# Motivational and Fun! Preservice Teachers' Recontextualising of Discourses on ICT Integration in Mathematics in Their Practicum Assignment

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Even though it is advocated in educational policies worldwide to integrate digital tools as a way of transforming teaching, this has not occurred, even with teachers who have grown up surrounded by digital technologies. To expand understandings about why this might be the case, the study reported here investigated preservice teachers' collective meaning-making about ICT integration. The preservice teachers' mandatory group assignments for their first mathematical course, in a Norwegian teacher education institution, were analysed. Bernstein's description of recontextualising is employed to gain insights into preservice teachers' meaning-making through the discourses that they produced from the resources made available to them in their teacher education. The recontextualising of discourses shows, for example, how mathematics curriculum references to playing games with digital tools were recontextualised by the preservice teachers into discourses about fun and motivation. This allowed the preservice teachers to focus on general pedagogical positive aspects of ICT beyond perceptions of students being bored but hindered them in attending to other mathematics classroom issues.

**Keywords** · curriculum · ICT · Bernstein · critical discourse analysis · practicum assignments

## Introduction

A recurring issue that preservice teachers (PTs) need to make meaning of is the integration of digital tools or Information and Communications Technology (ICT) into their teaching. Digital tools are generally considered to be useful for teachers in "transforming" traditional teaching through, for example, the use of appealing games to enhance motivation (Hwa, 2018), with game design being valued as enriching participation (Melander Bowden & Aarsand, 2020). Aside from some small-scale studies, however, claiming that the use of digital tools was transformative for controlled groups in schools (e.g., Hwa, 2018), previous research suggests that such transformations are not simple with PTs struggling to transform teaching (e.g., Luo et al., 2021). These struggles in integrating ICT have been widely explained as being due to a lack of competencies and confidence (Luo et al., 2021), while PTs' meaning-making about ICT has been under-researched.

Educational reforms concerning ICT in various places of the world, including Norway, have been commonplace in the last three decades (McGarr et al., 2021). As a result, teaching practices, including those of PTs, are required to incorporate a variety of aspects related to ICT. In Norway, teachers have been expected to integrate digital tools for almost two decades, with it being a formal requirement since the 2006 mathematics school curriculum (see Norwegian Directorate for Education and Training [NDET], 2006). In the most recent curriculum reform in Norway, teachers are also expected to integrate other aspects of ICT, with students being required to learn computational thinking in mathematics lessons (see NDET, 2019). Since digital tools were the main focus in the context where this study was conducted, and ICT is a term that is more frequently used in international research, I will refer to both digital tools and ICT interchangeably in this article.

Although research has demonstrated that PTs were experienced digital users and had positive attitudes toward ICT integration (Marbán & Mulenga, 2019), a deficit viewpoint is often used to describe their struggles. PTs' struggles have commonly been attributed to a lack of competencies and knowledge (e.g., Marbán & Mulenga, 2019) and beliefs about the effective use of ICT in mathematics classrooms (e.g., Perienen, 2020; Thurm et al., 2022). These deficit perspectives need to be challenged as they limit the failure of reforms to those who teach (Montecino, 2018), with the principles in the reforms and frameworks for ICT integration positioned as achievable and indisputable. The gap between the reality of teaching practices and ideal views promoted by governments and frameworks about ICT, might lead continuously to simplistic explanations for the failure of reforms, positioning those who teach as deficient (Rice, 2021), and teacher education as the main body responsible (Thorvaldsen & Madsen, 2020).

To expand views about why PTs' might struggle to integrate ICT in a transformative way, there is a need for a more nuanced understandings of how PTs make meaning. Yet, little is known about PTs' meaning-making about integrating ICT into mathematics teaching. Remillard (2005) argued that teachers' meaning-making is influenced by specific contexts, even when the curriculum requirements have a normative connotation. Further investigation is necessary to study meaning-making as a process that is constituted by and constitutes institutional practices (Chouliaraki & Fairclough, 1999), and hence collective practices.

In mathematics teacher education, PTs can select, utilise, and adapt resources, including the national school curriculum and digital tools. This process is comparable to the recontextualisation of discourse by teachers, as described by Bernstein (2000), but it is mediated by resources in PTs' mathematics teacher education courses (Gomez Marchant et al., 2021). As Adler (2012) argued, recontextualising provides insights into meaning-making, "what comes to function as ground in their practice, how and why" (p. 7), contributing to understandings about the potential meanings that are opened and closed within teacher education institutions.

Bernstein's (2000) description of recontextualising discourses considers how the official curriculum becomes adopted and adapted by PTs as part of a collective meaning-making process. The adoption and adaptation of discourses provides insights into how some knowledge becomes legitimised within an institution. Thus, understanding how PTs' meaning-making is related to the recontextualising of official discourses can provide nuanced insights into why the potential of ICT to transform mathematics teaching has not been realised. Therefore, the aim of this study was to investigate PTs' collective meaning-making about ICT integration by identifying the discourses that they drew upon from their mathematics teacher education. this was achieved by examining three group mandatory practicum assignments written by 12 PTs, for their first mathematics course.

The next section discusses how previous research about transforming mathematics teaching though ICT and PTs' meaning-making.

## Transformation of Mathematics Teaching

The need for mathematics teaching to be transformed is related to an ongoing concern that typical practices have not led to students learning mathematics that could help them in real life or in their further studies (Lessani et al., 2017). Some decades ago, Skovsmose (2001) described traditional practices in mathematics classrooms as including four features that were likely to result in the absence of relevant learning. The first feature was that lessons began with the teacher explaining mathematical concepts or procedures, followed by students practicing these by completing exercises. The second feature was that these exercises were typically produced by external authorities, often through textbooks, which were promoted as covering curricular goals. The third feature was that the exercises contained all the information needed for their solution, rendering real-world data irrelevant, and so requiring a single correct answer. The fourth feature was that students were often stratified based on their ability to obtain the correct answer, contributing to a performance-based hierarchy. Skovsmose suggested teachers could use ICT to transform mathematics teaching to provide a more inquiry-based learning approach.

Without care, however, ICT could also result in the reinforcement of traditional approaches (Skovsmose, 2001). An example of this is found in Hwa's (2018) study of game-based learning of mathematics at the primary school level. The digital games were found to increase students' concentration, with unmotivated students viewing mathematics as transformed from "boring" to "fun". In Hwa's intervention, however, the requirement to solve a series of exercises as part of the game can be seen as reinforcing the traditional mathematics teaching features identified by Skovsmose (2001). This would result in mathematics teaching not being transformed. Similarly, Player-Koro (2012) found that despite the use of a techno-positive discourse about ICT being transformative, the PTs in her study reproduced traditional practices of teaching mathematics.

In contrast, Melander Bowden and Aarsand (2020) identified other features of traditional teaching that could be challenged through ICT integration. They argued that traditionally, ICT in schools required students to use games and so situated them as consumers of technology. These features were challenged by having students negotiate the criteria for designing and assessing games rather than consuming existing ones. However, what was problematised about teaching was the situating of learners as consumers of commercial games rather than more particular features of the traditional teaching of subjects, such as mathematics. Thus, what needs to be transformed about mathematics teaching practices is dependent on local contexts.

