Still a long way to go

Narrow and transmissive use of technology in the classroom

Marte Blikstad-Balas
Professor, Department of Teacher Education and School Research, University of Oslo
marte.blikstad-balas@ils.uio.no

Kirsti Klette
Professor, Department of Teacher Education and School Research, University of Oslo

Abstract
Drawing on 178 video-recorded lessons from 47 lower-secondary classrooms with high technological infrastructure in Norway, the present study sheds light on how and for what purposes teachers use technology in their everyday instruction, providing important insights into what kind of digital literacy practices students experience in a classroom context. Key findings are that teachers' implementation and uptake of technology in everyday instruction was narrow and limited. Despite good access and high national ambitions for the development of students' digital competence, teachers' uptake of the available digital technology was very often limited to supporting traditional teacher-centered practices, with low student participation, suggesting that information and communications technology (ICT) was used for traditional transmissive pedagogy. Teachers' discourse around ICT in class was practical and technical, rather than conceptual. Further, students' use of technology mainly revolved around writing digital texts, individually, not the promising pedagogical practices associated with ICT in previous research. These findings show that the implementation of digital technology and the development of digital competence in schools require far more than an ambitious curriculum and a basic digital infrastructure. Structures at a national level are not enough, and there is an urgent need for professional development at the local level to increase the instructional repertoire and the didactical motivation of teachers in relation to digital technology.

Keywords
digital literacy, teaching with ICT, video observation, technology uptake, lower-secondary school

Introduction

Digital technologies are profoundly changing what it means to be literate and the kinds of competence needed to participate fully in an increasingly digital world. How teachers use information and communications technology (ICT) in the classroom is a topic that has gained substantial and increased attention. Digital competence is considered a crucial aspect of education that schools should develop systematically (Ferrari, 2013; Griffin, Care, & McGaw, 2012). Research shows that access to digital tools are less important for students' learning than how teachers use them across subjects (Aflalo, Zana, & Huri, 2017; Blikstad-Balas & Davies, 2017; Baker, Goodboy, Bowman, & Wright, 2018; Jewitt, Moss, & Cardini, 2007; Lei & Zhao, 2007). However, this consensus has not resulted in larger-scale systematic investigations of teachers' use of ICT in their everyday teaching.

Methodologically, the field of ICT in education has broadly relied mainly on (1) small-scale case studies (e.g. Blikstad-Balas, 2012; Rusk, 2019; Sahlström, Tanner, & Valasmo, 2019) and experimental or quasi-experimental designs that delve deeply into specific contexts (e.g. Siew, Geofrey, & Lee, 2016), or (2) large-scale surveys that investigate self-reported access to and/or use of digital tools, attempting to link such access to learning outcomes without actually investigating how the technology is used across the investigated classrooms (e.g. Claro et al., 2012; Diaz, García, & Cano, 2019; OECD, 2015). The former tradition typically draws on small samples and emphasizes local context and participants' own experiences and/or interaction with and around technology, often with limited possibilities for generalization. The latter approach often draws on large sample sizes, but can be critiqued for lack of attention to contextual factors. While both traditions have proven to be highly relevant for the field of ICT in education, there is an urgent need for comparative studies at the classroom level that are more systematically sampled andthat actually look at teachers' uptake of technology in their everyday teaching, as well as a systematic overview of the digital literacy practices engaged in by students and teachers across classrooms.

The present study draws on one of the largest systematically sampled datasets of consecutive video-recorded lessons in Northern Europe (n=178) from 47 lower-secondary language arts (L1) classrooms in Norway, a particularly relevant context of global interest due to its high ambitions regarding digital competence (Gil-Flores et al., 2017) as well as its high level of access to ICT (OECD, 2015). It aims to address the methodological and empirical gaps described above by investigating what teachers with access to ICT in their regular classrooms choose to do with this access across their different lessons, including how and to what extent digital technology is integrated into their teaching. The study breaks new ground by systematically examining and describing teachers' everyday uptake of technology. There are two guiding research questions:

1. How and to what extent are teachers embedding ICT in their everyday instruction?
2. What are the aims of teachers' and students' use of ICT (identified in RQ1) across classrooms?

Background

A number of literature reviews have addressed the general effects of ICT in classroom settings (Ditzler et al., 2016; Elstad, 2016; Islam & Grönlund, 2016; Haddad, 2008; OECD, 2015); therefore, the following literature review will briefly address the topic of ICT access and use by examining what is known about (i) access in lower-secondary schools, (ii) what is known about teachers' general ICT competence, and (iii) teachers' attitudes toward ICT integration. These are three areas directly associated with the implementation of ICT (Bingimlas, 2009).

Access to ICT in the Classroom

ICT infrastructure is an obvious prerequisite for integrating digital technology into instruction. At the school level, the inadequacy of such structures is considered to be one of the key barriers to ICT implementation (Baydas & Goktas, 2016; Bingimlas, 2009; Gil-Flores et al., 2017). The question of access has long dominated the discourse around ICT implementation, and many schools report pressure to provide 1:1 access for all students (Blikstad-Balas & Davies, 2017). However, access is not a reliable predictor of teachers' actual implementa-

tion of digital technology (Gil-Flores et al., 2017). The discrepancy between access provision and teachers' preparedness to use the technology in their everyday teaching is, for example, highlighted as critical in the newest Teaching and Learning International Survey (TALIS) report from Norway (Throndsen, Carlsten, & Björnsson, 2019).

