



Unsolicited

A study on the attitudes of Swedish teachers regarding the inclusion of tangible and non-tangible ICT

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Abstract

Europe is becoming more technology-saturated with each passing day, and due to the 1:1-initiative, the school is no exception. The field of education is in a state of change, with a myriad of ICT (abbr. Information and communications technology) tools under development and trial. The evaluation of these tools are done mostly from the perspective of the students as users, and while the perspectives of the teachers are often utilized in their roles of educational experts, their reality as users of technology is not considered. In this thesis, through a literature review of both ICT in education and tangibility, the qualitative means of semi-structured interviews, and a framework for technology-enabled practice transformation, we find that the inclusion of ICT into education is largely extrinsic. We also find that the teachers have not been sufficiently educated on the changed practice of education in an ICT context, which brings about a number of negative emotional consequences. With this result in mind, we propose, among other things, the need for a modernized teacher education based around ICT didactics, and an explanation as for why tangible ICT is not utilized in education.

Keywords: ICT, tangibility, education, teacher attitudes, didactics

1. Introduction

1.1 ICT in education

ICT is an abbreviation for ‘Information and communications technology’, related to the more general term IT, but with an emphasis on connectivity and human practice. The current practice of using ICT in the education is defined as TEL, or ‘Technology-enhanced learning’ (Chan, Roschelle, Hsi, Kinshuk, Sharples, Brown, Patton, Cherniavsky, Pea, Norris, Soloway, Balacheff, Scardamalia, Dillenbourg, Looi, Milrad, & Hoppe, 2006). The European Union has authored a digital agenda to be used as a guideline for its member nations regarding the implementation and use of ICT (European Commission, 2010). In regard to ICT literacy, the agenda states the following: *“It is essential to educate European citizens to use ICT and digital media and particularly to attract youngsters to ICT education.”* (p. 25). To this end, a ‘1:1-teaching initiative’ was advocated, which aims to provide as many students as possible access to a personal computer for educational purposes (Balanskat, Bannister, Hertz, Sigillò, Vuorikari, Kampylis, & Punie, 2013).

ICT for everyone is the Swedish version of the digital agenda, outlining the nation-wide goals and requirements in relation to the equipment coverage and computer literacy of the Swedish people (Näringsdepartementet, 2011). Since the advent of the 1:1-teaching initiative, Swedish schools are quickly becoming saturated with ICT. However, despite having among the largest amount of ICT equipment in European school systems with roughly 80% coverage, only 30% of the Swedish teachers consider themselves to be supportive of ICT (Wastiau, Blamire, Kearney, Quittre, Van de Gaer, & Monseur, 2013). Furthermore, an encompassing European ICT study found, among other things, that there are *“no overall*

relationship between high levels of ICT provision and student and teacher confidence, use and attitudes.” (European Commission, 2013, p. 155).

As actors inside this systematic approach to introducing ICT into the educational context, combined with their low ICT acceptance, lends us to believe that teachers in the Swedish school system are the ideal objects of a qualitative study: being an integral part of a rapidly evolving ICT environment affords them both a personal reason and the proper experience to deliberate on the usefulness and implementation of the tools they have (or have not) been provided with.

1.2 Tangibility

There is no doubt that the human species is a physical one, developed to act in the external space around them. It is only recently that our species have strayed from our physical context, through the interaction with the digital realm. If we look to academia, however, it appears as if we are trying to find a way back to our roots. Embodied interaction is a strong research field subsumed under human-computer interaction, described by Paul Dourish as follows: “*Embodied Interaction is interaction with computer systems that occupy our world, a world of physical and social reality, and that exploit this fact in how they interact with us.*” (2004, p. 3).

‘Tangible’ is defined in the Oxford dictionary as “Perceptible by touch” and “Clear and definite; real”. This adjective is the cornerstone of tangibility, or, the property of realness. In the field of embodied interaction, tangibility concerns translating computational resources and data back and forth between the physical and digital realms through the use of TUIs, or ‘tangible user interfaces’, often situated within ‘digitally augmented physical spaces’ (Hornecker & Buur, 2006). In other words, tangibility describes an interaction in which you are afforded control of a digital artifact by using a physical (and often metaphorically inspired) interface.

The current field of tangibility research seems to indicate a great potential of use within the field of education, with a myriad of tangible prototypes for education in current and previous development (Lee & Kim, 2014; Pandey & Srivastava, 2011; Antle, Wise, & Nielsen, 2011 etc). However, we have not been able to find any studies on the attitudes of the educational professionals towards tangibility-enhanced education, nor whether or not they have a sufficient awareness of its existence.

1.3 Purpose

In this study, through comparing the seemingly unsolicited inclusion of ICT in education with the puzzling lack of tangible ICT in education, we want to investigate the field of technology-enhanced learning, with a particular focus on tangibility. By designing and carrying out semi-structured interviews, we aim to identify and analyze the attitudes and feelings of the Swedish teachers regarding ICT, and how they are using it within their educational activities. From the results of this study, we hope to be able to draw conclusions regarding the current path of educational ICT in general and tangible ICT in particular.

1.4 Research question

What are the current attitudes of Swedish primary school teachers regarding use and inclusion of ICT, and tangible ICT, in the educational context? Do those attitudes differ between tangible and non-tangible ICT?

2. Background

2.1 ICT in education

Use and inclusion of ICT in educational settings is a highly populated area of research. Kadiyala and Crynes (2000) arrived at the conclusion that ICT may face a slow rate of acceptance in education despite being useful in most respects. Another literature study (Mumtaz, 2000) shows the same results when it comes to practitioner acceptance of ICT in education, and argues that having ICT equipment in the school does not mean that the teachers will use it. Thirteen years later, this slow rate of acceptance remains the same (Wastiau, Blamire, Kearney, Quittre, Van de Gaer, & Monseur, 2013).