In the examples of Hwa (2018) and Melander Bowden and Aarsand (2020), the transformation of teaching through ICT integration was limited to overcoming students' demotivation and their positioning as consumers of digital games. Although these may affect some aspects of their learning, there are other aspects that could be in focus. For example, Samuelsson (2006, p. 77) found "using drill programs that include games and competitions does not encourage students to reflect, but the competition elements reinforce fast handling of procedures," suggesting that the value of speed was reinforced rather than challenged. Transforming traditional mathematics teaching through the integration of ICT may include PTs determining the appropriateness of digital tools for supporting students in reflecting on what mathematics they are using to solve different types of problems.

## PTs' Meaning-making and the Techno-positive Discourse

In the limited research about PTs' meaning-making, PTs drew on a variety of resources, such as coursework materials (e.g., Adler, 2012; Gomez Marchant et al., 2021). These resources could also be texts such as national curricula, which PTs should consider when teaching, the literature they find about using ICT in schools, and descriptions of the digital tools they choose for their teaching. Discourses about digital tools having the potential to transform traditional teaching (e.g., Luo et al., 2021), often circulate at the school level (Mertala, 2020) and in how digital tools are advertised (Darragh, 2021). Consequently, PTs are likely to encounter discourses about ICT integration being transformative.

The circulation of these discourses can be reinforced at the policy level, where curriculum changes are usually accompanied by optimistic justifications, even if such justifications are not always practically helpful in teaching situations (McGarr et al., 2021). For example, curricular justifications, such as enhancing employability and improving education through an ICT agenda, may be too general to support teachers to know how to adapt their teaching practices appropriately (Mertala, 2020; Sancho-Gil et al., 2020). Other justifications, such as those found in the Norwegian mathematics curriculum, could be seen as more specific. For instance, in the 2006 curriculum digital tools could be used to support students "to learn through games, exploration, visualization and presentation" (NDET, 2006, p. 4). Nevertheless, school curricular reforms rarely provide insights into the potential changes needed at the teacher education level, contributing to the complexity of decision-making in teacher education (Parkes, 2013).

To match curricular changes, teacher education institutions need to adjust their courses to ensure that PTs gain experiences with ICT in schools. Ndlovu et al. (2020) suggested that teacher education curricula should include, as early as possible, a variety of digital tools such as GeoGebra and online video-sharing platforms. It was shown that PTs needed experiences with the use of ICT tools for teaching

mathematics, regardless of whether they were already familiar with them in other contexts or were being introduced to new ones during their teacher education (Ndlovu et al., 2020).

Thus, the decisions made at the teacher education level about what resources to make available to PTs would affect their meaning-making about ICT. The experiences, such as programming with robots (Alqahtani et al., 2022) or storytelling digitally (Istenic Starčič et al., 2016), were shown to impact PTs' understandings of teaching mathematics. Even when being provided with experiences with digital tools during their teacher education, PTs still needed to learn how to choose and evaluate critically digital tools from the resources available for teachers (Caniglia & Meadows, 2018).

For Bernstein and Díaz (1985), discourses provided insights into how meaning was shaped in educative institutions, as they are produced and reproduced within a social network of practice, tied to demands of the social order. Therefore, PTs' meaning-making about ICT integration would be shaped within what Valero (2010) described as "a network of social practices." This network would include different stakeholders such as policymakers, teacher educators, and others who affect the field of mathematics education.

One discourse that has become evident within the network of social practices associated with the integration of ICT into mathematics education is that of the techno-positive discourse. This discourse is characterised by the use of the language of certainty in asserting ICT's positive impact on education, with limited discussion of alternative outcomes (Mertala, 2021; Selwyn, 2015). The idea that ICT is a universal good can be considered part of a policy-driven techno-positive discourse, which has been connected to computer industry needs rather than what is needed in local teaching contexts (McGarr et al., 2021). Nevertheless, this discourse was identified as being evident in policymaking demands in Norway, Ireland, and Spain (McGarr et al., 2021). In Norway, teachers were required to develop digital skills in all school subjects (NDET, 2006). Learning through games was included in the curriculum as an approach for integrating ICT into mathematics teaching. The reform was justified by the need for students to develop digital skills as well as changing and expanding school subject content and teaching practices (Kelentrić et al., 2017). The development of policies such as these, which require teachers to have digital competence, provides evidence of a government-driven, techno-positive discourse (McGarr et al., 2021).

The prevalence of the techno-positive discourse has begun to be critiqued, particularly in relation to the resources that are made available for teaching situations by policymakers (e.g., McGarr et al., 2021), teacher educators (e.g., Thorvaldsen & Madsen, 2020), and school administrators (e.g., Mertala, 2020). Adopting a techno-positive discourse may limit the problematisation of challenges in teaching mathematics, which is required if local needs are to be met through responsive instruction (Darragh, 2021) and professional learning of PTs is to take place. A similar discourse labeled by Mertala (2021) as "Ed-Tech speak" was found in empirical research articles, suggesting that it was pervasive within the network of social practices to do with educational research. A similar critique was also raised about the adoption of this discourse as it was also considered to reduce possibilities for examining critically ICT integration (Selwyn, 2015), leaving little room to discuss the complexity of education through ICT (Mertala, 2021).

The techno-positive discourse within curricula is often implicitly connected to a need for educational transformation (Chronaki & Matos, 2014). For teachers, the wish to facilitate educational transformation is reinforced by regular curriculum updates demanding further ICT integration (Singh-Pillay & Samuel, 2017).

## Theoretical Framework

To analyse PTs' meaning-making about ICT integration, Bernstein's (2000) description of recontextualising has been used. This choice represents a change of paradigm from what has been common in research on the struggle of transforming teaching through ICT. According to Rice (2021), research on the lack of transformative teaching with ICT is often based on ideal and static models that measure teachers' technological competence and use, such as the Technological Pedagogical Content Knowledge model (Mishra & Koehler, 2006) and the Substitution, Augmentation, Modification, and

Redefinition model (Puentedura, 2013). These models, however, focus on the ideal of integration, providing a narrow understanding of teachers' choices and contributions to the types of transformations needed in their local and dynamic circumstances (Rice, 2021). The Professional Digital Competence Framework for Teachers in Norway is another example of a model that can lead to deficit perspectives by focusing on what teachers should have (Straume Bussesund et al., 2023) rather than how the circumstances in which they operate affect their opportunities for implementing different practices. Such models can reinforce deficit perspectives about mathematics teachers rather than supporting understandings of PTs' meaning-making within a social network of practices.

Bernstein's (2000) recontextualising of discourses can provides insights into PTs' meaning-making about ICT integration that illustrate how the contextual dynamics affect the possibilities for utilising different practices. This can make it possible to understand whether a potential meaning of transforming mathematics teaching through ICT integration is realised or not by PTs and why. Bernstein described recontextualising as rules that explain the adaptation and adoption of discourses from official curricula to local teaching contexts. For example, Parker and Adler (2014) used recontextualising to describe the difference between what was taught in teacher education and neophyte teachers' practices in schools:

> The "gap" between what is taught in a program for prospective teachers and the practice adopted by teachers in their first year of teaching is not simply a function of teacher beliefs on the one hand, or constraints in schools on the other. The gap is explained through the principle of recontextualization. (p. 206)

Bernstein (2000) highlighted that in recontextualising a discourse for pedagogical purposes a new one was generated. The recontextualised discourse is similar, but not identical to the original discourse as it has been adapted to suit the new context and, in so doing, is put in relation to other discourses. The recontextualised discourse, seemingly in line with original discourses, is then used to justify pedagogical choices. He described the recontextualising of discourse as occurring through two principles: de-location and re-location. De-location is about the selective appropriation of discourses from fields of knowledge when deciding what can be appropriate to say or do within a particular context. Re-location is about incorporating the selected discourses into a recontextualised discourse. This principle describes how teachers make meaning of these discourses. This contributes to them making pedagogical choices that they can justify as socially legitimate, resulting in more or less significance being given to some classroom activities (Bernstein, 2000).

