Chapter 5
Conditions for Teaching with Mobile Technology in the School Classroom

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Abstract The uptake and use of mobile technology in the classroom and the conditions for teaching with mobile technology were studied in the research project Unos Umeå in Sweden from the student, teacher, and school leader perspectives. A 1:1 laptop initiative was studied in two schools over a period of 3 years. The aim of this chapter is to explore, analyze, and discuss the conditions for teaching, as possibilities and challenges, in the final phase of this initiative from the teacher perspective. Teachers saw possibilities in teaching through information, communication, and structure, noting the importance of pedagogical reflection and design. The challenges were technical problems, student use of the laptop, and time for and access to professional development. Teachers focused on helping students see the laptop as a school tool as well as taking on a new tool in the classroom, that is, the mobile phone.

Introduction

The expectations of society regarding teachers' uptake and use of mobile technology, such as laptop computers, tablets, and mobile phones, in the classroom and the conditions for Technology Enhanced Learning (TEL) are high. The intentions put forward in policy (EC, 2010; Eurydice, 2012; OECD, 2012) comprise hopes for enhancing learning outcomes and student engagement, as well as more efficient administration and organization of learning. However, the actual impact in practice appears to involve challenges (cf. Kirkwood & Price, 2013, 2014; Olofsson, Lindberg, Fransson, & Hauge, 2011; Olofsson, Lindberg, & Hauge, 2014; Tondeur, Forkosh-Baruch, Prestridge, Albion, & Edirisinghe, 2016; Voogt, Erstad, Dede, & Mishra, 2013). Teachers, according to Hixon and Buckenmeyer (2009), often receive the blame for not integrating technology in their teaching, with reasons such as lack of time, training, equipment, and support. Although research on Information

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and Communication Technology (ICT) in education points toward teachers gradually beginning to integrate ICT into their teaching, significant differences can be observed in how ICT is integrated in the K–12 classroom (cf. Bocconi, Kampylis, & Punie, 2013; Tondeur, Cooper, & Newhouse, 2010). This may reflect differences in how teachers consider the uptake and use of mobile technology in relation to didactical design (cf. Jahnke & Kumar, 2014; Jahnke, Svendsen, Johansen, & Zander, 2014; Olofsson & Lindberg, 2014; Selander, 2009) or orchestration (cf. Hauge, 2014; Öman & Svensson, 2015; Perrotta & Evans, 2013) for enhancing student outcomes and creating conditions for TEL.

It appears that successful technology integration requires more than just having access to computers in classroom. Deployment is not enough, according to Warschauer, Zheng, Niiya, Cotten, and Farkas (2014), and there is the need to address the many challenges which have impact on teachers' decisions regarding the uptake and use of mobile technology in the classroom. Mandating teachers' uptake and use of mobile technology does not appear to be sustainable. A more fruitful approach, according to Yeung, Taylor, Hui, Lam-Chiang, and Low (2012), may be to enhance the competence of teachers in mobile technology by helping them to see the value of the effectiveness of technologies and thus gain confidence in applying these in practice in their teaching activities. This also goes beyond using the laptop as an administrative tool (cf. Halverson & Smith, 2009). The act of both balancing analog and digital communication as well as intertwining these types of communication in the classroom may even prove to present new environments in the form of CrossActionSpaces (Jahnke, 2016).

Teachers' use of ICT and their skills appear to be related (Sipilä, 2014). When studying teachers' strong technology practices in K–12 classrooms, Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, and Sendurur (2012) found a close alignment between teachers' beliefs about student-centered beliefs and student-centered practices such as authenticity, student choice, and collaboration. According to Drayton, Falk, Stroud, Hobbs, and Hammerman (2010), teachers need teacher professional development (TPD) as well as time to discuss content, students' work, pedagogy, and technology. Ertmer and Ottenbreit-Leftwich (2013) report that teachers' activities regarding the uptake and use of mobile technology in schools and the shift from technology to pedagogy takes time. It is also important that teachers believe in their own abilities and work in a school culture that sustains a type of TPD, which combines technical, pedagogical, and subject-related didactic competences (Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012; Mishra & Koehler, 2006; Voogt, Knezek, Cox, Knezek, & Brummelhuis, 2013). Towndrow and Wan (2012) emphasize the importance of teachers' collaboration through seeking and sharing, and according to Vrasidas (2015), for TPD to have impact, it should be collaborative and situated in teachers' everyday practice.