It is generally supported that ICT can be useful for education, assuming cooperation between educational practitioners and educational researchers. (Voogt, Knezek, Cox, Knezek, & Ten Brummelhuis, 2013). Research has been conducted regarding technology integration in schools (Dede, 2000, Jahnke, Bergström, Lindwall, Mårell-Olsson, Olsson, Paulsson, & Vinnervik, 2012), where the technology is believed to have numerous effects on the practice of education: “... *enrich curricula, enhanced pedagogies, more effective organizational structures, stronger links between schools and society, and the empowerment of disenfranchised learners [...]*” (Dede, 2000, p. 282). Furthermore, Jahnke and Norberg (2013) argue about the definition of digital didactics, suggesting a structure to completely rebuild education with ICT in mind, rather than trying to augment it with technological fixes.

While Almqvist and Östman (2006) have shown that use of the internet alters learning and information finding behavior in a limited way, it has also been suggested that properly designed technology should be able to foster creativity and encourage students to reach beyond the spectrum of available options (Jahnke, 2011).

The research on teacher attitudes and education surrounding ICT is however a bit sparse. Österlund and Lindholm (2013) suggest that while some teachers are aware of the effects of ICT inclusion on classroom context, the majority of them face a lot of changes to their role and practices, changes that they have to adapt to on-the-go, largely unsupported. Furthermore, a study on the Swedish teacher education has shown that some teacher educators are resisting digitalization, which seems likely to generate adverse effects on the ICT acceptance of the teachers they educate (Vestling, 2012). However, the conclusions of a study done by the European Commission suggests, among other things, that “*Countries might consider making ICT a compulsory component of initial teacher education programmes and to seek to improve the quality and consistency of ICT training across institutions.*” (European Commission, 2013).

2.2 Tangibility

Tangibility is generally considered to be useful in education, especially for young students and students with learning disabilities (Marshall, 2007, Antle et al., 2011). However, adult students and scientists also use tangible ICT to visualize and experiment with abstract theories, for example within the fields of molecular biology and dynamic systems (Marshall, 2007).

Young students are said to be able to “... *solve problems and perform in symbol manipulation tasks with concrete physical objects when they fail to perform as well using more abstract representations*” (O'Malley & Fraser, 2004, p. 3). This happens not only because of the properties of tangibility, but also because of the embodied activity intrinsic to the interaction. Furthermore, certain constructivist learning theories, for example epistemology, claims that information is tightly bound to the environment, and to how the people in it interact with artifacts and each other (Antle et al., 2011). This suggests that idea retention may be stronger when the student is physically involved with the learning context and material, as opposed to being a passive recipient of information.

A large number of educational tangible artifacts have been researched and prototyped since the rise of embodied interaction, a sample of which will be presented below. Ely (Africano, Berg, Lindbergh, Lundholm, Nilbrink, & Persson, 2004) is a puppet equipped with a personal digital assistant, and is used as a link between the physical environment and a digital world. Magic Carpet (Stanton, Bayon, Neale, Ghali, Benford, Cobb, Ingram, O'Malley, Wilson, & Pridmore, 2001) is a carpet-like set of sensors meant to improve collaborative storytelling. Towards Utopia (Antle et al., 2011) is a TUI tabletop, which in combination with RFID tags facilitates understanding of sustainability-related concepts. Tiblo (Pandey & Srivastava, 2011) is an artifact, which allows recording and playback of voices and sounds, to be paired with pictures and rearranged physically in a jigsaw puzzle manner. A recent example is RoyoBlocks (Kleiman, Pope, & Blikstein, 2013), a tangible artifact meant to improve literacy through the use of RFID-enhanced wooden blocks and a reading companion in the shape of a monkey doll.

These are a few examples of the different tangible educational prototypes that have been created during the last decade, but it is far from an exhaustive list. Within the annual TEI conference (abbr. Tangible, Embedded and Embodied Interaction) is presented prototypes and theories regarding tangible and embodied ICT. TEI has been held annually since its inception in 2007 and its prolific yield argues for the strength of the tangibility and embodied interaction research field.

3. Method

Our questions are closely related to understanding the opinions and experiences of the teachers in Sweden. With the prediction that the data on this topic would be much too rich and multifaceted to succeed with any kind of quantitative study, and a timeframe that does not allow for a more in-depth qualitative research method, we decided to utilize semi-structured interviews (Blandford, 2013, Patton, 2002) as our main data gathering method. While observational studies would have been able to portray the practices of the teachers in a

more solid manner, it would likely be a less accurate picture of their feelings and thoughts - how they reason on a more personal level about the way they practice education in an environment saturated with IT.

Since we could not deliberate on the definition of tangibility without risking the neutrality of the respondents, we had to find another way to make them talk about it. To this end, we used two examples of IT artifacts - one being tangible (Pandey & Srivastava, 2011), and the other being intangible (Duolingo, 2014). The reason for including these examples were as such not to evaluate the specific artifacts, but to through them give the respondents a platform through which to elaborate on tangibility without necessarily understanding the rather academic term.

The first interview was conducted as a pilot study and served to formalize the order in which the questions appeared in our interview guide. The subsequent alterations we made after the pilot study did not seem severe enough to risk the validity of the interview, and as such we decided to include the pilot data into the results. The final version of the semi-structured interview guide can be found in the Appendix section of the thesis (Appendix 1). It is important to keep in mind that an interview guide for a semi-structured interview is not a strict questionnaire. Rather, it is a tool for the interviewers to keep the conversation on track, and to ensure that all-important subjects have been touched upon, and that this is done in largely the same order.

3.1 Participants

In order to find respondents for our semi-structured interview study, we contacted 35 schools over the course of two weeks. Seven of these schools expressed an interest to participate in our study. In the end, the total sum of participants in our study was thirteen, of which twelve were teachers, and one being an ICT teacher with formal teaching education and experience.