Lerman and Zevenbergen's (2007), for example, researched the implementation of interactive whiteboards (IWBs) and documented how teachers' pedagogical choices were linked to the expectations raised by national curricula and the producers of ICT tools or materials for education. The teachers justified ICT integration, in this case, IWB integration, using terms such as "motivation," "fast-paced," and "time-saving," which could be found in discourses from the official curricula, although not specifically about mathematics teaching. Using Bernstein's (2000) terminology, the teachers had recontextualised the discourse about transforming mathematics into a discourse about enhancing students' motivation, which reduced teachers' attention to mathematics teaching. Similarly, Darragh's (2021) research about the discourses in the commercialisation of digital tools for mathematical instruction showed that the role of motivation could also be identified as a recontextualised discourse by producers of digital tools about the transformation of mathematics teaching, which could impact what mathematics teachers value about integrating ICT.

Identifying the operation of the recontextualising principles could provide a more nuanced explanation of why such a discourse gained predominance. Therefore, the research question for this study is:

> *What discourses on ICT integration are recontextualised by PTs in their assignments about their mathematics teaching practicum experiences within teacher education*?

# Methodology

To identify the discourses being recontextualised, Critical Discourse Analysis (CDA) (Chouliaraki & Fairclough, 1999) was used as it provided a way to understand how PTs' meaning-making occurred within a social network of practices. CDA allows for the identification of ICT discourses in institutional contexts (Selwyn, 2015), in this case, of PTs in their meaning-making within teacher education. Fairclough (2013) argued that meaning-making can be identified in how justifications are configured within the social practices where spoken or written texts are produced. This is in alignment with Bernstein (2000), who described meaning as being socially constructed within education institutions, with the identification of recontextualisations as providing understandings about the predominant discourse appropriated within those institutions.

CDA provides procedures for locating the recontextualised discourses, through identifying how language, in particular social events (those that take place in institutions as part of regular activities), aligns with expectations about how language would provide meaning in these events (Chouliaraki & Fairclough, 1999). In this study, the group assignments represented a particular social event in teacher education.

## *Data Collection*

To identify how discourses about ICT integration were recontextualised within the social event of mathematics teacher education, PTs' group practicum assignments as well as other resources that were available to them, such as the national curriculum (NDET, 2006), the assignment description (see Appendix A), and the course literature, were collected. The producers' descriptions of the digital tools chosen by PTs and literature found by PTs were also collected. This is because PTs used such tools and literature in their assignments for teacher education. The wider social event was the five-year Master of Education degree that all teachers in Norway must complete. To become teachers for Grades 1-7, PTs must take two mandatory mathematics courses, one in the second semester of the first year and the second in the first semester of the second year. In the first semester of the first year, the PTs had completed a pedagogy course and a practicum.

In the first mathematics education course, "Beginner Education in Mathematics," the PTs were expected to learn about the affordances and constraints of using multiple digital tools in teaching mathematics. The course literature included four ICT-related resources, two of which emphasised links between games and mathematics (Kluge & Dolonen, 2014; Spurkland, 2013) and two which discussed links between programming and mathematics (Lie et al., 2017; Nygård, 2018). The rest of the course literature was non-ICT-related articles and books on mathematics education.

The course included a 3-week practicum in groups in which they should try out teaching mathematics through ICT. Each group was placed in a school class, and the practicum teacher indicated which mathematical topic was to be covered. Before going to the schools, the PTs collaborated in the planning of their lessons and presented their ideas to their peers and a teacher educator for feedback. During the practicum, they were visited by the same teacher educator. At the end of the practicum, the groups presented their reflections about their implementation of the lesson in a workshop.

Simultaneously, the PTs worked together on a compulsory written assignment that needed to be passed in order for the PTs to attend the exam at the end of the semester. The PTs submitted the assignment after having implemented the activities in their practicum. In 3000 words, the PTs were asked to describe, explain, document their teaching, and analyse their implementation according to relevant theory from the course (see Appendix A). The PTs were also asked to discuss how their teaching plan with ICT allowed for variation, creativity, mathematical conversations, and learning. Therefore, analysing the assignments offered an opportunity to identify PTs' collective meaning-making as they participated in a common social event of teacher education, recontextualising the course materials in relation to their teaching experiences. It was common for the assignments to include subsections, such as introduction, theory, description of the teaching plan and implementation, analysis, discussion, and conclusions.

The data for this study were chosen from a diverse database, collected in a larger project[1] of which this study is part. The project's data comprised, among other things, data from regular mathematics teacher education events gathered to learn about what promotes and hinders preservice teachers in learning about various aspects of mathematics teacher education. Data from mandatory assignments about ICT were used to gain insight into PTs' meaning-making, which corresponded to the research topic and were suitable for CDA. Twelve PTs from one class consented to their group assignments being analysed. The PTs were informed that the assignments were going to be anonymised and not used until after the course had been completed. After the PTs received their final course grades, the written mandatory assignments were collected. This was an ethical consideration to ensure that the PTs did not perceive the agreement to use their assignments in the project as being linked to the assessment in the course. Table 1 provides an overview of the focus of each group's assignments.

Table 1.
*Overview of the Groups and Tasks*

| Group | Number of PTs | School grade | Mathematical content | Tools chosen as ICT by PTs | Description of tasks implemented with students |
|---|---|---|---|---|---|
| G1 | 4 | Grade 4 | Statistics | Google spreadsheet in Chromebook | After collecting data for a survey and creating bar charts manually, students set up tables and created different types of charts in a spreadsheet. |
| G2 | 3 | Grade 7 | Geometry | Google drawings and digital tasks in Chromebook | Students created geometric figures drawings. They then described them to a classmate who was supposed to replicate the drawing based on the description. Those who completed these activities were required to work on geometric tasks from matemania.no, a digital resource. |
| G3 | 5 | Grade 6 | Measurement | Smartboard and digital textbook tasks in computers | The students rotated through four different task stations. Two of them involved ICT. In one, students were split into two groups and played smartboard games. They competed to see who could get the correct answer the quickest. They were tasked with converting measurement units like grams to kilograms. In the other, they used computers to complete similar tasks from a digital textbook called Multi. |

## *Data Analysis*

The data analysis steps of CDA were used to identify PTs' recontextualised discourses about integrating ICT into mathematics teaching. The steps centred on the changes in the language employed within and across texts. Singling out these changes allowed for the identification and study of recontextualised discourses by examining the appropriation of meanings in relation to the context and the resources employed (Chouliaraki & Fairclough, 1999; Fairclough, 2013). To prepare for the data analysis, the assignments were read thoroughly. The focus was on excerpts about ICT. Those excerpts were related to other passages in the same text and across texts. Analysing them together made it possible to gain insights into PTs' meaning-making about ICT.

[1] The larger project this study was part of was *Learning about Teaching Argumentation for Critical Mathematics Education in Multilingual Classrooms* (LATACME). The project included various sub-groups, including one about ICT.