The aim of this chapter is to explore, analyze, and discuss the conditions for teaching, as possibilities and challenges, related to the uptake and use of mobile technology in the classroom. This aim hopes to provide new knowledge regarding the conditions for TEL from the teacher perspective in the final phase of a 1:1 laptop

initiative in two schools in Sweden. This chapter seeks to examine how teachers' perspectives related to the uptake and use of mobile technology in teaching activities developed over time. The following research questions are posed: (1) *How can the uptake and use of mobile technology in the classroom in teaching activities be described and related to the conditions for TEL?* and (2) *How can the possibilities and challenges in the development of the uptake and use of mobile technology in teaching activities over time be understood as conditions for TEL?* This chapter aspires to contribute to the research areas of 1:1 and TEL from the teacher perspective, as well as contributing to insight in emergent practices and material conditions in teaching and learning with mobile technology.

Overview of Research Studies on the Integration of ICT in Schools

Internationally, the uptake and use of mobile technology through one to one (1:1) involving one laptop per student continues to increase, even being described as a tsunami (cf. Livingston, 2007). This has also been the case in Sweden, where access to laptops in schools is considered to be good (National Agency for Education, 2013a, 2016). However, the laptops are not used to the extent as intended in school policy (Swedish Schools Inspectorate, 2011, 2012). In the National Program for School Development, The National Agency for Education (2017) views digitalization as one of eight prioritized areas for supporting students' learning, development, and achievement. In an international perspective, 1:1 initiatives are reported to offer benefits such as equity in access to technology, the quality of instruction, student engagement, academic achievement, digital competence, economic competitiveness, and improved communication between the home and school (Harper & Milman, 2016; Penuel, 2006; Rosen & Beck-Hill, 2012). Despite the increasing number of 1:1 initiatives around the world, there appears to be limited research concerning prevalence, scale, and scope of research initiatives in 1:1 settings (Richardson et al., 2013; Zheng, Warschauer, Lin, & Chang, 2016). While some 1:1 initiatives are reported to be sustainable (Bebell & O'Dwyer, 2010; Penuel, 2006; Silvernail, Pinkham, Wintle, Walker, & Bartlett, 2011), there are also challenges put forth in research (Cuban, 2001, 2013; Hu, 2007). Studies show that results related to laptops in the K–12 classroom may have minimal effects on academic results (Cuban, 2001, 2013). Student achievement may be improved under certain conditions and in different content areas (Dunleavy & Heinecke, 2007). When using the laptop as a school tool, that is, meaningful learning (Jahnke, Bergström, Mårell-Olsson, Häll, & Kumar, 2017), there appears to be potential for transformative added value in the 1:1 classroom (Zheng et al., 2016). Thus, in 1:1 implementations, the focus on if students' academic achievement is improved or not, should perhaps be studied more in terms of "how, why and under what conditions" (Harper & Milman, 2016, s. 140). If teachers see students as receivers of knowledge, learning

environments will prevail to be directed by teachers, despite access to 1:1 (Varier et al., 2017). These researchers see values, goals, and pedagogical innovation which optimize technology use as important to successful integration. In addition, integration calls for high-quality TPD (Dunleavy, Dextert, & Heinecke, 2007). While mobile devices such as laptops, tablets, and mobile phones appear to prove potential as learning tools in the classroom (Sung, Chang, & Liu, 2016), teachers, students, and parents do not always agree on the roles of these tools, that is, mobile phones (cf. Gao, Yan, Wei, Liang, & Mo, 2017). Research in 1:1 in the Swedish context appears to be in line with international research (Andersson, Hatakka, Grönlund, & Wiklund, 2014; Fleischer, 2013; Grönlund, 2014; Grönlund, Andersson, & Wiklund, 2014; Tallvid, 2010, 2015) echoing many of the possibilities and challenges reported in the international literature. This chapter will add on to previous studies reported on the conditions for TEL in a 1:1 initiative from the student, teacher, and school leader perspectives (Håkansson Lindqvist, 2013, 2015a, 2015b, 2015c, 2015d). In these studies, teachers saw possibilities in new forms of teaching, sharing materials, and documentation. The challenges were related to students' use of the laptops, motivating students to use the laptop as a school tool as well as time for and access to TPD. In this chapter, the results of the last year, the final phase, will be explored, analyzed, and discussed.

The Ecology of Resources Model

The ecology of resources model (Luckin, 2010) is based on learning as an interaction between the individual and the sociocultural environment (Säljö, 2000, 2005, 2010; Vygotsky, 1978). According to Luckin (2010), the model can be used to design or redesign learning contexts or as a theoretical foundation for improving particular learning contexts or activities. The model illustrates the resources available to the learner as shown in Fig. 5.1.