One of the regular teachers was a part time ICT teacher, and most of the respondents were language teachers (English and Swedish). The gender distribution was, as shown in the table below, a large majority of females. While this fact on its own could merit an inquiry of gender bias, it is not a large deviation from the 75/25 female/male split of elementary school teachers nationwide (Women and men in Sweden, 2010) and as such still a representative selection group.

The interview period lasted three weeks, and since we had no real limitations of participation other than being a teacher and wanting to be a part of the study, it can be said to be a convenience sample (Patton, 2002). Our goal was to conduct as many interviews as possible in the three weeks we had allotted to the study. However, it turned out to be quite hard to find willing interview participants, likely because the inconvenient time period - most of the teachers were in the process of preparing, administering and carrying out national exams. Furthermore, the presented subject of the study seemed to make them apprehensive, or even uncomfortable to the point of hanging up on us mid-sentence. In the table below (Table 1) we describe and enumerate the participants.

| # | Gender | Age group | Grades | Subjects |
|----|--------|-----------|--------|---|
| 1 | Female | 40 | 4-9 | English, Swedish, ICT teacher |
| 2 | Female | 40 | 4-9 | English, Swedish |
| 3 | Female | 50 | 7-9 | English, Swedish, Swedish as a 2 nd language |
| 4 | Male | 30 | 0 | ICT teacher |
| 5 | Female | 40 | 4-6 | Special needs teacher |
| 6 | Female | 40 | 2 | All subjects, Additional studies |
| 7 | Female | 40 | 1-3 | All subjects, Special needs |
| 8 | Female | 50 | 1-3 | All subjects, Special needs |
| 9 | Female | 40 | 6-9 | English, Swedish |
| 10 | Female | 20 | 6-9 | Swedish |
| 11 | Male | 30 | 6-9 | Social sciences, Music |
| 12 | Female | 40 | 7-9 | English, Swedish, Swedish as a 2 nd language |
| 13 | Female | 50 | 7-9 | English, Swedish, Social sciences |

Table 1. Participants

3.2 Procedure

When we had scheduled enough respondents, we proceeded to the interview period. The interviews were conducted in situ at the participants' respective schools, generally during school hours (with one exception where we met a participant after school hours). Both interviewers were present for each interview, with one leading the main conversation and the other one taking notes and making sure that the interview stayed on track. Sometimes, we went for single interviews and in other cases we went for full day excursions to interview three or four teachers at the same school. The main body of the study was in English, but since all our participants were natives, a number of participants requested the interview to be carried out in Swedish, which we could accommodate with one interviewer understanding and speaking both languages. This way, the participants were assured to be able to properly express themselves, even if they could not speak English very well. For a similar reason, we referred to 'ICT' as 'IT' throughout the interviews (and subsequently, the result section) to avoid unnecessary misunderstandings. The interviews were planned to last for around half an hour, but the actual range was between 20 and 45 minutes, and they were all recorded with a Dictaphone app.

3.3 Interview artifact examples

Tiblo is an artifact that allows recording and playback of voices and sounds, to be paired with pictures and rearranged physically in a jigsaw puzzle manner. It is a tangible plastic artifact, which has two buttons, one red and one green. Pressing the red button activates sound

recording and the green is for playback. The surface is designed in a way to be able to attach text or images on it. Duolingo is a smartphone application used to learn languages through multiple choice questions, text ordering, writing, and voice recording. Since we did not have access to a Tiblo prototype, the examples were presented in the form of paper prints. These paper prints can be found in the Appendix (Appendix 1).

3.4 Methods of analysis

Thematic analysis (Blandford, 2013) has been used for the analysis of the data. Through repeated listening of the recordings and in-depth discussions, we identified a set of themes, which, after reorganization, painted a clearer picture of the respondents' opinions. We then condensed the data into a summary, which we then used to populate the table found in the result section. Furthermore, we used Kaptelinin and Bannons (2012) 'Technology-enabled practice transformation' schema as a framework to investigate whether the ICT inclusion in education is extrinsic (driven by outside factors to change practice), intrinsic (natural evolution of practice and toolsets), or both. This schema concerns itself with six different evaluation points and is presented in full in the Analysis section (Figure 1).

4. Results

From the thematic analysis of the interviews, we found a number of recurrent themes in the responses, which we will outline and describe below. Some of the quotes used in the result section have been altered for clarity. Unless otherwise stated, any instance of data is a representation of the opinion of one or several respondents. In the end of the Results section is a summarizing table of the data for quick reference (Table 2).

The results are presented in this order:

1. General questions about the respondents, about their work, and about their feelings regarding technology.
2. The advantages of technology in the school context.
3. The disadvantages of technology in the school context.
4. Tools that are currently used by the teachers (IT and non-IT).
5. The examples that we show them in order to make them talk about tangibility.
6. Their expectations about IT use in the future.
7. The compilation of implicit tangibility-related issues.

4.1 Background and general answers

General computer interest. About half of the respondents claimed to have a personal interest in the use and being of computers, and one additional respondent expressed an indirect interest (related to its usefulness in their professional context). The rest of the respondents did not explicitly mention an interest in computer-related technology. "... I have also been reading a lot IT courses, lately, as well as being very interested in using the internet technology in schools, because I can see that there are lots of benefits." (Participant 1)

ICT teachers. There were several notions regarding ICT teachers spread throughout the interview data, with the most of them coming from the actual ICT teachers. Two respondents stressed the importance of role priority, saying that it is more important for the ICT teacher to be a school teacher first and an IT professional second - the ICT teacher needs to be intimately familiar with the experience of being a classroom teacher in order to properly understand their needs. Furthermore, a few respondents also tried to describe the education and practice of an ICT teacher. “... *it is more important that it is someone from the educational part that knows technology than someone who only knows technology because you have to understand what it is to teach when you are choosing [applications]...*” (Participant 10)

IT as a silver bullet. A few respondents talked about the danger of seeing IT as an ‘elixir’ for education, as a collective response to the feeling that many executives and politicians seem to believe that a majority of the problems in education can be solved by a mindless implementation of more IT. This mindless implementation ties into budget concerns, where some respondents had the opinion that the money could be better spent on improving the working conditions for teachers, and that teachers in their role as the most important ‘tool’ in the classroom never could be replaced by computers. Some respondents did however refer to their increased dependence of IT, claiming that they could not remember how they worked before its implementation, nor imagine how they could possibly go back to teaching without them.