In the first step of CDA, the PTs' justifications for their pedagogical choices regarding ICT were located by searching for terms such as "because," "so that," "for that reason," "we wanted to," and "it can." CDA focuses on the justifications in relevant passages within the text and across other texts in order to identify recontextualisations. This gave insights into the appropriation of meanings and the resources that contribute to them (Chouliaraki & Fairclough, 1999). Six excerpts were identified as justifications that were related to ICT integration. One was found in the assignment from Group 1, one from Group 2, and four from Group 3. These excerpts were considered appropriate for unpacking the discourses that had been recontextualised by PTs and the resources that contributed to their meaning-making about integrating ICT into their mathematics teaching.

In the second step, key terms in PTs' justifications were identified, which indicated "why" they chose a specific digital tool or used it in a particular manner. In CDA, justifications provide insights into the values that are ascribed to a network of social practices, such as the meanings that are highlighted and how they are employed and contrasted (Fairclough, 2013). For example, "variation" was identified as a key term in an excerpt written by Group 2. In the excerpt, they stated, "We chose to do this [referring to integrating a digital tool] so that the students could see other ways in which geometry is used, and to give them some variation if they finished early". In this excerpt, PTs' agency, "we chose," with a justification introduced with "so that," about their reasons for integrating digital tools, indicated that the PTs valued "variation" in connection to integrating ICT. It was also an essential part of the process to locate the key terms in other interrelated texts, as each key term allowed me to identify what the PTs valued and relate it to what others in their network of practices valued, and so identify the original resources drawn upon in the recontextualising. For example, "variation" appeared in the guidelines for the mandatory assignment, and it seemed that the PTs had recontextualised the discourse about the importance of variation into their collective meaning-making.

The third step involved identifying where repetitions of key terms appeared within the text and across texts. The repetitions provided further insights into the meanings given to the key terms and their relation to the specific and wider context (Fairclough, 2013). Repetition occurred through linguistic variations, including its synonyms or antonyms. For example, "motivation" was identified as a key term in an excerpt from Group 1. Variations of the key term, such as "motivated," "motivating," "motivational," "demotivated," and "unmotivated," were found within the assignment, in the other assignments, in teacher education course literature cited by PTs, and in documents by the NDET (2006, 2019).

Identifying the variations within a text made it possible to locate related extracts, which were labeled "associated sentences." In the assignments, the associated sentences provided information about PTs' meaning-making in relation to the key terms. This information was compared to how the key terms were used in the original resources, such as the guidelines for the assignment, national curricula, and course literature. The latter was of special interest as references to academic literature about mathematics education were required in the assignment guidelines. Excerpts and associated sentences are included in the results, together with the page number and the section name from which they came. CDA requires clarity about where and in connection with what specific statements are provided by participants (Fairclough, 2013).

An example of the third step is from Group 1, who justified ICT integration as promoting motivation with more references to motivation in the associated sentences. The PTs wrote, "central to Illeris' model is the idea that one needs a driving force, a motivation, to acquire knowledge." This was an associated sentence because it did not serve as the PTs' justification for their pedagogical choices about integrating ICT. Rather, it provided background regarding the value of motivation, a key term that had been identified in their justification. The PTs rephrased Illeris' definition of motivation as "a driving force" for learning and described learning as "acquiring knowledge." This provided insights into the meaning that the PTs gave to motivation and one of the resources they had used, which may have contributed to their recontextualised discourse about integrating ICT.

The last step in the analysis involved comparing the discourses in the original resources and PTs' justifications. This was done to understand the recontextualisation process, and whether the potential of ICT in transforming the teaching of mathematics was realised or not by the PTs and why. This is in line with Bernstein (2000) who described recontextualising as the process in which discourses in official

documents change when interpreted by actors at different levels in the education system. CDA contributes to understanding the recontextualising process by locating changes of meaning between the original resource(s) and the recontextualised discourse. PTs' references to course literature and other resources indicated what the original discourses may have been. In the example of motivation from Group 1, there was an explicit reference to Illeris' (2012) model. The definition of motivation in that resource, and others when provided, were compared with how the PTs had referred to it in their assignment, providing insights into the recontextualising process.

## Results and Discussion

Regardless of the ICT tools and tasks chosen by the groups (see Table 1), the PTs' justifications for ICT integration focused mostly on a consideration of the generally positive impact of ICT for motivating students, with a secondary focus on how this would support them to learn mathematics. The assignments did not include explicit critical reflections about what could be transformed in their mathematics teaching as a result of integrating ICT. To support their justifications, the groups of PTs recontextualised three interconnected discourses, which I have labeled: the ICT-motivation discourse; the ICT-variation discourse; and the ICT-mathematical practice discourse. In the next subsections, I discuss each of the recontextualised discourses and their relationships to the course literature and other resources.

### *The ICT–motivation Discourse*

The ICT–motivation discourse appeared in the justifications for ICT integration in all three assignments. However, when referring to "motivation", the PTs often limited it to being about the students generally needing enjoyment to learn, which restricted the possibilities of discussing mathematics teaching more specifically.

An example, with an excerpt and three associated sentences, is provided from Group 1, which is representative of how the groups referred to this discourse. In the example, the PTs explicitly used points from two articles, one from the mathematics course literature and another from the previous semester's pedagogical course, to justify their interpretation about how ICT should or could be integrated into mathematics teaching:

> Excerpt: We wanted to trigger the schoolchildren's internal motivation by letting them explore mathematics with digital tools
>
> [p. 14 in a section called discussing teaching]

In the same section, motivation was connected to the course literature, but without a direct reference to ICT:

> Associated sentence 1: We wanted each student to experience that "he learns because he finds the subject matter important" (Mellin-Olsen, 1984, p. 41). Then it was important that we based the teaching on elements that could motivate the students to form such a basis of reason.
>
> [p. 14 in a section called discussing teaching]

In an earlier section of the assignment, the PTs had used the reference to Illeris (2012), described in the data analysis section, to argue that motivation is important:

> Associated sentence 2: Central to Illeris' model [referring to a previous quote from Illeris, 2012, p. 46] is the idea that one needs a driving force, a motivation, to acquire knowledge.
>
> [p. 5 in the theory section]

The PTs' also used quotes from the students in their class to make an implicit reference to motivation, by describing the students' enjoyment of a task which required them to use ICT:

> Associated sentence 3: There were several positive reactions after the classes such as "This was fun, can we do another survey?"

> [p. 12 in a section on students' activity and motivation]

In Example 1, motivation was linked to articles by Mellin-Olsen (1984) and Illeris (2012). The Mellin-Olsen (1984) reference was part of the mathematics course literature, although it did not refer to ICT integration. In this reference, the key term "motivation" is not used and no connections between motivation and ICT or mathematics were present. Motivation was, however, in the Illeris (2012) reference, which was part of the course literature for the earlier pedagogy course. Illeris described what is needed for schoolchildren to learn in general, describing motivation as a driving force. In another section of the book, 32 pages before the passage cited by the PTs, traditional classrooms are problematised, with the subject of mathematics being highlighted as being boring. The PTs did not explicitly relate motivation to transforming mathematics teaching with ICT. Instead, they implicitly problematised students' boredom by highlighting their enjoyment of the chosen activities, including also those not involving ICT, such as decorating graphs:

> Those who thought this was fun were more creative in their decorating methods and had generally developed a better understanding.
>
> [p. 12 in a section on students' activity and motivation]

Using digital tools was situated, through the discussion about motivation, as being a solution to the issues of boredom which negatively affects students' learning, rather than to do with transforming mathematics teaching. Motivation was de-located from a general pedagogical discourse on students' learning and re-located in connection to ICT integration into mathematics teaching. Lerman and Zevenbergen (2007) had found that teachers who focused on students' motivation to use technology, limited their possibilities for problematising and transforming their own mathematics teaching. This may also be the case with this group of PTs, as the references they used to justify their pedagogical choices had no explicit connections between the motivation provided by using ICT and mathematics teaching. Traditional mathematics teaching seemed only to be implicitly problematised in terms of it being boring.