In the model, the learner is surrounded by the three resource elements, *Environment*, *Knowledge and Skills*, and *Tools and People*. These resources are said to be accessible to the learner, and be accessed both directly and indirectly. If the learner is situated in the central position of this learning activity, demands can be placed on the surrounding environment, context and design (Luckin, 2010). In this chapter, the teacher is in focus as a learner. The use of the ecology of resources model (Luckin, 2010) and the theoretical concept of filters has been fruitful in identifying possibilities and challenges in the development of teachers' perspectives on their teaching activities over time. In this chapter, the use of the model as a tool can be closely linked to understanding the conditions for teaching and learning processes and the relationship between tools and technology as an emergent practice in the classroom (cf. Cerratto Pargman, Jahnke, Damsa, Nussbaum, & Säljö, 2017).

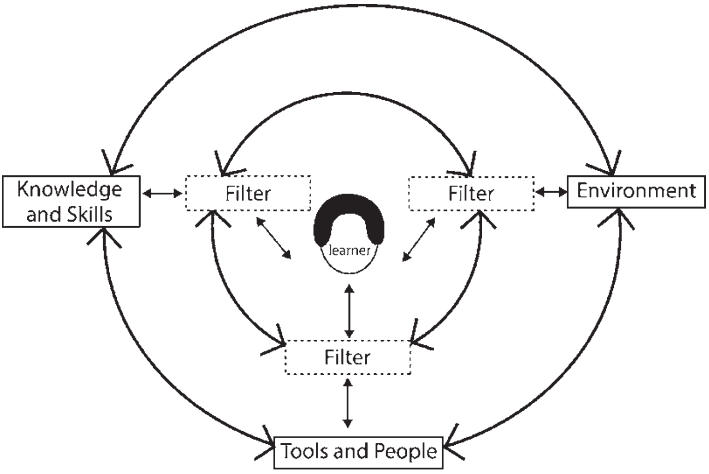

Fig. 5.1 The ecology of resources model (Luckin, 2010). Elements and their filters

Mobile Technology in the Classroom

The research project Unos Umeå studied the uptake and use of mobile technology, laptop computers, in teaching and learning activities from the student, teacher and school leader perspectives, as well as the impact on the schools as organizations in a 1:1 laptop initiative. The empirical base was collected over three phases of a 2-year period of an overall 3-year research project, at two schools in Umeå, Sweden. The Unos Umeå project can be described as a 1:1 case study with a research design involving a case study approach (Simons, 2009; Yin, 2009). All of the studies took place within both schools, in two classes in the compulsory school and two classes in the upper secondary school. Both schools had schools leaders and teachers who had a positive view of technology to support learning. The teachers who participated in the study showed a wide range of use and design for mobile technology in their teaching. While some teachers were hesitant to integrate technology, other teachers integrated the new technologies fully.

Method

The empirical data can be said to be threefold, in an attempt to achieve a more complex form of data material, and thus a wider understanding of the 1:1 initiative in its specific context crosschecking findings (Patton, 2002) and triangulation (Hammersley & Atkinson, 2007). The empirical data in total comprised surveys, interviews, and classroom observations (N = 1370 surveys/39 interviews/126 lessons, 124 h) with teachers, students, and school leaders (Håkansson Lindqvist, 2015a) for the first

three phases of the project (P1–P3). The first phase (P1) was the initial phase of the project in the fall of 2011. The second phase (P2) was some 6 months after the start of the project (i.e., spring 2012). The third phase of the projects was 1 year later (i.e., spring 2013). In this final phase, Phase 4 (P4), the data set in focus is the final interviews with the ten teachers ($N = 10$) and the field notes from classroom observations ($N = 49$ lessons, 50 h) in the classes involved the last year and final phase during spring 2014. Both the interviews and the field notes from the observations were coded and categorized using content analysis (Hjerm & Lindgren, 2010).

Results

In this section, the interviews with the teachers (T1–T10) and some notes on the classroom observations are presented, in the following themes: *teachers' laptop use* and *teachers' perspectives on students' laptop use*.

Teachers' Laptop Use

When teachers' expressed their perspectives on their own use, the following themes were discussed: *own use, laptops and other tools, TPD*, and *technical problems*.