“... *computers are not supposed to replace anything, you should use computers at what computers does best and you should use all the other techniques in the areas that they are most suitable [...] this is not a magical box that solves everything - it is just one way that we could integrate with all the other [educational tools].*” (Participant 4)

Feelings of inadequacy. Several respondents, among them the ICT teachers, believed that many teachers were afraid of using IT in the classroom. Some respondents also reported that they felt inadequate in the context of classroom IT use, and others reported a loss of authority related to the inclusion of IT and how the students allegedly know more about IT than they do. “*Even though we have all this technology I can say I am not the best one to use it. I do not use the smart board as much as I want to be able to do...*” (Participant 2)

Knowledge. A common theme in the interviews was the being or unbeing of knowledge. A majority of the respondents claimed a lack of knowledge regarding the IT they are expected to use, stemming from shortcomings both in teacher education and further competence training. Some of them also talked about the students having a lack of knowledge of IT, while others reflected on the children being ‘technological natives’ as opposed to the teachers, who were said to be ‘technological immigrants’. One respondent also believed that IT made children devalue education with the motivation that since all information can be found on the Internet, there would be no reason to internalize the knowledge. The ICT teachers, among others, claimed that teachers do not think about IT enough, and finally, one respondent reflected on the issue of their principal not being interested in IT questions.

“... we learned some things during the teacher programme [...] but the things we learned there was how to build your own homepage. It didn't seem really relevant to what we are doing here. You didn't get like didactic or pedagogic tips on how to build lessons around computers or anything...” (Participant 11)

Time. Several respondents reflected on the lack of time to learn to use IT to a greater degree, although one of the ICT teachers claimed that preparing materials for a lecture or a class has become a lot easier since they do not need to handle physical copies of handouts anymore. One of the respondents reflected on the predicted usefulness of a centralized teaching resource database, while yet another gave an example of a database she used to find and download premade lecture material. One teacher also pointed to the fact that the modern teacher has too many roles, and expressed that it would be preferable to leave the ICT to a full time ICT teacher.

“I feel ok, but sometimes... I feel stressed, of course, because you don't get time as a teacher to learn things, its [snapping of fingers] just coming in like this. For example when all the students got a computer each it was just like [whistle] out with the computers, so... I wish that we had more time to sit down and think about what we would like to do? What do we need? Who can help us with this and what do I need to learn?” (Participant 12)

Methods of teaching. Throughout the interviews, the respondents talked about a number of educational methods. The traditional didactics of education was understandably the one most talked about, although in an indirect manner. Other themes include IT and non-IT educational games, writing-to-reading, physical and sensory learning, and online collaborative work.

4.2 Advantages

Administrative communication - Connectivity. Three of the respondents reported on the use of internet to connect with their colleagues and the parents of their students, to keep the students informed of the class and homework specifics, and to help the students connect with each other.

IT motivating children. Several respondents claimed that the children are more willing to work with the computer than with traditional tools. *“They're so into it... If I say 'You're going to write a text on a piece of paper' it goes like 'Ugh' for a lot of kids but if I say that we are going to do it on the computer - 'Yeah sure give me the computer, lets get started!'”* (Participant 9)

The Internet as a source of information - Current information. Almost half of the respondents used the Internet as a source of information and some of them pointed out that the information that can be found there is far more current than the information that can be found in books.

Digital visualization. More than half of the respondents talked about the use of multimedia and its effect on visualization. IT also made this inclusion of multimedia a lot easier since they no longer need to plan ahead by borrowing movies and booking a TV, since they can just download the content through the Internet. *“It's good that you can find things*

to show things that you are learning in a [better way], if you see a movie too. It's not the same as me always telling them about something. It gives them a wider perspective..." (Participant 12)

Disability aid. More than half of the respondents referred to the fact that through the use of specialized applications, it has become a lot easier to help people with learning disabilities, in particular those related to reading and spelling.

IT as a time saver - Flexibility - Adding variety to tools - Minimization of paper use. A few respondents talked about the time saving properties of IT in regards to the creation of teaching material since they can download class material through the Internet. Furthermore, they no longer need to print out as many handouts since they can distribute them digitally via Google Drive or other IT solutions. They also noted that the use of a computer added variety and flexibility to the way they conduct their educational activities. *"If you want to show something, you can do it very fast – you do not have to go to the library and search for something, and you can be more spontaneous as well..."* (Participant 11)

4.3 Disadvantages

Focus difficulties - Avoiding focus difficulties. More than half of the respondents referred to focus problems related to use of IT in the educational context, that is, students using their computers for non-school activities on school time. Some of the respondents had a band-aid solution in telling the students when to open or close their laptops, and others reflected that the computers did not introduce the problem, but is the contemporary tool through which an ubiquitous lack of focus manifested: *"... that's not particular for kids in school, I mean, go to a company, and watch them have a conference and try to see if these fifteen adult people did not sign in on Facebook."* (Participant 1)

"... we can't control what they do all along. If they go into a group room and work, we do not know if they are watching Youtube or Facebook and stuff like that – but if I look back to when I was in school, Youtube wasn't invented, but you can do other stuff. Just talk, or draw..." (Participant 4)

Reduced face-to-face time - Internet bullying - Non-school activities on school time. A few respondents talked about the negative effects of interpersonal distance in the new ways of communication, resulting in things like Internet bullying. Additionally, some respondents had concerns about the computer being more entertaining than the teachers.