## *The ICT–variation Discourse*

Another discourse, related to the motivation discourse, was the variation discourse. The key term "various" appeared frequently in the assignments of Groups 2 and 3, but in different forms. Various was a determiner (indicating more than one), an adjective (different kinds or sorts), a noun (variation, indicating a change), or a verb (to vary, indicating the action of changing). In the assignments, there were discussions of the value of various working methods, activities, mathematical topics, materials, and games. In the course assignments, "various" or "variation" was identified by the PTs as supporting them in promoting mathematical thinking through ICT. The PTs also referred to variation as a way to motivate students to engage with mathematical tasks.

Variation was described as particularly important for students who finished the set learning activities before their peers. The ICT–variation discourse seemed to be based on the assumption that some students needed to be occupied with multiple tasks to reduce their possibility of being bored. The following example includes an excerpt and two associated sentences and is typical of what was found in the assignments of Groups 2 and 3. A recontextualisation of discourses about variation from the descriptions on the websites for the digital tasks and the course assignment seemed to have been re-located into the PTs' justification of integrating ICT into mathematics teaching. ICT was situated as one of the ways to vary teaching. The PTs in Group 2 linked variation to how digital tools gave students choices about the tasks they could work on, but only for those who had finished the other set activities:

> Excerpt: When they [referring to the students] had finished explaining to each other, we had extra tasks on the website matemania.no. Here they could choose freely between tasks related to geometry. We chose to do this so that the students could see other ways in which geometry is used and to give them some variation if they finished early.
>
> [p. 8 in a section called ICT in the practicum]

Later in the assignment, the PTs related varying teaching to general pedagogy discourses on motivation and students wanting to learn.

> Associated sentence 1: Varying the teaching, which we have discussed before, can create motivation and desire to learn in the vast majority of students.
>
> [p.10 in the conclusions section]

Earlier, the PTs had described how requiring students to complete many similar calculations could lead to boredom, in contrast to motivating students with variation.

> Associated sentence 2: If the focus is on doing as many calculations as possible instead of how to vary the teaching, schoolchildren can find math to be boring.
>
> [p. 3 in the theory section]

Digital tools were positioned as a type of variation which was linked to a discourse on motivation, which could overcome the boredom of teaching mathematics by having students complete multiple tasks. Variation in teaching practices was also described on the website, *matemania.no* (https://matemania.no/) used by the PTs and in the description of the course assignment. On the website, schoolchildren, parents, and teachers have opportunities to navigate between "different" [in Norwegian, *forskjellige*] subjects and "various"[2] [in Norwegian, *ulike*] working methods and activities. As a key concept in PTs' meaning-making, variation was de-located from discourses on transforming boring mathematics teaching through ICT and was re-located into general pedagogical discussions about motivation.

The need for students to complete multiple tasks in a limited time was not questioned. Instead, the use of ICT promised the possibility of reducing the boredom associated with learning mathematics. Therefore, this recontextualisation parallels the ICT-motivation discourse in that rather than transforming mathematics teaching, ICT is considered a way to overcome students' expected experiences of finding mathematics boring.

The PTs' recontextualisation of the ICT–variation discourse is similar to what Skovsmose (2001) had raised as a concern that of technology simply resulting in an adaptation of traditional approaches. As Player-Koro (2012) indicated, when ICT integration is framed as a techno-positive discourse, traditional discourses about how to teach mathematics can remain unquestioned. The assignments provided some evidence of the techno-positive discourse being recontextualised by PTs and presented as a valid argument for justifying their mathematics teaching to their teacher educators in their compulsory assignments.

## *The ICT–mathematical Practice Discourse*

The third discourse was a recontextualised discourse about mathematics learning being about practice. The PTs de-located discourses about practicing, playing, and mastering, from references to the official curriculum from literature and a document from the NDET (2019), both found by them. The PTs re-located such discourses into one in which ICT supported possibilities for competition that would contribute to mathematics learning through practice with multiple exercises. This was labeled as the ICT–mathematical practice discourse. Using this discourse allowed the PTs to emphasise the need for a more playful way to complete exercises and so it connected to the ICT-motivation and ICT-variation discourses. Although only found in Group 3's assignment, the suggestion that it was related to the other two discourses may indicate that others may have held similar views, but the choice of ICT tools meant that it did not appear in their assignments. In recontextualising discourses about ICT integration, the

[2] The Norwegian word "ulike" could also be translated as "different". However, "various" was chosen as the most meaningful translation because in the original resource there were two words, namely "forskjellige", here translated as "different", and "ulike", here translated as "various". Such a choice is not problematic since the nouns of such words (variation, difference, and variety) were identified as synonyms.

PTs made meaning from recontextualising multiple discourses to focus on students' positive experiences and having fun in mathematics.

In the assignment, Group 3 described how they set up several stations for students to rotate around during the lesson. In the first excerpt, they described the station where students were expected to play with digital games related to measurement:

> Excerpt 1: At this station, the students should play mathematics games [Norwegian: matteleker[3]] on a smartboard. First, we split the groups in two so that they could compete against each other. The first game was to find the two units of weight that belonged together, such as 1000 grams and 1 kg. They were given six such boxes on each level and were to find three pairs that belonged together. They got a score for how many they got right. The students were given two minutes per group to get the highest score possible.
>
> [p. 5 in a section called practicum work at the smartboard]

Later in the assignment, the PTs described the students' reactions to playing these games and how they saw this as facilitating students' willingness to engage and consequently their possibilities to learn.

> Excerpt 2: Several of the students got into competition mode and concentrated on completing it. The fact that there is variation in the teaching can make the students more engaged, while at the same time giving them more opportunities to feel mastery, and maybe some got something out of one station but not another. Students provided feedback ranging from "this was a blast" to "this was too easy".
>
> [p. 7–8 in the discussion section]

The PTs gave more details about how they saw the relationship between mastery and variation with which they made meaning of digital tools for playing games, as well as provided insights about what might have influenced these understandings:

> Associated sentences: Our goal was to create a program that had variety, where we wanted to focus on practical and theoretical teaching. This is what it says in The Norwegian Directorate for Education and Training (n.d.), that students are motivated by feeling mastery. In order for the student to feel mastery, they must be given room to develop and try to achieve the common goal of several different activities. While the learning activities should facilitate mastery for all students (The Norwegian Directorate for Education and Training, n.d.), we did not want students to just work on tasks in the book.
>
> [p. 7 in the discussion section]

The PTs had also provided information about the importance of digital competency in relation to learning and mastering:

> Associated sentences: digital competence is one of the basic skills to be integrated into all subjects at all levels of primary school (Holm, 2012 p. 114). Digital competence is defined as skills, knowledge, creativity and attitudes that everyone needs to be able to use digital media, this is important for learning and mastering (Holm, 2016).
>
> [pp. 2–3 in the theory section]

In Group 3's assignment, practicing, which they arranged in the form of a playful competition using digital games and tasks from a digital textbook called Multi (see Table 1), was linked to a resource by the NDET (n.d.), as well as a text by Holm (2012), mentioned in the associated sentences. The Multi website (Gyldendal Norsk Forlag, n.d.) used by PTs, the curriculum of mathematics (NDET, 2006), and the course literature can also be linked to their understandings about integrating ICT. Although the Holm (2012) reference was not part of the mathematics course literature, it stated that ICT should be integrated in the form of play and different games [Norwegian, *lek-og spill*], in different subjects as part of the Norwegian curricular guidelines. In the description of the web-based tasks (Gyldendal Norsk

[3] PTs refer to "leker" which closely relates in English to "play", but in this context the word "games" is closer to the PTs' meaning.

