he likes learning games because of the up-tempo and activities:

> *"It is not boring and slow".*

Some teachers have designed game based learning activities by themselves to enhance focus learners' motivation as e.g. a Run & Spell game with QR tags to provide restless focus learners more mobility in the lessons:

> *"I find these games really funny" (girl, 4th grade).*

Another teacher uses online resources to test and monitor how well his learners are doing. He finds quizzes motivating because of the competition between learners and the immediate feedback. He states it is easy to conduct quizzes and sees them as funny activities at the end of the lessons.

Assistive Reading and Writing Technologies

Assistive reading technologies read text aloud for learners while writing technologies offers learners word suggestions, help them spelling or write what they are saying. Assistive Reading and Writing Technologies helps focus learners to feel flow and self-efficacy:

> *"We have used it for some years now. Earlier, I found it very difficult to write a text. I made a lot of failures and all sounded wrong. Now it is easier. When I got it, I wrote a whole story, and it was almost right. Then I was happy and joyful and thought it was funny to write" (girl, 4th grade).*

Almost every focus learner in the project mention Assistive Reading and Writing Technologies as valuable tools they would recommend to other learners. Slow readers or learners with reading difficulties appreciate to

> *"hear the reading while being attentive at the text" (6th and 7th grade).*

Reading and writing technologies helps them to work more independently (self-efficacy):

> *"Then I do not need help from the teacher all the time" (boy, 6th grade).*

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Individual and Shared Summary/Comprehension Tools

Some schools successfully use digital tools to foster summaries of the individual learners' comprehensions, as e.g. *Word-of-wisdom-blogs*, *Concept-mind-map* or *Expectation-Diaries*. Such interventions give learners a place for reflection, reification and evaluation of what they have done and learned. It seems valuable for focus learners to compile their experiences of success and development. Likewise, many schools start using shared digital platforms to gather all learning material for the classes. It was a learning process to design and use these new Virtual Learning Environments (VLEs), but after a period of experiments, adaptions and modification they offered learners a great help in their learning processes:

> *"Google Websites is a good resource in Danish Language, where all topics from all years are compiled. All learners can see, what the peers have made. They learn to find help from other learners and be respectful for that. We have e.g. structured a novel reading course with on page for introduction to the novel, another with tasks before reading, a third while reading and a fourth after reading. Tasks are compiled and different modalities are used for information, instruction, analysis models etc. The learners return to and compile with earlier work. It works well for all learners that content and contributions in a subject are structured and gathered. They can add text, pictures or videos to support their individually comprehension" (Teacher B).*

Discussion and Perspectives

Even though we during this paper have enlightened how valuable digital resources can be, our research has also uncovered some negative implications. In order to keep a high arousal, a feeling of control and flow it is important that focus learners meet both high-perceived challenges and skills. But many of our focus learners are – due to their deficits – years behind their peers developmentally, socially and academically. In mainstream classrooms, they often meet the same tasks as their peers, and even though they might get a helping hand or an assisting tool, they still will be evaluated against the same curriculum. This impacts their experience of self-efficacy or being good enough. Teachers are frustrated, when they cannot appreciate and acknowledge focus learners' progression with marks in relation to their actual growth.

> *"I tell him he is doing well, but tomorrow he will have his marks, and then I know his courage will fail and he will stop trusting me." (Teacher J).*

We cannot expect learners to grow in the same speed. The same problem is noticed in relation to assistive reading and writing technologies: When teachers encourage learners to use text-to-speech or speech-to-text-tools other teachers, parents or peers express, it is a kind of "cheating". It seems important to clarify the purpose of reading and writing activities for all stakeholders: "To be able to read or write" or "To learn as much as possible and express knowledge and thoughts"? An inclusive school should generate a Universal Design for

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Learning approach – not only when developing, buying or providing assistive tools – but also when it comes to pedagogy and policies. We have experienced how pedagogical deliberate introductions to and use of Virtual Learning Environments, digital resources and assistive tools impact focus learners self-efficacy in terms of knowing what and how to do things:

> *"We have many academically weak children in our classes and observes how CDord (reading/writing technology) makes them much more autonomic. It is difficult to find good reading materials to weak readers, but now they can unassisted read and be more at the same level as their peers" (Teacher J).*

Unfortunately, we have seen, that many teachers do not know how to use these technologies, which is why they cannot support focus learners and leave them on their own.