Norway has been a front-runner in providing schools with ICT (OECD, 2015). ICT has been defined as a core competence in the Norwegian curriculum since 2006 (Erstad, 2006), making it a priority of the national research agenda (Gudmundsdottir & Hatlevik, 2018). There is emphasis in the curriculum on student engagement with a range of digital literacy practices, both as writers/makers and readers/users of digital texts. Both primary and secondary schools have access to digital technologies (Dalaaker et al., 2012; Egeberg et al., 2016; Hatlevik, Egeberg, Gudmundsdottir, Loftsgarden, & Loi, 2013). While 1:1 access is the norm in upper-secondary schools, most lower-secondary schools can also provide either permanent 1:1 access, lend students laptops or tablets for use in specific lessons, or take students to a computer room at the school. In summary, access to ICT in Norwegian schools enables broad use of ICT in the classroom, and the national curriculum explicitly places this responsibility on all teachers across all grades.

Teachers' Competence

TALIS 2018 shows that in Norway, one teacher in five reports a strong need for more knowledge about how to integrate digital technology into their instruction—and most teachers identify this as an area where they need further professional development (Throndsen et al., 2019). This does not change for newly qualified teachers or student teachers. Another recent study from Norway, drawing on survey data from 356 newly qualified teachers, found that nearly half of the participants define their own ICT training as poor; they also indicated that their recent teacher training had played a fairly limited part in developing their professional digital competence (Gudmundsdottir & Hatlevik, 2018).

Across countries, student teachers and novice teachers report that they do not feel that their teacher education has prepared them to use ICT in their classrooms (Røkenes & Krumsvik, 2016; Sang, Valcke, Van Braak, & Tondeur, 2010), and many have called for more systematic approaches to ICT in teacher education (e.g. Hershkovitz & Karni, 2018). While newly educated teachers have vast experience with digital apps and social media, their experience with digital technology for education is limited, and their repertoire of relevant digital technologies for teaching and learning is restricted (Sang et al., 2010; Valtonen et al., 2011). These findings are important because they undermine the assumption that young, newly qualified teachers who spend time on social media and a variety of apps automatically understand how to implement this technology as an instructional tool in and across different school subjects.

The somewhat limited tool-oriented approach to ICT often found in teacher education has been highlighted by several empirical studies (Haugerud, 2011; Tømte, 2013). In a study of the integration of professional digital competence in teacher training in Norway, Instefjord and Munthe (2017) found that only 35% of teacher educators believed they were good role models for the use of technology. Madsen, Thorvaldsen, and Archard (2018) found that Norwegian teacher educators tended to report that they do not consider digital technology essential for good teaching. Moreover, an analysis of curriculum documents in teacher education (Instefjord & Munthe, 2016) showed that technology use did not have a prominent position in those documents.

Teachers' Attitudes toward ICT

Teachers' positive attitudes toward ICT are associated with the use of ICT in the classroom (Baş, Kubiatko, & Sünbül, 2016; Lawrence & Tar, 2018). Newly qualified Norwegian teachers report that they have both positive and negative beliefs about the usefulness of ICT in the classroom (Gudmundsdottir & Hatlevik, 2018). In Gudmunsdottir and Hatlevik's (2018) nationwide survey of newly qualified teachers, more than 80% had a positive attitude toward ICT use for educational purposes; however, half of the respondents were also concerned about the negative aspects of its use. Gudmunsdottir and Hatlevik (2018) also showed, in line with international studies (Drent & Meelissen, 2008), that integration of digital technology has relied on enthusiastic teachers who procure technology and have ambitions to use more technology in their classrooms.

Methods

This study is part of the large-scale video study *Linking Instruction and Student Achievement* (LISA) funded by the Research Council of Norway on a FRIPRO grant (see Klette, Blikstad-Balas & Roe, 2017). During the 2014–2015 school year, our research team systematically collected data from 47 different Grade 8 Language Arts (LA) classrooms (13- to 14-year-old students) across Norway. Three or four consecutive lessons were videotaped in each class over a one-week period, totaling 178 lessons. While 1:1 access to laptops and tablets still varies across Norwegian schools, all the teachers in the sample have access to a digital interactive board (Smartboard) or a projector and a laptop, which makes it timely to investigate the degree to which and the ways in which this technology is integrated into their lessons. Many of the videotaped classrooms also provided class-sets of computers or tablets, supporting 1:1 use.

Sample and Recruitment of Participants

The schools were purposefully sampled to include both a demographic and geographic spread and various levels of student achievement, as measured through national reading tests. Both rural and urban schools are represented in the sample, which also includes small and large schools. Most of the participating teachers are female, reflecting an overall gender imbalance among teachers of lower-secondary school LA. The teachers included in the study vary in age and in number of years of teaching experience. The number of professional development courses attended by teachers also varies, as does the schools' overall commitment to implementing ICT, which reflects the general variation across schools.

Written and informed consent to participate was provided by the parents, students, and teachers.

Video Recordings of Lessons

Video data made it possible to systematically track how much time teachers spent using different technologies and devices across lessons, and to systematically code the purpose of their use in and across different lessons. In contrast to *in situ* inductive coding, video technology facilitated the mapping of the material, development of the codes, and rigorous application of the codes across all the lessons to generate comparable data on the roles of digital technology across the 178 recorded lessons. Such analyses have been highlighted as particularly relevant for complex literacy practices in a school setting (Blikstad-Balas & Sørvik, 2015). The video design relied on two cameras simultaneously recording the same lesson,

one capturing the class, and one focusing on the teacher (see Figure 1). Two microphones were used, one placed on the teacher and one fixed to capture the classroom talk. This provided reasonably good audio of both the whole-class discourse and the teacher's interactions with one or several students at a time.

Class camera   Teacher camera

Figure 1 Video design: Two fixed camera angles showing the same classroom from two opposite angles.