Lack of equipment and/or unpredictable absence of computers. More than half of the respondents had problems with the hardware either because of an unpredictable lack of computers, or because they had to book the equipment, i.e. they did not have personal laptops for every student. The unpredictable lack of computers occurred either because the computers had technical problems, or the students forgetting or choosing not to bring them to school. *"... students that don't bring their computer, students that haven't charged the battery, students that have broken their computer, and [this] means that you cannot count on every student having their own computer..."* (Participant 3)

4.4 Tools

According to the big picture of the responses, the most common tools (other than pencils, school books and whiteboards) appear to be the laptop and Google Drive, followed by interaction boards, tablets and a class homepage. Further examples of tools that are reportedly used are (in no particular order): Dropbox, social media, digital textbooks, voice synthesis, audiobooks, smartphones, and smart pens.

Three of the respondents made a comparison between tablets and laptops. Their concern was related to three things: the absence of a physical keyboard, the increased portability of the tablet, and the tablet being less teacher-centric due to its mobility.

Most of the schools have an ICT teacher, which are used as an expert advisor when they needed to learn more about or include IT in their teaching. Some of the ICT teachers are however responsible for a whole school district, giving them limited time to help the teachers.

4.5 Examples

Tiblo. The most common reaction to Tiblo was that it seemed to be designed for younger students and/or children with learning disabilities. The respondents also expressed beliefs about the limits of its usefulness and were concerned with how it would be financially viable compared to the more flexible computers. One respondent also pointed out the benefits for the students in listening to their own voices and that it may be easier to focus on tangible artifacts than on computers.

Duolingo. Some respondents pointed out the quick feedback that Duolingo afforded the students, and also that the game-like structure of the game would appeal to motivate the increasingly competitive students. There were also a few respondents who recognized the general structure of the game and compared it to similar grammar training tools on the computer. However, they did not believe it could replace conversational teaching, also noting that it presupposes each student to have a smartphone or a tablet available.

4.6 Future

More than half of the respondents predicted an increase of IT in the future of education. Furthermore, close to half of them also believe that the implementation of IT in education will be more goal-oriented, and that there is a need of more IT education in teacher university programmes (specifically related to IT didactics). Other concerns in the subject of the future of IT in education are increased demands on teachers, health problems due to sedentariness, student-chosen toolsets, and new physical structures for teaching environments. “... *I want to melt down the school.*” (Participant 13)

4.7 Tangibility

Learning through physical movement - Reduced physicality. One respondent worried that the computer had negative effects on the physical health. However, courses like arts and gymnastics could offset that drawback, simply because they will make students move around and perform tasks with their hands.

Computers have not changed the physicality of students. A few respondents indicated that computers have not changed the physicality of students because they did not replace anything - the activities that took place before the inclusion of the computer are still claimed to be used in the education.

“I haven’t seen any indications that just because we have technology [it] would change stuff like the importance of doing, or touching, or feeling, or smelling things [...] That would be terrible if anyone thought that looking at a picture could replace touching something...” (Participant 4)

Inability to physically touch digital software. One respondent suggested that apps would be preferable to tangible artifacts due to the low cost of an app compared to a physical device, and that the only thing missing would be the property of tangibility:

“There are so many web based free places you can go and pretty much do most of these things, [for example] with the software that comes with your active board, or smart board, you can make them yourself pretty easy. The only thing missing is that you can’t hold – touch it with your hands.” (Participant 4)

Physical constraints of school. A few respondents referred to the importance of the physical school environment to coincide with the educational goals, and that we needed to have a more flexible or customizable school layout: *“... and you can’t rearrange the buildings very quickly, we’re stuck with this form of the room for a long time...”* (Participant 5)

Abstraction. A number of respondents talked about abstractness, and how some students, particularly those with disabilities, disliked writing with the computer because they felt no ownership of the text. However, there seemed to be some upsides as well: *“... it makes it more visualized. Everything you use in the computer, you can see. But at the same time it is a kind of abstraction because you can not touch it – you can only look at it.”* (Participant 5)

4.8 Result table

This table (Table 2) is a summarization of the general themes and opinions found throughout the interview study.

| General questions | |
|---|--|
| <i>General computer interest</i> | <ul style="list-style-type: none"> • Around half of the respondents claimed to be interested in computers. |
| <i>ICT teachers</i> | <ul style="list-style-type: none"> • ICT teachers should be teachers first and computer specialists second. |
| <i>IT as a silver bullet</i> | <ul style="list-style-type: none"> • Respondents do not believe that IT is a ‘miracle fix’ for education. • Mindless implementation of IT is a problem. • There are concerns about wasteful use of money. |
| <i>Teachers’ feelings of inadequacy</i> | <ul style="list-style-type: none"> • Some teachers are afraid of using IT in the classroom. • Some teachers feel inadequate in the use of IT in the classroom. • Some teachers feel a loss of authority related to IT in the classroom. |
| <i>Knowledge</i> | <ul style="list-style-type: none"> • A lack of IT related training is reported, both in the teacher universities and post-graduate. • Students, while being ‘technological natives’, are still not experts in the |