Own Use

When teachers reported their own use, they reported several aspects of use. One teacher saw the administrative side of use: "Lots of administration on the side of lessons. Lots and lots, all the time" (T2). Another teacher did not see any specific change in use, but noted that the laptop was always used in teaching: "I use it [the laptop] as I have before. Now, I always have it with med during lessons. I use the active whiteboard a lot" (T8). One teacher also reported new use of the laptop: "I only use the interactive whiteboard now. I didn't do that last year… It is great because you can save everything and send it out to the students" (T6).

Teachers also reported possibilities in the use of the laptop and the need to test and experiment: "I thought that I would try to record in a few things myself and see how it works" (T9). This appeared to be an attempt to develop and expand the use of the laptop in new teaching methods. Another teacher noted encouragement by the school leader to use the laptops to help students in their learning process: "Use them [the laptops] as much as you can and use the in a way that supports learning" (T1).

Variations in laptop use in different subject areas were evident: "I have two subjects and in one subject, I use it a little more, that is Music. Here, I use the laptop every lesson. In English, I don't use it as often" (T2). One teacher reflected upon the connection between different subject area use as well as teacher use and student use:

"If they don't bring them we don't use them. Then I also think that it really depends on the subject, too. I know that the Swedish teacher for example, she goes crazy because the laptops are never there" (T5). Variation in different levels of classroom use by teachers was also seen to be a challenge. One teacher noted the use the laptop in combination with the interactive whiteboard with students: "There was a discussion about this this morning. The students want all of the teachers to do what I do. There are a lot of teachers who are not happy about this" (T1). There appeared to be variations in teachers' use of the laptops in classroom as well as variations regarding the level of use.

Laptops and Other Tools

Teachers expressed the use of the laptop as a tool, combined with other tools. One teacher used the laptop with the interactive whiteboard and an interactive Math book: "It works well in Maths. You can show it on the interactive whiteboard. I have my interactive book. There are examples… where you can click so that a graph changes and they can see which equations are related" (T1). The laptop also offered the possibility to find information and examples easily: "I have become dependent on it [the laptop]. As soon as I am going to plan some work, I look to find examples… it is fast" (T4).

The use of new tools in classroom work was also reported. For instance, one teacher used social media as an efficient channel to distribute information directly to students: "I have a Facebook account… Miss Sofia" (T1). One teacher also noted challenges related to the use of digital textbooks: "There are some digital textbooks, but they have not been connected" (T7). Another challenge in regard to student use, was according to the same teacher that: "Many students feel that digital textbooks are more difficult. It is hard to read them on the screen" (T7).

TPD

When the teachers were asked about TPD, they reported a basic course: "What is offered is the traditional basic course in interactive whiteboards" (T2). Another teacher reported new tools which were in the process of being introduced: "There is a lot going on with GoogleApps and this kind of thing… the cloud… and a new LMS (Learning Management System)" (T9). Another teacher expressed the introduction of new tools as a form of professional development: "There have been active whiteboards, GoogleApps, and things that happen all the time" (T10). Beyond these basic courses, other courses were offered, depending on available resources: "It is also up to oneself, if one can find courses. At the same time, there is a limited amount of money" (T7).

Beyond the individual TPD which was offered, teachers also reported collaborative efforts in teaching with the laptops. There were opportunities for teaching each other in collaborative learning in subject groups: "Our subject group is important.

So it is really up to us" (T3). Teachers also reported work in teacher teams and collaborative work to support each other's learning: "We also have teachers teach teachers and in our teacher team" (T3). Another teacher expressed this as sharing: "If there is something that we know, we show each other" (T4).

Teachers also reported further technical and pedagogical support in the form of workshops: "Every Thursday we can visit, well, we can go to a classroom and there is ICT training" (T10). One teacher noted challenges in having time and interest in increasing ICT skills: "I constantly feel bad… that I should be cleverer… But I think I do pretty well, but I don't have enough interest either" (T4). One teacher reported possibilities for the teachers and the schools to build competence through efforts in the work with the laptops: "The school is building up higher competence and higher use of smart technology where we can use the laptops more and use our active whiteboards" (T7).

Technical Problems

Teachers also brought up problems with mobile technology, and the connections related to teacher use and student use: "The technology doesn't always work. The students don't have the laptop with them" (T4). Another teacher discussed the technical problems related to a project:

> I have gotten good at finding solutions, so to say. All the terrible technical problems we had with the film thing [project]. And the cameras. The films were in the cameras, but we couldn't get the films over to the computers... And then we got an e-mail that the computers were going to be shut down. Everything has to be taken off the computers, Yes! We will take a few hours. We will book it in. We will do our best and see what happens. (T1)

Here, teachers took on a pragmatic stance of meeting these technical challenges when needed.