Analyses

Phase 1. The first phase of analysis consisted of identifying which of the 178 LA lessons (including 21 double lessons) included the use of digital technology. This is a typical way of winnowing the data in a large data corpus (Creswell & Creswell, 2018). Segments where teachers used technology during their lessons were identified. Examples of technology use included writing on a digital interactive board, showing PowerPoint or Prezi presentations, and showing assignments on the learning management system (LMS). All lessons where teachers encouraged students to use digital technology for school purposes in any way were also included. Through this phase of the coding, all lessons where the teacher, the students, or both used digital technology were identified.

Phase 2. In the second phase, the lessons identified in Phase 1 were reviewed systematically to map the different kinds of hardware and software used. The analyses were conducted and organized using Interact software, and descriptive codes were developed to describe precisely all the occurrences of different digital technologies or applications. These codes were applied according to the duration of technology use, as done in previous smaller studies of ICT use in classrooms (Blikstad-Balas, 2014); thus, if a teacher used the software Kahoot for 7 minutes, these 7 minutes were tagged as "Kahoot." This was a descriptive way of generating codes, which, when saturated (e.g., Fusch & Ness, 2015), were applied to all the lessons. In addition, the main purposes of students' use of ICT were identified in all lessons where students were asked to use their personal laptops or tablets, or where digital boards or projectors were used. Analysis of purpose was based on previous work on typical student ICT purposes in the classroom (Juvonen, Tanner, Olin-Scheller, Tainio, & Slotte, 2019; Knobel & Lankshear, 2007). It systematically examined whether students were engaging in literacy events centered on (a) production of texts, (b) presentation of information, (c) reading digital texts, (d) finding information, (e) sharing information with others, or (f) other purposes. All coding in Phase 2 was double-coded by two coders. In rare cases of discrepancy between the coders, segments were reviewed and discussed until agreement was reached.

Limitations

While extensive measures were taken to ensure the representativeness of the sample, the data collection occurred during the 2014–2015 school year. At that time, all the classrooms had ample access to technology; the teachers had laptops and digital boards or at least projectors. Many of the classrooms also had 1:1 access, and the number has increased since 2014–2015 because Norway has invested heavily in providing each student with his/her own tablet or laptop. While the sampled lessons provide a good overview of typical teaching practices across all lessons, making trends and patterns across classrooms and teachers visible, they will not show the entire digital repertoire of each teacher.

Results and Discussion

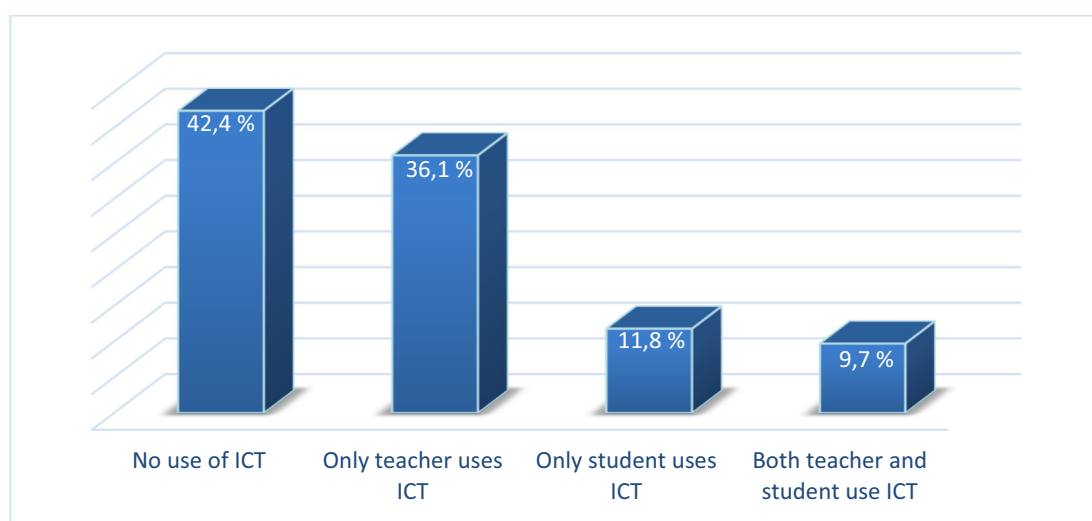At the lesson level (N=178), the distribution of ICT is shown in Figure 2.

Figure 2 The use of ICT across all lessons.

As can be seen, the mutually exclusive scoring of the use of digital technology at the lesson level showed that technology was not used in 42% of the lessons. In 36% of the lessons, teachers used digital technology in their teaching; students were observed using technology in 11.8% of the lessons. In almost 10% of the lessons, both the teacher and students used digital technology in the same lesson (although not necessarily for the same purposes or simultaneously). The distribution of technology use at the teacher level was also investigated on the basis of the four lessons by each teacher. In seven of the classrooms, there was no use of technology by either the teacher or the students during any of the four recorded lessons. In six classrooms, the teachers used technology in all four lessons.

Teachers' Use of Technology in the Classroom: What Technologies and Software Are Being Used?