| | |
|---|---|
| | <p>use of IT.</p> <ul style="list-style-type: none"> • The accessibility of information on the Internet can make students question the purpose of education. • The ICT teachers believe that teachers should spend more time thinking about how they can use IT. |
| <i>Time</i> | <ul style="list-style-type: none"> • There is not enough time to properly educate oneself on IT. • IT can be a time-saver when preparing materials for a lecture or a class. • Some teachers expressed a need for a centralized teacher resource database. • Some teachers are using pre-made lecture material downloaded from the Internet. • One teacher wants a full time ICT teacher to handle any IT related issue. |
| <i>Methods of teaching (as mentioned throughout the interviews)</i> | <ul style="list-style-type: none"> • Traditional didactics. • Games. • Writing-to-reading. • Physical and sensory learning (mainly used in special education). • Online collaborative work. |
| Advantages | |
| <i>Administrative communication - Connectivity</i> | <ul style="list-style-type: none"> • Connecting teachers to parents. • Increased ease of informing students. • Connecting students with each other. |
| <i>IT motivation children</i> | <ul style="list-style-type: none"> • One teacher claims that children are more willing to work with the computer than with traditional tools. |
| <i>The internet as a source of information - Current information</i> | <ul style="list-style-type: none"> • Internet is the most up-to-date source of information. |
| <i>Digital visualization</i> | <ul style="list-style-type: none"> • Multimedia makes it easy to visualize information. • Use of IT makes multimedia easier to use in the classroom. |
| <i>Disability aid</i> | <ul style="list-style-type: none"> • Some applications are specialized for students with learning disabilities. • IT makes it easier to assist students with learning disabilities. |
| <i>IT as a time saver - Flexibility - Adding variety to tools - Minimization of paper use</i> | <ul style="list-style-type: none"> • The use of IT can save time when preparing teaching material. • Teachers do not need to print handouts if the student has access to a computer. • Using IT adds variety and flexibility to the way that the educational activities are carried out. |
| Disadvantages | |
| <i>Focus difficulties - Avoiding focus difficulties</i> | <ul style="list-style-type: none"> • Students can use computers for non-school activities on school time. |
| <i>Reduced face-to-face time - Internet bullying - Non-school activities on school time</i> | <ul style="list-style-type: none"> • There could be negative effects of interpersonal distance. • Internet bullying. • Worry that the computer is more interesting than the teacher. |
| <i>Lack of equipment and/or unpredictable absence of computers</i> | <ul style="list-style-type: none"> • Laptops are prone to breaking. • Outside of the one-to-one project, booking computers is a hassle. • Students do not always bring their laptops. |
| Tools | |
| | <ul style="list-style-type: none"> • Laptop and Google Drive. • Interaction boards, tablets and a class homepage. • Dropbox, social media, digital textbooks, voice synthesis, audiobooks, smartphones, and smart pens. |

| | |
|---|--|
| | <ul style="list-style-type: none"> • ICT teacher: <ul style="list-style-type: none"> ○ Used as a general advisor. ○ Holds educational seminars for the teachers. ○ Assists teachers in their classrooms. |
| Examples | |
| <i>Tiblo</i> | <ul style="list-style-type: none"> • Believed to be designed for younger students and/or learning disabled students. • Limited areas of use. • May be too expensive to buy. • Possible benefits of hearing own voice for educational purposes. • Believed to keep the student focused. |
| <i>Duolingo</i> | <ul style="list-style-type: none"> • Affords quick feedback. • Recognizable game-like structure. • Could motivate competitive students. • Teachers recognized it as a general structure of the game and compare it to similar training tools on the computer. • Unable to replace conversational teaching. • Presupposes the possession of a smartphone or a tablet. |
| <i>Future</i> | <ul style="list-style-type: none"> • Increase of IT in education. • More goal-oriented implementation of IT in education. • IT education in teacher university programmes (related to IT didactics). • Increased demands on teachers. • Health problems due to sedentariness. • Student chose their own toolsets. • Change the physical structures of the school. |
| Tangibility | |
| <i>Learning through physical movement - Reduced physicality</i> | <ul style="list-style-type: none"> • Negative effects of computers on the physical health. • Arts and gymnastics classes may combat this negative effect. |
| <i>Computers has not changed the physicality of students</i> | <ul style="list-style-type: none"> • One ICT teacher claims that computers have not changed the physicality of students because they did not replace any physical activity. |
| <i>Inability to physically touch digital software</i> | <ul style="list-style-type: none"> • Software solutions like phone apps would be preferable to tangible artifacts due to the assumed lower cost. • The only thing missing from software applications is that you cannot touch them physically. |
| <i>Physical constraints of school</i> | <ul style="list-style-type: none"> • One teacher reflects on the need for a physical school environment which coincide with the educational goals, and that the physical environment should be more flexible and adaptable to the teaching situation. |
| <i>Abstraction</i> | <ul style="list-style-type: none"> • Reflection about certain students feeling that they have less ownership in computer-written texts than with the pen-written. • Computers make text more visual, but not tangible. |

Table 2. Results of semi-structured interview study

5. Analysis

The definition of our research interest is, as stated in the introduction, “*What are the current attitudes of Swedish primary school teachers regarding use and inclusion of ICT, and tangible ICT, in the educational context?*” Through the semi-structured interview study, we

have generated data that strongly supports our ability to deliberate on answers to this question.

5.1 ICT

Regarding the general attitudes towards the increase of ICT in the educational system, the respondents seemed quite wary – while they eventually learned to see the value of the technology they were given, and expressed a difficulty to imagine how they could go back to working without it, they still seemed uncomfortable with the way it had been implemented.

“I think that the executives don’t always think about the consequences, they buy a lot of things and then it s up to the schools to do something good about it. And some schools do find good usage of the material and some schools don’t. So you should really start off by thinking what needs do we have, and what do we need to buy in order to fill that need, instead of just buying stuff and see ‘How can we use this?’” (Participant 3)

“You buy a lot of things but then you [haven’t always] thought about how you are going to pedagogically use them. So, there [is a] problem if the teachers are not on board on the project and they have not time to think about [what I actually want to do] with this technique.” (Participant 10)

In other words, while they could understand the need for the students to learn the ins and outs of ICT, it did not seem to have been implicitly requested by the teachers. Neither did they seem to have had any say in the procedure leading up to the decision to transform the school into an ICT environment. There is also a widespread respondent notion that they are not given enough opportunities to educate themselves regarding the use of ICT in their classrooms.