Teachers' Perspectives on Students' Laptop Use

When teachers expressed their perspectives on their own use, the following themes were seen: *student use*, *students' ICT skills*, *non-schoolwork use*, and *technical problems*.

Student Use

When teachers expressed their perspectives on student use, they reported several different types of use. This included digital and analog use. In certain cases, the teacher decided that the students had to have their laptops: "In the labs… they have to have them with them" (T6). However, this teacher also noted alternatives for

students: “If they have a lab with a laptop, then they have them. But if they don’t… I say that it is better that they take notes by hand, you will learn better” (T6). Another teacher also reported challenges in student use in a project: “Many of them use their mobile phones to search for information, but when they presented, they were supposed to do a Power Point … and they said, I do not have my laptop. Well, why not?” (T3). There also appeared to be challenges related to when to use the laptop and when to draw by hand: “And then there are a few… I want to write on paper instead! Yes, well, ok. Do it. But this is tricky question, because, for example, I want them to draw in Chemistry and Biology, and this is difficult to do in Paint” (T1).

One teacher placed the responsibility for use on the students: “I have been a lot more like, ok, you take notes. Now you can use the laptops. Now you have to be responsible” (T9). Another teacher expressed that students have taken on this responsibility themselves: “I have seen that many [students] have put the laptop aside… they use it when they need it” (T6). Overall, teachers appeared to see a shift more in their laptop use than in student use: “I don’t think that there has been an increase… the students have their laptops and they are happy to use them. GoogleApps is still getting started for us… being able to add calendars and share documents which we haven’t done earlier” (T10). Laptop use remained at the same level: “Well for our computer programme… the number of students is increasing. Otherwise I don’t think that there is any difference in laptop use” (T7). Other teachers reported lower laptop use and more mobile phone use: “There are fewer and fewer laptops and more and more mobile phones” (T5). One teacher spoke about working on a blog assignment with students in class: “A few of them used the mobile phone. There is more and more of this. It is easier for them in some way” (T3).

Several teachers also reported changes in student use over time. This involved the strong interest in the first year to the final year: “I think they were new in grade 7… most of them do very well when they get to grade nine … they realize that, now, I have to work during lessons” (T1). This progression was noted by another teacher: “In their first year they are fascinated by the laptop. They can sit in the lessons doing something else. But in the second year… they realize, now I have to work… they should have realized this during their first year” (T6). The first year was reported as being the most “laptop-concentrated” (T5). Another teacher reflected upon this progression: “In part that they always had them with them, and in part that we used them. It has flattened out and I am not sure why this is the case, or if it is me, us or them” (T5).

Students’ ICT Skills

When teachers reflected upon students’ ICT skills in using the laptop, several teachers mentioned the need for a short introduction in ICT skills for students: “I think that it is too bad that they don’t have a short introduction in their first year in some

way, a shorter course in the basics in Excel and Word" (T9). One teacher spoke of previous experiences of a short introduction: "…we put down a line for the laptops, they are to be used for this. Nothing else" (T3). Some of the teachers already provided this type of introduction: "We have a resource hour per week. The first week, we go through the laptop, the LMS, and all that. How to use Word" (T6). Over time, according to one teacher, students' ICT skills improved: "I thought that they would be more prepared and know more about Word documents… how to attach files … but they didn't. Now they do. They are also more critical about their sources." (T2). Another teacher noted that students see the laptop as a tool for spare time: "Some of them think more about the laptop being more of a spare time thing... and not so much that it is a school tool" (T2).

Non-schoolwork Use

Many of the teachers reported non-schoolwork use of the laptops:

> They use a great number of hours for games whether appropriate or not… we have glass walls in the classrooms and when you pass by many rooms, you can see that 95% are doing this. The teacher up front is doing something. This is not unusual. (T7)

Another teacher noted that these activities were not only related to laptop use: "they use the laptop for lots of other things than what they are supposed to be doing… but if they don't have the laptop they have their mobile phone" (T3). Teachers reported different solutions for dealing with this use. Sometimes speaking to students was enough: "Sometimes there is someone who is sitting and disrupting things, you can see that they are sitting and texting. But if you speak to them, they stop" (T6). Other teachers reported collecting mobiles at the start of the lesson: "…some programs have had a box in the front of the classroom" (T6). Another teacher summed up the use of laptops: "They have used them for writing and as a school tool, but I also think that they have been a source of frustration, a trap. But if they hadn't had their laptops, they would have had their mobile phones" (T9).