Drawing on the lessons in which teachers used digital technology, the different software, educational apps, and websites included by teachers in the lessons were analyzed. Figure 3 shows how the teachers' total time using digital technology in class was distributed:
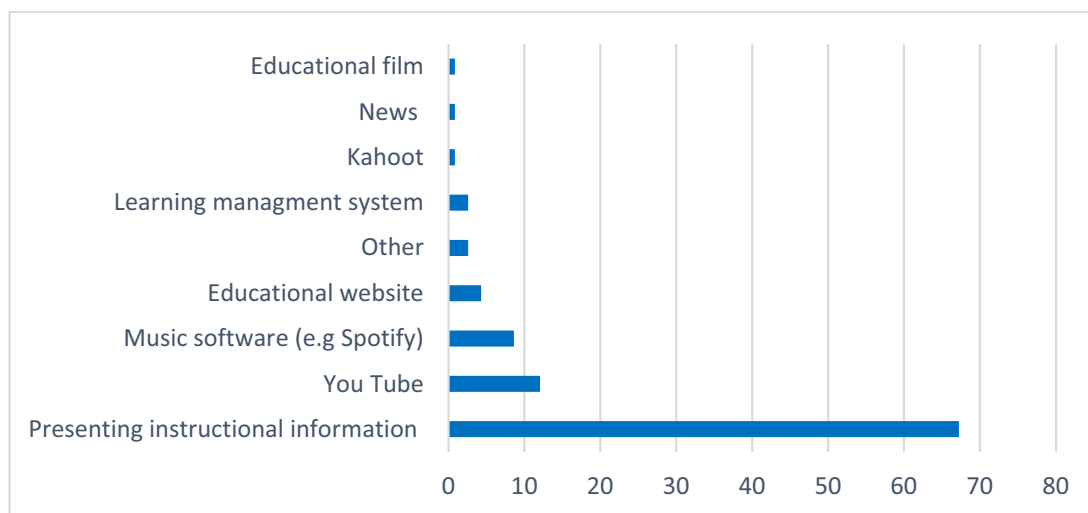

Figure 3 Teachers' total time using ICT in the classroom distributed across different digital tools.

The technology was mainly used to aid the teachers in presenting information about content. This kind of teaching relied on PowerPoint presentations or other documents and was very often monologic. While a distinction was initially made between the codes "PowerPoint" and "digital interactive board," it was found that most digital boards were used in the same way as a traditional analog canvas, and their main purpose across classrooms was for PowerPoint presentations, thus making the distinction redundant. While a few teachers used the digital board pen for highlighting and/or writing in their presentation or the document that was shown, most did not. Thus, most of the content was written before the lesson and not changed during the course of the lesson.

The use of texts from the authentic "outside world" in the classroom has been advocated as an important pedagogical opportunity that is enabled by Internet access. In the present study, the use of YouTube and musical applications showed that some teachers availed of this opportunity. Typically, the videos on YouTube were short poems/lyrics that the students were going to analyze, or relevant comedy clips whose theme could be related to the topic of the lesson. Thus, where teachers used Internet access, it was to embed authentic content into the lesson. This was also true for the one occasion when a newspaper was used to show argumentative writing in a contemporary real-life context.

The instances of teachers using digital content made for educational purposes (educational films or websites) involved pedagogical content created by organizations or textbook publishers. One teacher used Kahoot to review content. The code "Other" simply refers to situations where the teacher used his/her computer in front of the class without sharing the screen with the students and without stating what he/she was doing. Most Norwegian schools use an LMS, and in the present study's data, the most frequent LMS seems to be It's Learning. During instruction, the LMS was typically shown briefly by the teachers to clarify where students should deliver their assignments and where they could find specific content.

Students' Use of Technology in the Classroom

Figure 4 shows the students' total time using digital technology in class, distributed across different technological tools.
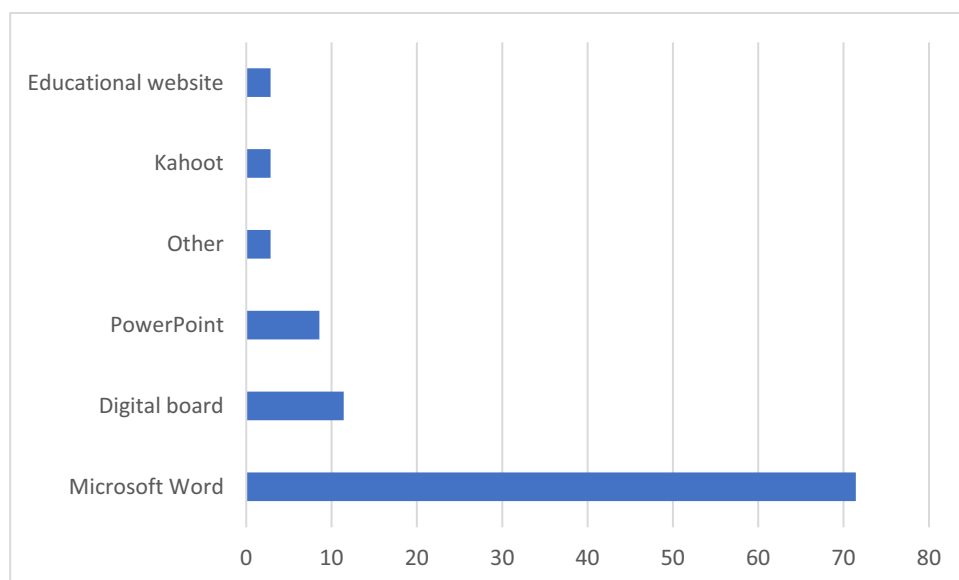

Figure 4 The digital tools students are using in the classroom.

As can be seen, 71% of the students' time using ICT in their lessons was spent on writing in Microsoft Word on personal laptops. This is not that surprising. The LA subject has a particular responsibility for developing students as writers, and previous studies have shown that students have sustained opportunities for text production (Blikstad-Balas, Roe & Klette, 2018). Students were not prompted to combine images and sound or make use of other multimodal possibilities. Multimodal text production was more relevant in cases where students were producing their own PowerPoint presentations or looking at their teacher's PowerPoint presentations (8.5%), as these more often used a combination of different modalities.

In Figure 4, the "digital board" category (11.4%) captures the four occasions when students were asked to write on the Smartboard. The "Educational website" category (2.8%) indicates when students accessed the page, rather than when they watched the teacher access it (as presented in Section 4.1); this is also true for "Kahoot" (2.8%). The "Other" category shows the rare occasions of unclear use.