Forlag, n.d.), games were also highlighted as possibilities for connecting mathematics to ICT. These games were described as supporting practicing and completing many similar exercises (in Norwegian øving og mengdetrening) in mathematics, and in alignment with the national curricula. The competitions were part of a textbook package that included both digital and non-digital materials. In the reference to The Norwegian Directorate for Education and Training (n.d.), neither ICT nor mathematics were mentioned. The PTs referred to the reference in relationship to the motivation and the working conditions students needed in general, highlighting the need for mastering and variation of working methods. The ICT–mathematical practice discourse which highlighted playing games and having fun aligns to statements in the national curriculum (The Norwegian Directorate for Education and Training, 2006), such as learning mathematics through games, which was given as an example of using digital tools in mathematics. Similarly, in the course literature, "games" were linked to ICT integration into mathematics, indicating PTs recontextualised discourse on ICT aligned with other discourses from the social network of practices, emphasising ICT as positively linked to playing games.

The PTs' reflections on integrating ICT into mathematics teaching on practicum did not result in them considering how to challenge aspects of traditional teaching, as described by Skovsmose (2001). Instead, they valued students completing many exercises that required one correct answer and were formulated by external authorities. The students were stratified by their ability to, in this case, solve multiple exercises quickly and correctly to win a game. Mathematics teaching was not problematised beyond needing to overcome students being bored. Consequently, the PTs seemed to recontextualise the discourse about ICT transforming mathematics teaching into discourses about overcoming boredom and motivating students through having them engage in competitions and games where they practice mathematics. In this way, the PTs aligned their practices to traditional mathematics teaching and fixed the problem of student engagement with mathematics by providing digital games which supported them to practice their mathematical knowledge and skills in a fun way.

## Conclusion

In much of the previous research (e.g., Perienen, 2020; Thurm et al., 2022), the reasons why ICT integration did not achieve expected transformations of mathematics teaching were linked to a lack of competencies, knowledge, and beliefs. Recently, these explanations have been critiqued as simplistic, reinforcing deficit perspectives about those who teach (Straume Bussesund et al., 2023). By using Bernstein's (2000) concept of recontextualising, this study provides a more nuanced explanation by analysing PTs' collective meaning-making through recontextualising official discourses into compulsory assignments.

The analysis highlighted three discourses that arose from the recontextualising process: motivation, variation, and mathematical practice. These discourses allowed the PTs, across the groups and regardless of the digital tools, to highlight the importance of students having fun, by problematising boredom as reducing possibilities for learning. The PTs then justified the use of ICT as providing more appealing tasks. Focusing on student learning in this way mitigated the need to critically reflect on issues related to their mathematics teaching, which could need transformation. The PTs seemed to recontextualise the discourses about the potential of ICT integration being transformative into ones that highlighted the need for students' boredom to be alleviated.

Although motivation and joy have been identified in previous research, such as Darragh's (2021) study on digital programs for mathematics and Lerman and Zevenbergen's (2007) study of teachers' justification for ICT integration, there had been no previous research on PTs' meaning-making about ICT integration. By showing how PTs made meaning from the different discourses as part of their teacher education, this study expands previous research by describing how some discourses gained prominence, connected to different resources, such as literature and curriculum documents.

Despite the assignment requiring PTs to engage with mathematics education literature, the PTs used only limited references and leaned heavily on general pedagogy references to justify their recontextualised discourses about ICT. This resulted in the PTs valuing fun and motivation. This may be because the PTs were very early in their teacher education program, and integrating ICT as a way of

transforming mathematics education requires more professional learning. However, the focus on integrating ICT as early as possible, promoted by research such as Ndlovu et al. (2020), was an institutional decision outside the control of mathematics teacher educators. Other kinds of solutions to support PTs to develop more nuanced understandings about integrating ICT into teaching mathematics may be needed. It is also possible that the PTs realised a more implicit expectation in and out of their teacher education of being positive about ICT integration, despite the explicit requirements of the assignment.

The fine-grained analysis of the assignments using CDA provided possibilities to illustrate how PTs' meaning-making drew on multiple references, from a wider network of social practices. Policy documents, teacher education resources, literature chosen by them, descriptions of digital programs for teaching, can all be linked to the PTs' recontextualisations. The techno-positive discourses in some of these resources seem to contribute to the recontextualising focusing on students' successful engagement with mathematics, rather than on transforming mathematics teaching.

It may also be that PTs' recontextualising was affected by other aspects, including the negotiation of their prior individual experiences with ICT, during their group decision-making as they were working on their assignments. Further research could contribute to an in-depth investigation into how other aspects may contribute to PTs' collective meaning-making.

The small sample size of 12 PTs in three groups at one institution in Norway means that further research is needed to see if the discourses —motivation, variation, and mathematical practice—appear in other PTs' justifications for integrating ICT into mathematics teaching. As well, the ongoing nature of the recontextualising process means that PTs will continue to make meaning about how ICT integration could transform mathematics teaching. A longitudinal study could identify changes in recontextualised discourses over the course of PTs' professional education and into their first years of teaching. It may also be that changes to the requirements in compulsory practicum assignments and the teacher education practices could result in different recontextualised discourses forming. Thus, future research could contribute to expanding understandings about the integration of ICT, taking into consideration institutional contexts and the resources available in the network of social practices.

CDA facilitated the identification of the discourses recontextualised by PTs in their assignments, as well as the resources that contributed to their meaning-making. This is helpful for deciding further steps in teacher education. Mathematics teacher education could pay further attention to resources, such as the literature provided to PTs. Resources in teacher education, such as literature about ICT emphasising links between games and mathematics, can be one aspect that resulted in PTs recontextualising discourses about motivation, variation, and practicing. PTs also made sense of curriculum documents and literature from other courses or documents they found, which also seem to have contributed to recontextualising such discourses. PTs may require resources that support them in identifying critical aspects of their mathematics teaching for professional growth. Literature focusing primarily on positive elements of ICT may have hindered PTs in raising critical perspectives and implied that ICT integration was expected to be primarily beneficial, as occurs in the dissemination of a techno-positive discourse. Such literature may also have facilitated the PTs' reliance on other discourses within their network of social practices, such as general pedagogy, rather than mathematics teacher education, to focus on fun as one of the positive aspects of ICT integration.

The results of this study align with Adler's (2012) recommendation that recontextualisation is beneficial for identifying the meanings available within mathematics teacher education institutions. The study illustrates that Bernstein's (2000) recontextualising rule, combined with CDA procedures of data analysis, provide insights into PTs' meaning-making about integrating ICT into mathematics teaching. Further research, however, is needed to understand fully other aspects that affect how PTs' meaning-making about ICT integration into their mathematics teaching in their teacher education, and how critical reflection about teaching mathematics can take place.

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## *Competing interests*

The author declares there are no competing interests.