Technical Problems

According to the teachers, there were technical problems with the laptops as well as the need for technical support. Students complained that the laptops were heavy and did not work well: "They [Students] don't think they are good quality [laptops]" (T4). Another challenge was the lack of laptops to use if a laptop broke: "The technical support… if their laptop goes in [for repair], it is gone for a long time. There aren't any laptops to borrow. There should be many more. But of course, this is expensive" (T3). As expressed by one teacher: "I don't think that is acceptable for them to have to wait so long" (T4).

Field Notes on the Classroom Observations

Many of the reflections expressed by the teachers in the interviews were seen in the classroom observations. Teachers had their laptops with them for almost all of the lessons observed. Teachers used the laptops in their teaching combined with the interactive whiteboards for introducing and presenting materials. While almost all of the teachers had their laptops with them, many students did not. Overall, there were large variations in student use, which appeared to be related to the teacher's use, the subject area, the students' ideas of expected use during the lesson, as well as having a choice of using the laptop or not. The laptops and mobile phones were observed as a distraction in the classroom, but were also used as school tools.

Teachers' Perspectives on the Integration of ICT Over Time

Teachers at both schools were optimistic over time and reported a focus on laptop use as well their teaching activities with the laptops. The challenges reported were the time and need for TPD, technical problems and the need for pedagogical leadership for ICT. While the teachers saw possibilities in teaching activities with the laptops, there were technical problems. Teachers reflected both on the pedagogical use in their work in supporting students' learning, and in their own learning. The uptake and use of mobile technology in the classroom from Phase 1 to Phase 4 are illustrated in Table 5.1.

The instantiation of the ecology of resources model from the development of teachers' perspectives on their activities over time is illustrated in Fig. 5.2.

Discussion

In the resource element Environment, the need for teachers to support student laptop use manifests a filter. This filter most likely involves individual use and collaborative use for teachers. Thus, how teachers support the conditions for TEL and collaboration with the students in the classroom will most likely have an effect on student use. This is noted by teachers in this study who link own use to student use.

Teachers will most likely need to develop their own use in order to support students' individual use, but also to provide assignments which support students' collaborative use. Classroom assignments, tasks, and activities which are designed for use of the laptop in the classroom with the supervision of the teacher and which are aligned to, designed for and support TEL will also be important for the students' learning environment in the classroom (cf. Hauge, 2014; Jahnke, 2016; Olofsson et al., 2011, 2014; Perrotta & Evans, 2013). For teachers, TPD which involves pedagogy, technology and subject content would also perhaps provide a wider

Table 5.1 Teachers' perspectives from Phase 1 to Phase 4

Themes	Phase 1	Phase 2	Phase 3	Phase 4
Preparedness	Low, undecided level of preparation Optimistic or very optimistic view toward ICT	Insufficient preparation Optimistic view toward ICT	Optimistic view toward ICT	Optimistic view toward ICT and possibilities with ICT
Use	Low laptop use initially Increased use expected Technological awareness	Increased laptop use in school Shift from use toward reflective use Pedagogical awareness	Laptop use and technical problems Need for pedagogical leadership	Laptop use and technical problems Reflective, pedagogical use
Own teaching and learning	Opportunities for TPD expected Classroom management issues expected New forms of teaching expected	Time needed for TPD and teacher collaboration Classroom management issues for maintaining student focus Element of choice for students and teachers	ICT skills, access to planned TPD, time for TPD, time for collaboration Focus on student use and students' non-school activities Element of choice for students and teachers	ICT skills, participation in TPD, collaboration Focus on student use, students' ICT skills and non-school activities Element of choice for students and teachers