Purposes of Student Use

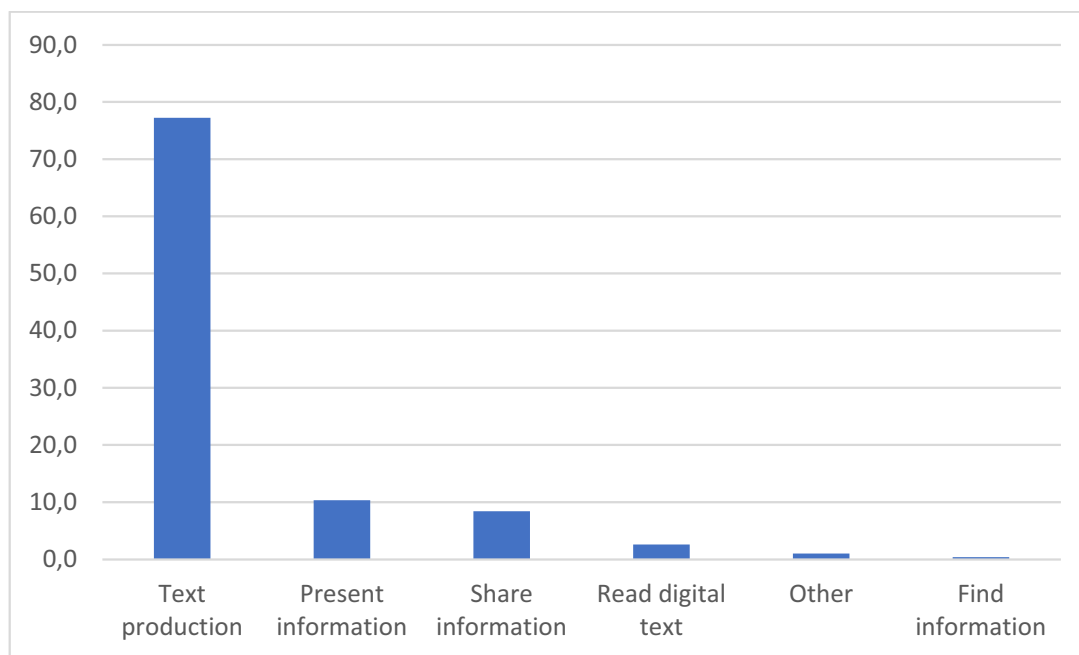In our analyses, we identified why students used ICT in lessons.

Figure 5 Purposes of technology use.

In contrast to Norwegian upper-secondary schools, where many students decide if and when to use ICT (Blikstad-Balas, 2012; Elstad, 2006; Krumsvik, Ludvigsen, & Urke, 2011), in lower-secondary schools the use of ICT is managed by the teacher. As seen in Figure 5, when students were prompted to use ICT, most of the time it was to write texts. This mirrors the findings presented in Figure 4, where Microsoft Word was the software most often used. The writing that was done in these lessons was often individual writing for individual assessment (Blikstad-Balas et al, 2018), and 70.3% of the time that the students were using technology was connected to individual work, often writing. The remaining time was either spent working in groups (25.2%) or in pairs (4.5%), often connected to preparing digital presentations. The purpose of presenting information was exclusively linked to students delivering digital presentations in front of the class, and the shared information was also connected to work that would later be presented to peers in the same classroom. While the texts read in the LA lessons were almost exclusively printed texts, in worksheets, handouts, literary books or textbooks, the students did occasionally read their teacher's PowerPoint slides or information on the LMS on their screen; thus, 2.6% of their time was spent "reading digital texts."

Teacher Competence and Student Competence: Some Observable Patterns

This study is a systematic descriptive study of technology use across lessons. It does not measure the digital competence of teachers or students. However, it is legitimate to ask whether the limited use of ICT in these classrooms by teachers can be interpreted as a lack of digital competence, given that the repertoire of teachers' ICT use was very limited.

The study's findings align well with previous studies that question the discrepancy between curriculum ambitions and the reality in the classroom. Very few efforts to increase students' digital competence and engage students in new literacies were observed in connection to ICT use, and those that were observed were purely technical. The teach-

ers' use of technology was largely consistent with what has been described as ineffective use of ICT (Van Braak, Tondeur, & Valcke, 2004) in the sense that it functions as a basic support for the teacher, who mainly uses it to prepare lessons. This use is consistent with the "application phase" of ICT implementation (Eng, 2005; Gil-Flores et al., 2017), in which teachers apply technology to the same teaching-learning process they have traditionally used. This is particularly evident in the use of PowerPoint and of Microsoft Word as an individual typing device. There is very little indication of technology being used in an "application phase" (Eng, 2005) where technology changes classroom practice through innovative pedagogies.

While the use of PowerPoint appears to be something that all teachers who use it are comfortable with, in terms of technical aspects the present study found some examples of teachers asking students for help with digital technology, often concerning sound or connecting the right cables. A more concerning – and perhaps surprising – finding is that there were several dialogs, both in whole-class situations and in teacher-student interactions, indicating that students across classrooms had difficulty navigating the basic functions of the software used for educational purposes. Logging in, finding the right digital "rooms," uploading content on the LMS, saving and finding documents and using basic functions in Microsoft Word all appeared to be challenging for several Grade 8 students, who have had digital competence taught as a basic skill throughout their previous seven years of education. Moreover, during writing lessons, the students asked many technical questions, and the teachers seemed comfortable showing students how to do the various things they wanted to do. Thus, the material clearly shows that, for school purposes, teachers seem to master the tools used far better than their students do. This is an important insight into the debate on so-called "digital natives" with generally good digital skills that several empirical studies, including this one, dismissed as assumed rather than proven (Brandtzæg, 2016; Samuel, 2017; Selwyn, 2009).