“... we learned some things during the teacher programme [...] but the things we learned there was how to build your own homepage. It didn’t seem really relevant to what we are doing here. You didn’t get didactic or pedagogic tips on how to build lessons around computers or anything...” (Participant 11)

This made it abundantly clear to us that the teachers did not consider themselves to have been included in the decision-making regarding the ICT implementation, but rather treated as voiceless cogs in the machinery that is education.

“I feel OK, but sometimes... I feel stressed, of course, because you don’t get time as a teacher to learn things, its [snapping of fingers] just coming in like this. For example when all the students got a computer each it was just like [whistle] out with the computers, so... I wish that we had more time to sit down and think about what we would like to do? What we do need? Who can help us with this and what do I need to learn?” (Participant 12)

From the general research of ICT in education we can postulate that while the development and design of ICT education seems to be user-centered, the ‘users’ of education are generally

seen to be the students. Meanwhile, the teachers are more likely to be cast as didactical experts. What we see in our study, however, is that the teachers are users of technology just as much as (if not more than) the students, and they sometimes know even less.

| | Technology-enabled practice transformation | |
|--|--|------------------------------------|
| | Extrinsic | Intrinsic |
| Initiated and accomplished mostly by | Designers | Users |
| Progression from the “source” to “target” practice | Discontinuous | Continuous |
| Effect of design on practice | Indirect | Direct |
| Abstraction level of design solutions | Generic designs | Idiosyncratic designs |
| Novelty of design solutions | Absolute | Relative |
| Scope of design solutions | Bound to a single technology | May involve different technologies |

Figure 1: Technology-enabled practice transformation (Kaptelinin and Bannon, 2012)

We have found a framework in the technology-enabled practice transformation schema of Kaptelinin and Bannon (2012) through which we can evaluate the ICT inclusion in the schools. The schema, presented in figure 1, consists of six attributes used to identify whether or not the practice transformation is extrinsic or intrinsic. By applying these attributes on the practice of ICT inclusion in education, we can see that it is initiated and accomplished by designers (European Commission, 2010, 2013), it radically and discontinuously alters the source practice (the general use of computers), the effect of design on the practice is indirect (Wastiau et al., 2013), the abstraction level of the design solutions is generic since there is no significant structural difference between the implementations of the 1:1-initiative (Balanskat, 2013). While there have been computers in the school context before the 1:1-initiative, it has not been transforming the teaching practice in such a significant way before, making the novelty absolute rather than relative, and the scope of the design solution is bound to a single technology (the personal computer, although it has some peripheral hardware like projectors and smart boards). This analysis shows that the practice transformation has been fully extrinsic.

5.2 Tangibility

While every respondent was given ample incentive to deliberate on tangibility, only a small minority was able (or chose) to do so. It was sometimes assumed that we were talking about physical education, and attempts at clarification did not help. Regarding the examples of tangible and intangible IT artifacts, the general impression was that the main use of the tangible artifact was for young or/and disabled students.

“I think it’s a lot about history, we have always worked in this way and often I think when the kids are older they are formed in this mold. They are ok with sitting down doing the stuff, leaving the classroom, sitting in small groups

working after the teacher told them what to do. But in younger years you need to have all the children in the classroom and you need to find ways to get them excited or focused on what they are going to do.” (Participant 4)

In the education of the disabled students, there were however examples of physical and sensory learning, which could be equated with non-IT tangible tools. “[...] *it makes it more visualized. Everything you use in the computer, you can see. But at the same time it is a kind of abstraction because you can not touch it – you can only look at it.*” (Participant 5) Furthermore, there was no indication from any respondent that any representation of tangible IT could be found in their classroom context. From a purely academic point of view, these findings are difficult to understand. If tangible ICT is indeed as good as it is claimed to be (Antle et al., 2011, Stanton et al., 2001, Africano et al., 2004 etc.), it should be able to significantly improve educational practice. Why is it then not used, and all but unheard of by the respondents?

6. Discussion and conclusion

In this thesis, we have visited several themes, amongst them the history and impact of ICT in education, and the potential of tangible ICT in education. To understand the current issues, values, and projections of these fields, we look to the professionals inhabiting the educational context in order to compare their feelings and attitudes to the conclusions made in academia. There are many reports claiming that ICT is useful in education (Kadiyala & Crynes 2000, Livingstone, 2012 etc.), but just as many empirical studies displaying underwhelming figures of ICT use (Mumtaz, 2000, Wastiau et al., 2013 etc). Even in a country with a modern 1:1-initiative and a high ICT coverage such as Sweden, the empirical evidence we generated pointed to teachers having negative feelings associated with the use and inclusion of ICT in education: fear, insecurity, a lack of knowledge, confidence, and time, as well as crises regarding their identity as professional educators stemming from the aforementioned issues. These identified attitudes provide an answer to our main research interest: *“What are the current attitudes of Swedish primary school teachers regarding use and inclusion of ICT, and tangible ICT, in the educational context?”*

Regarding the second part of our question, *“Do those attitudes differ between tangible and non-tangible ICT?”* we were unable to make the respondents elaborate in length about their experiences or attitudes surrounding tangible education beside some general notions about our tangible example, and how it seemed to be more suitable for younger children - which from the colorful, simplistic attributes of Tiblo is a reasonable assumption.

However, as presented in the analysis, we found claims indicating that young children require a set of didactics more closely related to tangibility while older students are made to learn with more abstract means. This is mirrored in Piaget’s cognitive development theory (Piaget, 1973), which claims that a child cannot properly use abstract reasoning until the age of eleven. This seems to suggest that one of the implicit goals of traditional education is to train the students to lose the ‘burden of tangibility’, i.e., to function better in the abstract environment of higher education. Can the failure to capitalize on the academically purported usefulness of tangibility stem from this reigning paradigm of abstraction? Assuming this

developmental path, it seems natural that the teachers pay little attention to the fact that the students are not afforded the opportunity to learn through tangible means. As such, traditional didactics may not be the proper context for tangible teaching. If tangibility were as beneficial for education as it is claimed to be, and it is incompatible with the current didactics of education, it would seem that we have no choice but to modify the didactics to be compatible with tangibility.

