THE IMPLEMENTATION OF DIGITAL TOOLS IN TEACHING: A QUALITATIVE CASE STUDY AT A SWEDISH PRIMARY SCHOOL

Pernilla Josefsson, Kai-Mikael Jää-Aro, Sofia Lundmark, Ann Mutvei Berrez

Södertörn University (SWEDEN)

Abstract

Digital competence is increasingly added as a subject in school curricula, which places new demands on teachers to not only teach in the use of digital tools but also to use such in their teaching practice. This in turn requires teachers to learn these tools and then to find meaningful ways of using them in their everyday teaching.

The FICTION project investigates how teachers currently use digital tools as teaching aids, but also aims to develop guidelines for what type of tools are most useful and how to best acquire the requisite skills in using these tools. The Swedish partners of FICTION have meet three times with the teachers in a local primary school, exploring what problems they meet using digital tools, the possibilities using digital tools in their occupation, their need for skill development and how they have applied several digital tools, suggested by the participating researchers, in their teaching.

The focus group interviews indicate that teachers' attitudes influence both what they feel to be useful tools and how to best use them in the classroom. But we have also uncovered a need to study how teachers prepare themselves for the use of these tools.

Keywords: Primary education, digital teaching, technology integration.

1 INTRODUCTION

Digital competence, defined as the ability to effectively use computer systems in daily life and to understand the impact of digitalisation on oneself and on societal development, has been identified as a critical skill in contemporary society. Accordingly, it is being introduced as a part of school curricula. Specifically, the 2018 revision of the curriculum of Swedish compulsory schools (identified here as "primary school") states "Teaching should give students the opportunity to use digital tools in a way which promotes knowledge development" [1], making it mandatory to use digital tools in teaching and learning. This poses challenges for schools and teachers: schools need to assist with infrastructure and make technology available, teachers need to acquire knowledge on how to use technology for educational purposes. This happens on several levels:

- Management of teaching, e g communicating with students and parents, collating and reporting results, giving and grading tests, etc.
- The use of digital tools in teaching, ranging from preparing slide shows to using dynamic visualisations of the current subject.
- Teaching the use of digital tools, from word processors and spreadsheet programs to video editing software and programming environments.
- Teaching the societal effects of digitalisation, such as the risks and benefits of using social media, critically analysing rumours and "fake news".

Achieving all this has been argued to be influenced by teachers' attitudes and pedagogical beliefs [2], and we follow up on previous research [3], investigating five teachers' use of ICT.

1.1 Background

This study is part of the Erasmus+ project Functional Information and Communication Technology Instruction On the Net (FICTION) [4]. The purpose of the project is to investigate how science teachers in primary and secondary schools can be supported in the choice of digital tools to use in their teaching work, and what additional professional training they need in order to use those tools. The project partners are Södertörn University and the Ronna school in Sweden, Limerick Institute of Technology and Coláiste

Mhuire Co-Ed in Ireland, and the University of Genoa and Liceo statale Niccolò Machiavelli Firenze in Italy. This paper is based on the work of the Swedish partners. Any conclusions should thus not be construed as valid for the entire project.

2 METHODOLOGY

During the spring term 2019 teachers from the Ronna school took part in three meetings with researchers from Södertörn University. The Ronna school is located in Södertälje south of Stockholm, in a disadvantaged area with a large proportion of recent immigrants; at the same time the student body has good academic results thanks to efforts by school management in upholding high pedagogic standards.

The meetings were designed as focus group interviews with the teachers, though all were not present for all meetings. Altogether there was the

headmaster of the school, four different teachers for grade 7–9: two maths teachers (MTa and MTb), one science teacher (ST), one technology teacher (TT), and one grade 4–6 teacher (T).

Except for three researchers the participants during the first meeting were the schools' headmaster, MTa, MTb and ST. In the second meeting two researchers were present and the the teachers were represented by MTa, ST, TT, and T. In the third and last meeting the participants consisted of two researchers and MTa, MTb, ST, TT, and T. All three meetings were audio recorded and transcribed.

The first meeting focused on questions regarding the teachers' current situation and use of digital tools. This generated input for the researchers to understand each teacher's situation and to identify the teachers' need for further development with digital tools. In the second meeting the researchers presented different scenarios where digital tools could be used in the teachers teaching. The researcher also introduced examples of digital platforms and discussed their experience of the devices and what they would like to use. Finally, at the third meeting the teachers presented how they have used the different tools in their teaching and showed some teaching situations from the classroom that they recorded as well as evaluation of how they perceived the usefulness of the specific technology. Our interest was to learn more about how the teachers used the tools in their teaching and what opportunities and problems that came out.