# References

Adler, J. (2012). Knowledge resources in and for school mathematics teaching. In G. Gueudet, B. Pepin, & L. Trouche (Eds.), *From text to 'lived' resources: Mathematics curriculum materials and teacher development* (pp. 3–22). Springer. https://doi.org/10.1007/978-94-007-1966-8_1

Alqahtani, M. M., Hall, J. A., Leventhal, M., & Argila, A. N. (2022). Programming in mathematics classrooms: Changes in pre-service teachers' intentions to integrate robots in teaching. *Digital Experiences in Mathematics Education*, 1–29. https://doi.org/10.1007/s40751-021-00096-6

Bernstein, B. (2000). *Pedagogy, symbolic control, and identity: Theory, research, critique*. Rowman & Littlefield.

Bernstein, B., & Díaz, M. (1985). Hacia una teoría del discurso pedagógico [Towards a theory of pedagogic discourse]. *Revista Colombiana de Educación*, *15*(1). https://doi.org/10.17227/01203916.5120

Caniglia, J., & Meadows, M. (2018). Pre-service mathematics teachers' use of web resources. *International Journal for Technology in Mathematics Education*, *25*(3), 17–34. https://doi.org/10.1564/tme_v25.3.02

Chouliaraki, L., & Fairclough, N. (1999). *Discourse in late modernity: Rethinking critical discourse analysis*. Edinburgh University Press.

Chronaki, A., & Matos, A. (2014). Technology use and mathematics teaching: teacher change as discursive identity work. *Learning Media and Technology*, *39*(1), 107–125. https://doi.org/10.1080/17439884.2013.776076

Darragh, L. (2021). The promise of online mathematics instruction programmes: producing the mathematics learner and school mathematics. *Research in Mathematics Education*, *23*(3), 262–277. https://doi.org/10.1080/14794802.2021.1993977

Fairclough, N. (2013). *Critical discourse analysis: The critical study of language*. Routledge.

Gomez Marchant, C. N., Park, H., Zhuang, Y., Foste, J. K., & Conner, A. M. (2021). Theory to practice: Prospective mathematics teachers' recontextualizing discourses surrounding collective argumentation. *Journal of Mathematics Teacher Education*, *24*(6), 671–699. https://doi.org/10.1007/s10857-021-09500-9

Gyldendal Norsk Forlag. (n.d.). *Multi smart øving: et digitalt læremiddel for øving og mengdetrening i matematikk 1-7* [Multi smart practice: A digital teaching tool for practice and exercises in mathematics for grades 1-7]. https://www.gyldendal.no/grunnskole/matematikk/multi-smart-oving/

Holm, M. (2012). *Opplæring i matematikk* [Education in mathematics]. Cappelen Damm Akademisk.

Hwa, S. P. (2018). Pedagogical change in mathematics learning: Harnessing the power of digital game-based learning. *Journal of Educational Technology & Society*, *21*(4), 259–276. http://www.jstor.org/stable/26511553

Illeris, K. (2012). *Læring* [Learning]. Gyldendal akademisk.

Istenic Starčič, A., Cotic, M., Solomonides, I., & Volk, M. (2016). Engaging preservice primary and preprimary school teachers in digital storytelling for the teaching and learning of mathematics. *British Journal of Educational Technology*, *47*(1), 29–50. https://doi.org/10.1111/bjet.12253

Kelentrić, M., Helland, K., & Arstorp, A.-T. (2017). *Professional digital competence framework for teachers*. The Norwegian Centre for ICT in Education. https://digitallschools.com/wp-content/uploads/2022/12/framework.pdf

Kluge, A., & Dolonen, J. A. (2014). Algebra som spill [Algebra as game]. *Tangenten–tidsskrift for Matematikk i Grunnskolen*, *25*(3), 23–30. https://tangenten.no/wp-content/uploads/2021/12/tangenten-3-2014-nett.pdf

Lerman, S., & Zevenbergen, R. (2007). Interactive whiteboards as mediating tools for teaching mathematics: Rhetoric or reality? In J.-H. Woo, H.-C. Lew, K.-S. Park, & D.-Y. Seo (Eds.), *Proceedings of the 31st conference of the international group for the Psychology of Mathematics Education* (Vol. 3, pp. 169–176). The Korea Society of Educational Studies in Mathematics. The Republic of Korea and PME.

Lessani, A., Yunus, A., & Bakar, K. (2017). Comparison of new mathematics teaching methods with traditional method. *People: International Journal of Social Sciences*, *3*(2), 1285–1297. https://doi.org/10.20319/pijss.2017.32.12851297

Lie, J., Hauge, I., & Meaney, T. (2017). Computer programming in the lower secondary classroom: learning mathematics. *Italian Journal of Educational Technology*, *25*(2), 27–35. https://doi.org/10.17471/2499-4324/911

Luo, W., Berson, I. R., Berson, M. J., & Li, H. (2021). Are early childhood teachers ready for digital transformation of instruction in Mainland China? A systematic literature review. *Children and Youth Services Review*, *120*(105718), 1–15. https://doi.org/10.1016/j.childyouth.2020.105718

Marbán, J. M., & Mulenga, E. M. (2019). Pre-service primary teachers' teaching styles and attitudes towards the use of technology in mathematics classrooms. *International Electronic Journal of Mathematics Education*, *14*(2), 253–263. https://doi.org/10.29333/iejme/5649

McGarr, O., Mifsud, L., & Colomer Rubio, J. C. (2021). Digital competence in teacher education: comparing national policies in Norway, Ireland and Spain. *Learning, Media and Technology*, *46*(4), 483–497. https://doi.org/10.1080/17439884.2021.1913182

Melander Bowden, H., & Aarsand, P. (2020). Designing and assessing digital games in a classroom: an emerging culture of critique. *Learning, Media and Technology*, *45*(4), 376–394. https://doi.org/10.1080/17439884.2021.1913182

Mellin-Olsen, S. (1984). *Eleven, matematikken og samfunnet: en undervisningslære* [The student, the mathematics and society: A teaching theory]. NKI forlaget.

Mertala, P. (2020). Paradoxes of participation in the digitalization of education: a narrative account. *Learning, Media and Technology*, *45*(2), 179–192. https://doi.org/10.1080/17439884.2020.1696362

Mertala, P. (2021). "It is important at this point to make clear that this study is not 'anti-iPad"': Ed-Tech speak around iPads in educational technology research. *Learning, Media and Technology*, *46*(2), 230–242. https://doi.org/10.1080/17439884.2021.1868501

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: a framework for teacher knowledge. *Teachers college record*, *108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Montecino, A. (2018). *The fabrication of the mathematics teacher as neoliberal subject* [Dissertation, Aalborg University, Danmark]. https://vbn.aau.dk/en/publications/the-fabrication-of-the-mathematics-teacher-as-neoliberal-subject

Ndlovu, M., Ramdhany, V., Spangenberg, E. D., & Govender, R. (2020). Preservice teachers' beliefs and intentions about integrating mathematics teaching and learning ICTs in their classrooms. *ZDM Mathematics Education*, *52*(7), 1365–1380. https://doi.org/10.1007/s11858-020-01186-2

Norwegian Directorate for Education and Training. (2006). *Læreplan i matematikk fellesfag (MAT1-04) [Curriculum in mathematics joint subjects (MAT1-04)]*. https://www.udir.no/kl06/mat1-04

Norwegian Directorate for Education and Training. (2019). *Curriculum for mathematics year 1–10*. Retrieved from https://www.udir.no/lk20/mat01-05/om-faget/grunnleggende-ferdigheter?lang&lang=eng

Norwegian Directorate for Education and Training. (n.d.). *Motivasjon, arbeidsforhold og læring*. [The themes in the student survey: Motivation, working conditions and learning] https://www.udir.no/tall-og-forskning/brukerundersokelser/Om-temaene-i-Elevundersokelsen/Motivasjon/

Nygård, K. (2018). *Programmering i skolen. Hvordan komme i gang?* [Programming in school. How to get started?]. Pedlex.