The value of technology-based interventions and assistive tools depends on the individual focus learner's deficits and challenges. When it e.g. comes to learners who are years behind their peers with small vocabulary, poor comprehension or weak memory they might need alternative pedagogical initiatives and approaches than the mainstream teaching practice offers:

> *"He (boy, 6th grade) has been at a special education school for three years. He cannot just jump into the curriculum here. He can read using technology, but he might not understand the words. We must help him step by step" (Teacher G).*

It seems difficult for teachers to help learners with weak working or short time memory:

> *"M (girl, 4th grade) finds math videos of relevance for what we are doing in the lessons. Videos for the lower classes are short and simple. Then she is concentrated. When they are getting longer with more operations involved – it is difficult for her to remain on task" (Teacher D).*

We will suggest further research in rehearsing memory capability, which seems crucial for a major part of our focus learners learning outcome. Gathering all learning materials into online portals improve focus learners access to learning experiences (e.g. enable differentiation, several modalities or repetition). Navigation in the VLE seems problematic for some focus learners why teachers must be aware of designing a simple and clear path to materials and keep away unnecessary distractions. Teachers must see themselves as role models for learners and provide focus learners simple learning pathways and structures to scaffold them in both the digital and real-world classroom. Schools must have a critical view on Human Computer Interaction at learning resources: How easy and intuitive is the navigation when the learner is 6, 10 or 14 years old? It is a child friendly learning environment or a measure friendly technology? Tests, quizzes, games, training resources etc. have been used in many of the investigated classes with both positive and negative impact for focus learners. With no differentiation and evaluation against the same goals, with time-limitations

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and competition it seems as a stressful adventure for our focus learners. It might be fairer to them, if learning groups were designed after stage rather than age. And it might be of greater value, if schools were more focused on facilitation of reification, meta-reflections and formative evaluation instead of narrow-minded focus on measuring, data documentation and summative quantitative reports of learning outcome. Teachers have during the project described, how they often feel guilty, because they know full well the focus learners' specific needs without being able to offer them what is needed. Half of the teachers do not feel competent pedagogically or technologically to design technology-based interventions for the target group and state that they neither have sufficient time for designing individual material, explanations and structures for a focus learner's full day at school. Many examples of successful interaction of technology and pedagogic have been found. But they are used in flash – from time to time – and not a consistent practise in the focus learners' time at school.

Conclusion

This paper has investigated the potential of technology-based interventions for differentiating learning experiences and increasing comprehension by learners with attention and developmental deficits (focus learners). We have observed how digital textbooks, digital course portals, video materials, digital training resources, learning games, reading and writing technologies and individual or shared summary tools have been used in 26 classes with more than 500 learners and successfully assisted 56 focus learners in their learning experiences. For teachers with both pedagogical and technological insight it seems to be possible to exploit this favourable potential in their classroom teaching and increase both a feeling of flow and self-efficacy in learning processes among this group of vulnerable focus learners. When using technology-based interventions consciously it is possible to provide learning challenges balanced to learner skills, and take advantage of the power of technologies in order to help learners overview what to do, how to do, where to go and how well they are doing. Our research has unveiled how technologies are able to minimise distractions for unattended learners, but it depends on teachers' classroom management in both real world and virtual environment settings. On the other hand, technologies may also be confusing for focus learners and provide distractions. If technology should be utilised to its full including potential it is necessary for schools not only to buy and provide technologies, but also use it in a Universal Design for Learning approach that gives all individuals equal opportunities to learn, allow them to meet learning challenges balanced to their actual skills and to grow in their own speed. Even though this investigation has shown us a lot of examples where technology and pedagogy interact successfully and increase focus learners' ability to be more self-driven and more actively participating in an including learning community, good examples only still appear in flashes and yet not as a consistent practise in the focus learners' time at school. To foster an including school system a much broader understanding and acceptance is needed by all stakeholders of this group of learners with respect to their specific challenges in the mainstream educational system.

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