Concluding Remarks

A key finding of our study is that teachers' implementation of technology in their classroom is limited in three ways. First, it is limited in the sense that technology is rarely a topic; there are very few instances where teachers have expectations of what digital competence students should have, and when they do, it is narrow and technical rather than conceptual. Second, the lessons in which technology use by teachers was identified were limited to teachers mainly presenting and showing instructional content in different ways. Third, the purposes of students' use of technology in LA lessons mainly centered on writing digital texts, individually. It was found that, in general, students did not seem to be very proficient in using the software used in school. These patterns show that the implementation of digital technology in schools requires far more than an ambitious curriculum and a basic digital infrastructure.

The study's findings clearly show how digital technology, often associated with innovative pedagogies and often viewed as a valuable tool for engaging students and connecting the classroom to the outside world (Blikstad-Balas & Davies 2017; Klette et al., 2018), can also reinforce the more traditional aspects of teaching. While the digitization of classrooms *can* represent a dramatic change in opportunities to participate in different kinds of communicative spaces, as well as for teachers and students to gain access to content and information (Klette et al., 2018), it can also have a preserving effect on teaching, in particular if PowerPoint is used merely as a transmissive tool to show students pre-planned content they

should listen to or copy, and if the only digital competence that students develop in school centers on technicalities in Word.

These findings are an important contribution to the field because they directly challenge the tenacious idea that access to technology, combined with explicit ideas about the digital competences students should develop across subjects, will lead to implementation and uptake of ICT and a range of new literacies in the classroom. While previous studies have revealed that teachers who have access may also report low use (Gil-Flores et al., 2017), the present study has systematically uncovered a limited, narrow, and transmissive repertoire of digital teaching practices across a large number of comparable lessons. We show that not only is time spent on ICT limited, but also that the software and applications used are very few, as are the purposes of use, for both teachers and students. If ICT was used at all, it was mostly for teachers' presentations of their own pre-prepared content or for students' individual writing. These practices are nothing like the innovative, best-practice pedagogies often portrayed in small-scale case studies.

There are several implications of this study for the educational field. First, the idea that technology in itself will transform education if teachers are given access to it in the classroom, has been seriously challenged with robust empirical data. If we want to meet the high ambitions for digital competence in the curriculum, the repertoire of ICT use in pedagogically meaningful ways has to be increased. We would argue that rather than focusing generally on ICT in teacher training, teachers should work systematically at the local level to increase the repertoire—not the use itself—of digital technologies. Our review suggests that implementation still relies on each individual teacher, and we believe a key obstacle for more innovative use of ICT is the lack of shared ambition at the school level revealed in prior research. As we have shown, technology and high ambitions at the structural level are not enough. There is a need for local structures as well—and, as highlighted by Grimalt-Alvaro et al. (2019), effective training programs for teachers need to target teachers' beliefs and be grounded in the subjects they teach—in line with research-based recommendations for professional development (Darling-Hammond, Hyler, & Gardener, 2017; Desimone & Garet, 2015).

Furthermore, this study indicates that when planning their lessons, teachers draw on ICT to aid their own frontal instruction and plan only to a limited extent for activities that would foster the systematic development of students' digital competence. Students' use of ICT is often limited to individual writing. The repertoire of students' use of technology should be increased systematically in line with the research showing potential opportunities for ICT in education (e.g., Castro Sánchez & Alemán, 2011; Lawrence & Tar, 2018).

References

Aarsand, P., & Forsberg, L. (2010). Producing children's corporeal privacy: Ethnographic video recording as material-discursive practice. *Qualitative Research, 10*(2), 249–268. https://doi.org/10.1177/1468794109356744

Aflalo, E., Zana, L., & Huri, T. (2018). The interactive whiteboard in primary school science and interaction. *Interactive Learning Environments*, 26(4), 525–538. https://doi.org/10.1080/10494820.2017.1367695

Baker, J. P., Goodboy, A. K., Bowman, N. D., & Wright, A. A. (2018). Does teaching with PowerPoint increase students' learning? A meta-analysis. *Computers & Education, 126*, 376–387. https://doi.org/10.1016/j.compedu.2018.08.003

Baş, G., Kubiatko, M., & Sünbül, A. M. (2016). Teachers' perceptions towards ICTs in teaching-learning process: Scale validity and reliability study. *Computers in Human Behavior, 61*, 176–185. https://doi.org/10.1016/j.chb.2016.03.022

Baydas, O., & Goktas, Y. (2016). Influential factors on preservice teachers' intentions to use ICT in future lessons. *Computers in Human Behavior*, 56, 170–178. https://doi.org/10.1016/j.chb.2015.11.030

Bingimlas, K. A. (2009). Barriers to the successful integration of ICT in teaching and learning environments: A review of the literature. *Eurasia Journal of Mathematics, Science & Technology Education*, 5(3). https://doi.org/10.12973/ejmste/75275

Blikstad-Balas, M. (2012). Digital literacy in upper secondary school-what do students use their laptops for during teacher instruction. *Nordic Journal of Digital Literacy*, 7(2), 81–96.

Blikstad-Balas, M. (2014). Redefining School Literacy. Prominent literacy practices across subjects in upper secondary school. Thesis. University of Oslo.

Blikstad-Balas, M., & Sørvik, G. O. (2015). Researching literacy in context: using video analysis to explore school literacies. *Literacy*, 49(3), 140–148. https://doi.org/10.1111/lit.12037

Blikstad-Balas, M., & Davies, C. (2017). Assessing the educational value of one-to-one devices: have we been asking the right questions? *Oxford Review of Education*, 43(3), 311–331. https://doi.org/10.1080/03054985.2017.1305045

Blikstad-Balas, M., Roe, A., & Klette, K. (2018). Opportunities to write: An exploration of student writing during language arts lessons in Norwegian lower secondary classrooms. *Written Communication*, 35(2), 119–154. https://doi.org/10.1177/0741088317751123

Brandtzæg, P. B. (2016). The social media natives: The relationship between young peoples' media user type and their media use at school. In E. Elstad (Ed.). *Digital expectations and experiences in education* (pp. 149–162). Rotterdam: Springer.