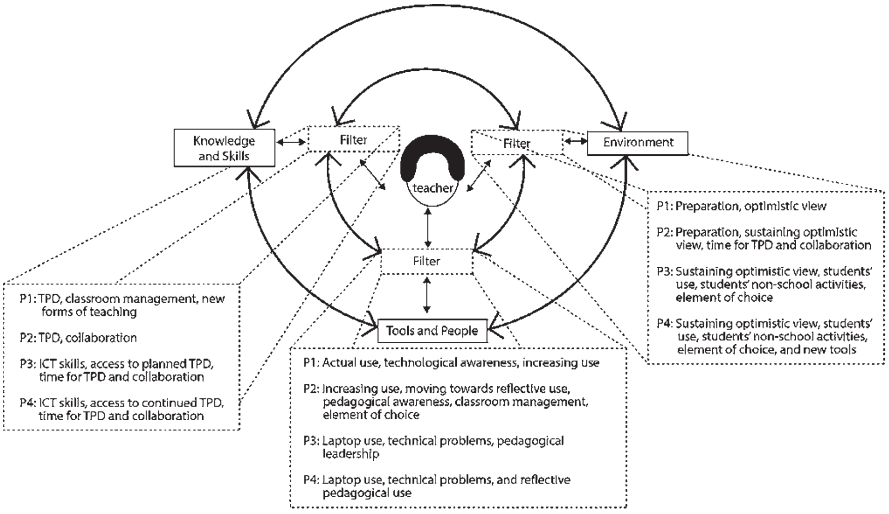

Fig. 5.2 Teacher perspective from Phase 1 to Phase 4. The ecology of resources model (Luckin, 2010). Elements and their filters

understanding for designing tasks and assignments specifically for the 1:1 classroom (Ertmer & Ottenbreit-Leftwich, 2010; Mishra & Koehler, 2006; Voogt, Knezek, et al., 2013). These skills may support teachers in their work (Drayton et al., 2010). It is most likely that in order to create conditions for TEL through individual and collaborative use, teachers will need to design and experiment with task design in the classroom. This could be said to manifest a filter in this resource element. However, this is something that the teachers in this study report, that is, the willingness to try new teaching methods in the classroom environment and experiment (Varier et al., 2017). Task design requires a move from traditional tasks toward new task designs for the digitalized classroom (cf. Jahnke et al., 2014; Olofsson & Lindberg, 2014; Selander, 2009). As noted previously, the teachers in this study were observed to have a wide range in variation in regard to integrating mobile technology and design for moving toward learning with technology in more meaningful ways (Jahnke et al., 2017). Teachers will need organized and systematic time to discuss the work in the 1:1 classroom together with their colleagues (Drayton et al., 2010; Vrasidas, 2015). In this study, how teachers support each other in their work and how school leaders support teachers' work for creating conditions for TEL in the classroom, as well as on the school level, will be of importance. If these conditions are not supported, it is likely that the building of competences in the school as a learning environment for teachers and students will be a challenge.

In the resource element Knowledge and Skills, TPD in ICT and subject-related skills for teachers are important (Hixon & Buckenmeyer, 2009; Tondeur et al., 2010; Vrasidas, 2015). In this study, the teachers reported that there is a need to develop their own ICT skills in order to increase the use of mobile technology. Here, these ICT skills can be linked to creating possibilities for TEL in the classroom with a reflective and wider understanding. Here, teachers need to implement mobile tools in order to make this possible (cf. Bocconi et al., 2013). In this study, teachers express the underlying possibilities in new ways of teaching through the use of interactive whiteboards and sharing documents in teacher teams. However, even when these tools have been implemented and are widely used, there will be the need for continued TPD (Tondeur et al., 2016). Thus, the lack of possibilities for TPD manifests a filter in this resource category. Further, the need for time to partake in these efforts can also be considered to manifest a filter in this category. According to the teachers, there are possibilities related to the use of the laptops to structure school materials, facilitate documentation, share materials and methods with colleagues. In the schools, teachers note that there are many tasks and different priorities and limited time (cf. National Agency for Education, 2013b). However, it is possible that ICT skills for teachers will facilitate the move from technology to pedagogy (Ertmer et al., 2012) and support student use of mobile technology in their learning. Moreover, teachers' ICT skills will also be of importance for supporting students' laptop use, through direct support for students, as noted in this study, when teachers discussed an introduction for students in their work with the laptops as a school tool.

Teachers' own uptake and use of mobile technology can be said to manifest filters in the resource element Tools and People. The same can be said for teachers' work in supporting students' uptake and use in school activities in the classroom. ICT skills for teachers and TPD will most likely support the uptake and use in the classroom (Dunleavy et al., 2007; Sipilä, 2014) as well as the time and opportunity to support experimenting with these tools. While some teachers see the potential benefit in using laptops and mobile phones as school tools in their teaching, others may need support in this process (Yeung et al., 2012). Thus, teachers may need help in sharing and collaborating within and across subject areas and finding time-efficient work methods (Ertmer & Ottenbreit-Leftwich, 2013; Towndrow & Wan, 2012). In this study, teachers note an increment in own use. However, from the teachers' perspectives it is difficult to see the same in student use. The teachers express possibilities in accessing information, examples, and pedagogical methods such as extra resources on the Internet. However, work will be needed to implement these skills directly in the classroom with the students.