3 FINDINGS

This section is structured as follows: first the current situation at the Ronna school is described, including access to computers and equipment, which digital tools that are in use today, and other important conditions prevailing at the Ronna school. Then the teachers' Dream scenario is described, which recounts the teachers' understanding and perspective on how the use of digital tools could work in a utopia. This is followed by the section Teaching tools, which reports on the tools that the teachers have tried during this study and their experience while using these tools.

3.1 The current situation at the Ronna school

All teachers have their own laptop computers (MacBook and PC) with administrator rights. All students from grade 6 onwards are provided by the school with laptop computers (Chromebooks), grades 4–5 have a few iPads per classroom. The choice of computers and hardware is based on economic concerns, administrative rights, desire for open access, as well as an equality concern for the students' rights to access to technology. The school uses the Ping Pong administrative platform [5], while sharing of files between teachers and students is done using Google Classroom [6]. The school has a full-time employee responsible for the support of their ICT environment.

The teachers listed a number of online resources that they regularly used: tools for maths such as GeoGebra [7], Kims matematik [8], Matlab [9], matteboken.se [10], and Mentimeter [11]. ST used Kahoot [12], which offers the possibility to do simple quizzes during lessons. The same function is also available in Studi [13], mentioned by MTa, MTb and ST.

When asked for challenges in the current situation, and when using these and other digital tools, the teachers emphasized unreliable Internet connections, and more general computer problems (such as computers that need updating, or computers that break).

One consideration of the teachers in their choice of tools is that these must work for the multiple languages necessary in this specific school environment.

Another important condition that prevails for the Ronna school is that the students often are unfamiliar with digital tools, as many do not have computers in their homes. This results in the students often needing more time to learn both the structure of the platforms as well as new digital tools. The teachers also clarified that this means the students' parents do not have or use email, which makes sending information from the school teachers to the students' parents difficult.

3.2 Dream scenario

The teachers were asked to develop a "dream scenario", explaining what kind of a digital teaching environment they would like to have and what would be necessary to achieve this.

The teachers and headmaster had several ideas about the potential of using digital tools in their occupation. They found greater opportunities to promote formative teaching as the teachers could give faster feedback to the students after a practice, doing exercises independent of place when all material is on the computer and a preparation for the students' future to be digital competent. It is also easier to adapt exercises with different languages and support with pictures for students that have difficulties to understand the task. Another important feature of the dream scenario was to increase the use and reuse of teaching material.

An opportunity the teachers saw with the use of digital tools, was to go on excursions with the students, browsing for example a digital version of a physical museum as preparation for a visit. The argument was that this would inspire the students to gain new knowledge. At the same time, it would demand less planning and scheduling compared to a physical visit for the teacher. Another aspect was for the teacher to pre-visit the place digitally him/herself to make it easier and more time-efficient to plan and schedule for a visit with the students. However, the teacher views this kind of digital environments as a complement to visiting physical localities and insist on the importance of being physically away from school.

The teachers emphasised the importance of the students loving to learn through the use of digital tools. Ideally the students *"should not want to leave school at the end of the day".* While discussing pleasurable and joyful learning, TT highlighted the need of challenging the students, promoting curiosity. MTa mentioned the need of supporting the students in making the lessons joyful. The teachers' vision was that the use of digital tools should prepare the students for the future, and enable the students reach their full potential. Programming was felt, by the teachers, to be an important part of this future scenario.

3.2.1 The means to the end

The teachers listed the prerequisites for their dream scenario: easy-to-use tools, more time, and competence development in programming. As programming was listed as their greatest challenge at the moment, we will explain the teachers' view on this further.

While programming was highlighted as pleasurable, and a possible way of working with several skills at the same time, it was also a challenge for the teachers who did not see themselves sufficiently competent. The teachers mentioned this in words such as lack of knowledge, and the needs for developing further knowledge in programming. This was also seen in statements related to uncertainty, for example MTa expressed that they cannot do anything that they do not feel secure with.

However, even though the teachers stated their insecurity and the need to learn programming tools, we interpret our findings in a way that shows that the teachers participating have quite a lot of knowledge about how to face this challenge. What they do lack is what can be described as computational thinking [14]. That is, the more basic understanding for how the program works and programming principles. One example on this is when TT stated that the students have to understand how to think about algorithms but that the specific programming environment is less important.

3.3 Teaching tools

At the second meeting the researchers demonstrated a set of physical artifacts, platforms and tools that had been selected by them as interesting and confirmed not to already be in use by the teachers: Arduino [16], Bee-Bots [17], littleBits [18], micro:bit [19], PhET Interactive Simulations [20], Raspberry Pi [21], SketchUp [22], and Tinkercad [23]. One thing that was considered important by the teachers was that the tools should trigger interest and not be regarded as childish by students who have used

similar tools at home. The teachers were requested to try out the tools in lessons, record the students' reactions, and report the results at the third meeting.