The lack of ICT education in the teacher universities (Vestling, 2012) seems to be a critical issue for this practice change. While we can understand that the teachers who were educated in the nineties, or even before that, would not have a lot of experience with the social and contemporary ubiquity of ICT, it seems unacceptable that even the newly graduated teachers of today have not been taught to relate to the ICT-infused educational context. Based on the technology-enabled practice transformation of Kaptelinin and Bannon (2012) and informed by the literature study of Voogt et al. (2013), we believe that the friction between academia and educational practice is the biggest impediment to conciliate between ICT and education. To mediate this friction, the educational practitioners need to be empowered to intrinsically evolve their ICT practices and tools as a cornerstone activity of their profession. We believe that the easiest way to bring about this empowerment is to reform their education into one that incorporates ICT didactics in a fundamental manner.

With the aforementioned problems of ICT acceptance in education, it is easy to understand why tangible ICT cannot be found in the classroom context, and easy to predict what would happen if someone tried to introduce it. It may be offhanded to try, as some of our respondents did, to make a direct comparison between the economic value of a computer and that of a tangible artifact, since the tangible artifact generally is not trying to compete with the computer as much as presenting an alternative means of learning. However, the reality for the schools is that they generally cannot justify spending money on alternative equipment that most likely would have been better placed towards the maintenance and upgrade of their computer equipment.

Regardless of the attitudes that teachers may have towards the use of personal computers, they are ubiquitous in the contemporary world, something that tangible ICT is not - there is no current representative of tangible computing that is close to the proliferous nature of the personal computer. In fact, there may very well never be - the physical requirements of a tangible interface, and how a physical interaction is far harder to make modular than a digital interaction both seem to indicate major hurdles for a mainstream acceptance of tangible ICT. However, by solving the general issue of ICT acceptance in education, which as mentioned would be done through increased understanding, interest, and acceptance of novel technological artifacts, it seems more likely that tangible ICT would receive a warmer reception in the schools of tomorrow.

6.1 Further research

There are a number of different directions to go from here, with a few research suggestions below:

- Where do we start with the change of the teacher education?

- Does the current paradigm of abstraction in the education effect the perceived usefulness of tangibility?
- What can be done to make tangible ICT more modular, or to make non-tangible ICT less abstract?

6.2 Study limitations

Teachers did not have the vocabulary or professional expertise to deliberate directly on the field of tangibility. The study was conducted in the geographical region in and around the municipality of Umeå, Västerbotten, Sweden.

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Pilot interview for teacher students

Introduce our research and ourselves.

Tell us a bit about yourself (Background question)

- How many years of experience do you have?
- What kind of education do you have?

Tell us a bit about your work (Background question)

- In which situations are you teaching?
- What classes are you teaching?
- Describe what we would see if we entered your classroom (Sensory question)

What is your opinion about technology in general? (Value question)

How do you feel about the technology that you use in your professional activities? (Feeling question)

- The positive and negatives of the technology you use
- Which technologies are those?
- How you use it? Give us a tour in a class in which you have used technology. (Sensory question)

How has the technology use changed over the years?

What kind of pedagogical tools do you like to use in your classroom? (Opinion & value question)

What is your opinion about learning through physical movement?

What effect do you think that technology as it is used today has on physical learning?

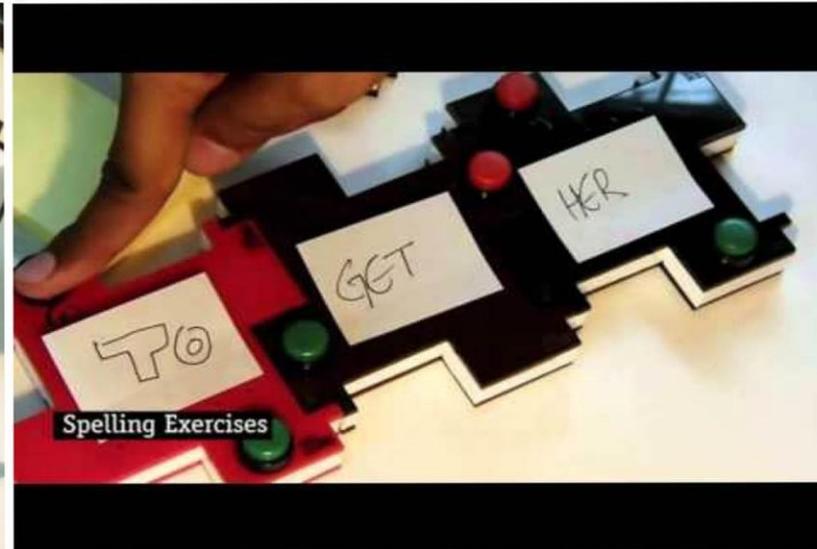
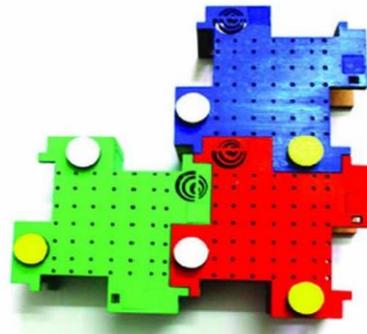
Give examples of tangible and non-tangible IT and ask their opinion.

What do you think a future classroom could look like? (Opinion & value question)

When you were first told about this interview, what did you think it would be about?

Do you want to add something? / What should I ask you that I didn't?

Appendix 1



duolingo™