Claro, M., Preiss, D. D., San Martín, E., Jara, I., Hinostroza, J. E., Valenzuela, S., . . . Nussbaum, M. (2012). Assessment of 21st century ICT skills in Chile: Test design and results from high school level students. *Computers & Education, 59*(3), 1042–1053. https://doi.org/10.1016/j.compedu.2012.04.004

Creswell, J. W., & Creswell, J. D. (2018). Research design: Qualitative, quantitative & mixed methods approaches. Los Angeles, CA: Sage.

Dalaaker, D., Egeberg, G., Gudmundsdottir, G., Guttormsgaard, V., Hatlevik, O. E., Ottestad, G., . . . Skaug, J. (2012). *Monitor 2012*. Report, Oslo.

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development*. Palo Alto, CA: Learning Policy Institute.

Desimone, L. M., & Garet, M. S. (2015). Best practices in teachers' professional development in the United States. *Psychology, Society and Education*, 7(3), 252–263. https://doi.org/10.25115/psye.v7i3.515

Díaz, L. M. B., & Cano, E. V. (2019). Effects on academic performance in secondary students according to the use of ICT. *IJERI: International Journal of Educational Research and Innovation*, (12), 90–108.

Ditzler, C., Hong, E., & Strudler, N. (2016). How tablets are utilized in the classroom. *Journal of Research on Technology in Education, 48*(3), 181–193. https://doi.org/10.1080/15391523.2016.1172444

Drent, M., & Meelissen, M. (2008). Which factors obstruct or stimulate teacher educators to use ICT innovatively? *Computers & Education, 51*(1), 187–199. https://doi.org/10.1016/j.compedu.2007.05.001

Egeberg, G., Hultin, H., & Berge, O. (2016). *Monitor skole 2016*. Report.

Elstad, E. (2006). Understanding the nature of accountability failure in a technology-filled, laissez-faire classroom: Disaffected students and teachers who give in. *Journal of Curriculum Studies, 38*(4), 459–481. https://doi.org/10.1080/00220270500508901

Elstad, E. (2016). Educational technology: Expectations and experiences. In E. Elstad (Ed.). *Digital expectations and experiences in education* (pp. 3–28). Rotterdam: Springer.

Eng, T. S. (2005). The impact of ICT on learning: A review of research. *International Education Journal, 6*(5), 635–650.

Erstad, O. (2006). A new direction? Digital literacy, student participation and curriculum reform in Norway. *Education and Information Technologies, 11*(3–4), 415–429. https://doi.org/10.1007/s10639-006-9008-2

Ferrari, A. (2013). DIGCOMP: A framework for developing and understanding digital competence in Europe. Luxembourg: Publications Office of the European Union.

Fusch, P. I., & Ness, L. R. (2015). Are we there yet? Data saturation in qualitative research. *The Qualitative Report, 20*(9).

Gil-Flores, J., Rodríguez-Santero, J., & Torres-Gordillo, J.-J. (2017). Factors that explain the use of ICT in secondary-education classrooms: The role of teacher characteristics and school infrastructure. *Computers in Human Behavior, 68*, 441–449. https://doi.org/10.1016/j.chb.2016.11.057

Griffin, P., Care, E., & McGaw, B. (2012). The changing role of education and schools. In P. Griffin, B. McGaw, & E. Care (Eds.), *Assessment and teaching of 21st century skills* (pp. 1–15). London: Springer.

Gudmundsdottir, G. B., & Hatlevik, O. E. (2018). Newly qualified teachers' professional digital competence: Implications for teacher education. *European Journal of Teacher Education, 41*(2), 214–231. https://doi.org/10.1080/02619768.2017.1416085

Haddad, W. (2008). Analytical review: ICT in education toolkit. Washington, DC: World Bank.

Hatlevik, O., Egeberg, G., Gudmundsdottir, G., Loftsgarden, M., & Loi, M. (2013). *Monitor skole 2013: Om digital kompetanse of erfaringer med bruk av IKT I skolen.* Oslo: Senter for IKT I utdanningen.

Haugerud, T. (2011). Student teachers learning to teach: The mastery and appropriation of digital technology. *Nordic Journal of Digital Literacy, 6*(04), 226–238.

Hershkovitz, A., & Karni, O. (2018). Borders of change: A holistic exploration of teaching in one-to one computing programs. *Computers and Education*, 125, 429–443. https://doi.org/10.1016/j.compedu.2018.06.026

Instefjord, E., & Munthe, E. (2016). Preparing pre-service teachers to integrate technology: An analysis of the emphasis on digital competence in teacher education curricula. *European Journal of Teacher Education, 39*(1), 77–93. https://doi.org/10.1080/02619768.2015.1100602

Instefjord, E. J., & Munthe, E. (2017). Educating digitally competent teachers: A study of integration of professional digital competence in teacher education. *Teaching and Teacher Education, 67*, 37–45. https://doi.org/10.1016/j.tate.2017.05.016

Islam, S., & Grönlund, Å. (2016). An international literature review of 1:1 computing in schools. *Journal of Educational Change*, 17(2), 191–222. https://doi.org/10.1109/educon.2015.7096023

Jewitt, C., Moss, G., & Cardini, A. (2007). Pace, interactivity and multimodality in teachers' design of texts for interactive whiteboards in the secondary school classroom. *Learning, Media and Technology, 32*(3), 303–317. https://doi.org/10.1080/17439880701511149