It is possible that teachers are balancing when to use mobile technology in their teaching in assignments and tasks for students, and when to use traditional school methods (cf. Harper & Milman, 2016; Kopcha, 2012; Mishra & Koehler, 2006). Here, this pedagogical choice by the teacher is the result of pedagogical reflection regarding assignments and tasks and combining competences in pedagogy and technology. In this study, teachers report that the laptops were used in labs, but in some cases, the student was given the possibility to take notes and draw. In this choice lies responsibility. For teachers, this may mean expanding knowledge and using the laptop as a school tool in the classroom, as well as explaining and justifying this pedagogical choice for students. Thus, teachers' individual choice as well as students' choice of using the laptop as a school tool can be considered to manifest a filter in the resource element Tools and People. Challenges related to own and students' technical problems with the laptops as well as student use for non-school activities can also be considered to manifest a filter in this resource element. If technical support is offered, it will most likely be easier to achieve the possibilities for TEL in the 1:1 classroom. The same can be said of teachers' support in helping students to focus on classroom assignments. Helping students shift from non-school activities to classroom work will be important (cf. Andersson et al., 2014; National Agency for Education, 2013a, 2016).

This study identifies that the teachers are striving to combine pedagogy and technology to implement and design teaching with mobile technology as school tools in the classroom. Teachers report that laptops are considered as a resource in the 1:1 classroom. Teachers also report laptops being put aside in order for students to be able to concentrate on classroom work. Teachers also note that students must be asked to put away mobile phones, which they do if they are asked to. With the introduction of new tools, such as mobile phones, this also appears to be a way to manage this challenge. How teachers manage this challenge can be said to manifest a filter in the resource element Tools and People. According to teachers, laptop use appears to have decreased over time making way for mobile phones. The laptops as school tools appear to either be supplemented or exchanged in favor for mobile

phones. Combining mobile phones and laptops as school tools may provide new conditions for TEL in the classroom, involving new and emergent practices for collaborative teaching and learning (cf. Cerratto Pargman et al., 2017). How teachers choose to take advantage of the possibilities, as well as taking on the challenges, in the use of mobile phones as new tools will be of importance for teaching and learning in the classroom (cf. Sung et al., 2016).

In returning to the research questions, the first research question posed was: *How can the uptake and use of mobile technology in the classroom in teaching activities be described and related to the conditions for TEL?* In the final phase of this study, Phase 4, teachers see possibilities in the use of mobile technology such as accessing information on the Internet and extra resources as well as new pedagogical methods. The findings also show that the possibilities from the teacher perspective are the use of the laptops to structure school materials, facilitate documentation, share materials and methods with colleagues in collaborative learning. Teachers see challenges in time for and access to TPD, technical problems, and supporting student use. One significant challenge is the lack of student use. The second research question posed was: *How can the possibilities and challenges in the development of the uptake and use of mobile technology in teaching activities over time be understood as conditions for TEL?* Using the ecology of resources model (Luckin, 2010), filters were identified in the resource elements. Teachers strive to combine pedagogy and technology to design teaching with the laptops as school tools in the classroom. While teachers appear to report an increment in own use, there are significant challenges concerning student use. The laptop as a disruptive force appears to have decreased over time making way for new mobile technology in the classroom, that is, the mobile phone. The laptops appear to either be supplemented or exchanged in favor for mobile phones in the 1:1 classroom. Teachers' efforts to support student use of both the laptops and mobile phones as school tools, taking advantage of the new possibilities for teaching and learning activities as well as the new conditions for TEL related to these tools are questions for future research. Both these possibilities and challenges can be related the conditions for technology enhanced learning and supporting collaborative learning and teaching processes with mobile technology.

Implications

This study points toward the need of supporting teachers in the ongoing work for integrating mobile technology of all forms in their teaching activities and designing for TEL. Based on this study, two recommendations can be provided. First, it will be important to take on the challenges in practice, such as supporting actual use for teachers and students in the classroom, including access and technical support. Second, stronger efforts in practice, such as access to and time for continued TPD, will be important to facilitate teachers' use and, in turn, student use. These efforts will most likely facilitate the uptake and use of mobile technology and facilitate the material conditions for collaborative learning and teaching processes. Combined,

these recommendations may accelerate the uptake and use of mobile technology as school tools in the classroom and therefore support teachers' and students' work. Further, they will most likely support the conditions for TEL through transforming teaching and learning practices and exploring the relationship between the tools and technology as an emergent practice.

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