Not all the teachers had had the time or opportunity to use their given tools within the requested time period, therefore we will report on the experiences so far with Arduino, Bee-Bot, Tinkercad, PhET Interactive Simulations, and SketchUp.

3.3.1 Arduino

There were only three Arduino kits available for the study, so nine students were selected to work in groups of three outside of normal class hours. The teacher TT at first found it difficult to identify what to use the kits for but found control theory and programming as relevant sections in the curriculum in combination with electronics. The students had already worked with Scratch and micro:bit in technology class, so they rapidly caught on to how the components of the Arduino kits worked, the electrical symbols being familiar from the micro:bit blocks and the programming concepts of Scratch easily translatable to C++.

3.3.2 Bee-Bot

T has no programming experience and her younger students do not have computers in the classroom. Still T considers it important to lay a good groundwork for the understanding of programming and has spent considerable time on planning the exercise. T works much with physical objects to shape the students' understanding and explain the concepts of loops and alternatives. The task given to the students is to write instructions for how to write programs for the Bee-Bots, using paper and pen.

3.3.3 Tinkercad

MTa and MTb had been assigned micro:bit, a handheld programmable micro-computer, but ended up not using them as they felt their lack of knowledge of programming precluded their use of the blocks. Instead they introduced Tinkercad during a geometry lesson. The students were requested to model a building with certain measures and then compute the surface area of the structure. The teachers noted that most students were very active and engaged in the task, trying out different configurations, while some students found the task difficult and thus boring. Students that got stuck were helped by their peers or by re-watching the instruction video accompanied by the teacher. At this stage it is difficult to say how much of the positive (as well as negative) reception was due to the novelty of the situation. The teachers suggest the students will need more time to learn the software properly.

3.3.4 PhET Interactive Simulations

ST knew of PhET since earlier, but had not used it much, as it does not cover all aspects of chemistry. The relevant PhET exercises were added to the Google Classroom for a grade 8 class who could then explore the relation between temperature, pressure and molecular motion. The students were reported to have been enthusiastic, normally restive students were able to concentrate for longer.

3.3.5 SketchUp

ST has introduced SketchUp in technology classes, letting students create houses of their own design, furnishing them. There is a potential connection to art class where the students could build physical models of their designs. The students were very enthusiastic and worked concentrated for long periods, even though their computers were not always up to the demands of the software.

3.4 Post Mortem

In the discussion of the teachers' experiences with the tools, some points were raised: The teachers often found it difficult to map available tools to specific requirements in the curriculum. They specifically asked for suggestions on what tools to use for what, and concrete proposals for lessons using digital tools. With regards to programming, they request courses adapted to the needs of teachers.

4 DISCUSSION AND CONCLUSIONS

While the school have invested in ICT infrastructure and equipment, there are still obstacles of an administrative character to the further use of digital tools, such as scheduling issues, lack of time for competence development, and no choice on platforms and systems to work with. At the same time our

results show that different teachers, based on personal conditions as well as their teaching context, consider the severity of these limitations quite differently.

However, since the use of digital tools now can be understood as a requirement in compulsory school, we strongly recommend that teachers should be given the opportunity to work towards a more digitized education. This emphasizes the need to offer competence development courses for active teachers. Another suggestion, based on the results from this study, is to find means for having continuous meetings with colleagues, which has been pointed out as an important factor for personal development. This is also in line with the changes in the school curriculum pointing towards the principal's responsibility to ensure that teachers receive the skills training required [24]. An example of how a meeting between the teachers sparked knowledge transfer is when T during the third meeting was listening to the results presented by ST on the use of PhET, and as a result wanted to try these with his/her students.

Regarding the teachers' pre-experience, we could see examples of teachers who had never used any technology or tool similar to the ones the researchers gave them the task of trying (T, MTa, MTb), as well as teachers already familiar with several different tools (TT, ST). Depending on the teachers' prior knowledge, we can also see that the focus shifts from familiarizing itself with concepts relevant to programming to what purpose the programming should be used for. The focus group interviews also show that when the teacher believes in the student's ability to learn to use digital tools the implementation of the tools has also been considered successful.

4.1 Limitations

One of the study's limitations is that the teachers who participated also made it on a voluntary basis. Thus, one can expect that we have reached the teachers who are most interested in the introduction of digital competences at school, and more motivated than others to explore different teaching methods to reach this goal in the curriculum.

4.2 Future work

Despite the possible limitations of this study, the results contribute to the understanding of Swedish school teachers' practice with digital tools after the implementation of digital competence in the school curriculum. The authors expect that the findings may have a wider validity as many countries now face similar challenges.

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