Juvonen, R., Tanner, M., Olin-Scheller, C., Tainio, L., & Slotte, A. (2019). 'Being stuck': Analyzing text-planning activities in digitally rich upper secondary school classrooms. *Learning, Culture and Social Interaction, 21*, 196–213. https://doi.org/10.1016/j.lcsi.2019.03.006

Klette, K., Blikstad-Balas, M., & Roe, A. (2017). Linking Instruction and Student Achievement. A research design for a new generation of classroom studies. Acta Didactica Norge, 11(3), Art-10. https://doi.org/10.5617/adno.4729

Klette, K., Sahlström, F., Blikstad-Balas, M., Luoto, J., Tanner, M., Tengberg, M., ... & Slotte, A. (2018). Justice through participation: student engagement in Nordic classrooms. *Education Inquiry*, 9(1), 57–77. https://doi.org/10.1080/20004508.2018.1428036

Knobel, M., & Lankshear, C. (2007). Sampling the "new" in new literacy studies. In M. Knobel & C. Lankshear (Eds.), *A new literacies sampler* (Vol. 29, pp. 1–25). New York: Peter Lang.

Knoblauch, H., Schnettler, B., Raab, J., & Soeffner, H.-G. (2006). Video analysis: Methodology and methods: Qualitative audiovisual data analysis in sociology. New York: Peter Lang.

Krumsvik, R. J., Ludvigsen, K., & Urke, H. B. (2011). Klasseleiing og IKT i vidaregåande opplæring. "Ei evaluering av LanSchool og klasseleiing i teknologitette klasserom." Report, University of Bergen.

Lawrence, J. E., & Tar, U. A. (2018). Factors that influence teachers' adoption and integration of ICT in teaching/learning process. *Educational Media International*, 55(1), 79–105. https://doi.org/10.1080/09523987.2018.1439712

Lei, J., & Zhao, Y. (2007). Technology uses and student achievement: A longitudinal study. *Computers & Education, 49*(2), 284–296. https://doi.org/10.1016/j.compedu.2005.06.013

Madsen, S. S., Thorvaldsen, S., & Archard, S. (2018). Teacher educators' perceptions of working with digital technologies. *Nordic Journal of Digital Literacy, 13*(03), 177–196. https://doi.org/10.18261/issn.1891-943x-2018-03-04

Maxwell, J. A. (2013). *Qualitative research design: An interactive approach* (3rd ed.). Thousand Oaks, CA: Sage.

OECD. (2015). Students, computers and learning.

OECD. (2019). TALIS 2018 results (Volume I).

Prensky, M. (2001). Digital natives, digital immigrants part 1. *On the Horizon, 9*(5), 1–6. https://doi.org/10.1108/10748120110424816

Prensky, M. (2009). H. sapiens digital: From digital immigrants and digital natives to digital wisdom. *Innovate: Journal of Online Education, 5*(3), 1–9.

Røkenes, F. M., & Krumsvik, R. J. (2016). Prepared to teach ESL with ICT? A study of digital competence in Norwegian teacher education. *Computers & Education, 97*, 1–20. https://doi.org/10.1016/j.compedu.2016.02.014

Rusk, F. (2019). Digitally mediated interaction as a resource for co-constructing multilingual identities in classrooms. *Learning, Culture and Social Interaction, 21*, 179–193. https://doi.org/10.1016/j.lcsi.2019.03.005

Sahlström, F., Tanner, M., & Valasmo, V. (2019). Connected youth, connected classrooms. Smartphone use and student and teacher participation during plenary teaching. *Learning, Culture and Social Interaction, 21*, 311–331. https://doi.org/10.1016/j.lcsi.2019.03.008

Samuel, A. (2017). Opinion: Forget "digital natives." Here's how kids are really using the Internet. Retrieved from https://ideas.ted.com/opinion-forget-digital-natives-heres-how-kids-are-really-using-the-internet/

Sánchez, J. J. C., & Alemán, E. C. (2011). Teachers' opinion survey on the use of ICT tools to support attendance-based teaching. *Computers & Education*, 56(3), 911–915. https://doi.org/10.1016/j.compedu.2010.11.005

Sang, G., Valcke, M., Van Braak, J., & Tondeur, J. (2010). Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. *Computers & Education, 54*(1), 103–112. https://doi.org/10.1016/j.compedu.2009.07.010

Selwyn, N. (2009). *The digital native-myth and reality.* Paper presented at the Aslib Proceedings.

Siew, N. M., Geofrey, J., & Lee, B. N. (2016). Students' algebraic thinking and attitudes towards algebra: The effects of game-based learning using Dragonbox 12+ App. *The Electronic Journal of Mathematics & Technology, 10*(2), 66–79.

Snell, J. (2011). Interrogating video data: Systematic quantitative analysis versus micro-ethnographic analysis. *International Journal of Social Research Methodology, 14*(3), 253–258. https://doi.org/10.1080/13645579.2011.563624

Throndsen, I., Carlsten, T. C., & Björnsson, J. K. (2019). TALIS 2018 Første hovedfunn fra ungdomstrinnet [TALIS 2018: First key findings from lower secondary school].

Tømte, C. E. (2013). Educating teachers for the new millennium? Teacher training, ICT and digital competence. *Nordic Journal of Digital Literacy*. Anniversary issue 2015, 74–88.

Valtonen, T., Pontinen, S., Kukkonen, J., Dillon, P., Väisänen, P., & Hacklin, S. (2011). Confronting the technological pedagogical knowledge of Finnish Net Generation student teachers. *Technology, Pedagogy and Education, 20*(1), 3–18.

Van Braak, J., Tondeur, J., & Valcke, M. (2004). Explaining different types of computer use among primary school teachers. *European Journal of Psychology of Education, 19*(4), 407. https://doi.org/10.1007/bf03173218