Parker, D., & Adler, J. (2014). Sociological tools in the study of knowledge and practice in mathematics teacher education. *Educational Studies in Mathematics*, *87*, 203–219. https://doi.org/10.1007/s10649-012-9421-y

Parkes, R. J. (2013). Challenges for curriculum leadership in contemporary teacher education. *Australian Journal of Teacher Education*, *38*(7), 112–128. https://doi.org/10.14221/ajte.2013v38n7.8

Perienen, A. (2020). Frameworks for ICT integration in mathematics education-A teacher's perspective. *EURASIA Journal of Mathematics, Science and Technology Education*, *16*(6), 1–12. https://doi.org/10.29333/ejmste/7803

Player-Koro, C. (2012). *Reproducing traditional discourses of teaching and learning mathematics: Studies of mathematics and ICT in teaching and teacher education* [Dissertation, University of Gothenburg].

Puentedura, R. (2013). *SAMR: Getting to transformation*. Hippasus. http://www.hippasus.com/rrpweblog/archives/2013/04/16/SAMRGettingToTransformation.pdf

Remillard, J. T. (2005). Examining key concepts in research on teachers' use of mathematics curricula. *Review of Educational Research*, *75*(2), 211–246. https://doi.org/10.3102/00346543075002211

Rice, M. F. (2021). Reconceptualizing teacher professional learning about technology integration as intra-active entanglements. *Professional Development in Education*, *47*(2-3), 524–537. https://doi.org/10.1080/19415257.2021.1891953

Samuelsson, J. (2006). ICT as a change agent of mathematics teaching in Swedish secondary school. *Education and Information Technologies*, *11*, 71–81. https://doi.org/10.1007/s10639-005-5713-5

Sancho-Gil, J. M., Rivera-Vargas, P., & Miño-Puigcercós, R. (2020). Moving beyond the predictable failure of Ed-Tech initiatives. *Learning, Media and Technology*, *45*(1), 61–75. https://doi.org/10.1080/17439884.2019.1666873

Selwyn, N. (2015). The discursive construction of education in the digital age. In A. C. R. Jones, and C. Hafner (Ed.), *Discourse and digital practices. Doing discourse analysis in the digital Age* (pp. 226–240). Routledge.

Singh-Pillay, A., & Samuel, M. A. (2017). Life sciences teachers negotiating professional development agency in changing curriculum times. *EURASIA Journal of Mathematics, Science and Technology Education*, *13*(6), 1749–1763. https://doi.org/10.12973/eurasia.2017.00696a

Skovsmose, O. (2001). Landscapes of investigation. *Zentralblatt für Didaktik der Mathematik*, *33*, 123–132. https://doi.org/10.1007/BF02652747

Spurkland, S. (2013). Spillrevolusjonen er her–ta den i bruk [The gaming revolution is here – put it to use]. *Tangenten–tidsskrift for matematikkundervisning*, *2*, 17–20. https://tangenten.no/wp-content/uploads/2021/12/tangenten-2-2013-nett.pdf

Straume Bussesund, E., Engen, B. K., & McGarr, O. (2023). Digital compliance or professional competence? Representations of teachers and digital futures in the Norwegian Qualification Framework. *Learning, Media and Technology*, 1-14. https://doi.org/10.1080/17439884.2023.2285831

Thorvaldsen, S., & Madsen, S. S. (2020). Perspectives on the tensions in teaching with technology in Norwegian teacher education analysed using Argyris and Schon's theory of action. *Education and Information Technologies*, *25*(6), 5281–5299. https://doi.org/10.1007/s10639-020-10221-4

Thurm, D., Geraniou, E., & Jankvist, U. T. (2022). Preservice teachers' beliefs about mathematical digital competency-a" hidden variable" in teaching mathematics with digital technology? In *The 12th Congress of the European Society for Research in Mathematics Education (CERME12), Bolzano, Italy.* https://hal.science/hal-03747817v1/document

Valero, P. (2010). Mathematics education as a network of social practices. In V. Durand-Guerrier, Soury-Lavergne, S., & Arzarello, F. (Ed.), *Proceedings of the 6th Congress of the European Society for Research in Mathematics Education (CERME 6, January 28–February 1, 2009)* (pp. LIV–LXXX). Institut National De Recherche Pédagogique and ERME. https://ife.ens-lyon.fr/publications/edition-electronique/cerme6/plenary2-valero.pdf

# Appendix A: Assignment Guidelines

(Translated from Norwegian to English)

## MANDATORY ASSIGNMENT –Practicum task
## Course –Beginner education in mathematics

The work assignment is linked to the practice groups and includes several elements:

a, week 3 - 5; planning the teaching
b, week 5; presenting the plan to the class (see the course schedule)
c, week 6- 8; carry out all or parts of the teaching program during practicum
d, week 10; writing workshop with group response to first draft of the text
e, prepare a final academic text within the submission deadline.

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Content requirements:

- The content must be linked to the relevant reading list
- Literature is referred to in APA 6th style (see **www.sokogskriv.no**)

Formal requirements:

- Word limit: approx. 3000 words. Table of contents, bibliography, data material, title page and any appendices come in addition.
- Clear headings
- Names of the students in the group
- Typed in Calibri or Times New Roman
- Font size 12, line spacing 1.5
- Page number in the form X of Y as footer
- Delivered in docx format

Supervision:
There is one obligatory supervision per group. The group contacts the teacher to arrange the time.

### Investigative conversations with students in mathematics

This group assignment is a compulsory assignment that consists of two parts. First, you will make a teaching plan that includes the use of digital tools, and then you will write about it. The teaching should last for 2–5 hours, and it should facilitate mathematical investigative conversations related to students' understanding of numbers or the mathematical topic that you are teaching. Natural objectives are to use variation, creativity, and student activity to promote relational understanding of the topic you teach.

The focus must be on students' mathematical reasoning, not technical challenges with the digital tools. Emphasize how representations, questions, ideas, arguments, and justifications can propel conversations in a mathematically investigative and creative direction. Use course literature and experiences from the course actively in your preparation for the conversations.

Extracts from conversations should be documented (observations, notes, photos, student statements1) and analyzed in light of the assignment text and relevant mathematics education theory from the course. We ask you to focus on mathematical concepts and language.

The teaching plan should be described concretely, explain, and show the tasks and the activities, and clarify the mathematical content used. You should discuss how the teaching provides room for variation, creativity, and student activity and discuss the potential for mathematical conversations and learning. The teaching should, as far as possible, be carried out during the practicum.

The teaching plan will be presented in the last lesson of the course before the practicum. This presentation should be concrete, while at the same time having a clear mathematics education rationale. The presentation should also include an academic research question that the rest of the class is invited to discuss

The work requirement is linked to the practice groups. Each group writes a group contract which is delivered on Canvas before the practicum period (deadline: Sunday 03/03). The finished text will be included as part of the presentation at the oral exam in spring 2019.

**Assessment**: Pass/fail, with written feedback. In the event of failure, the group has one (1) new attempt to pass. *The work assignment must be passed in order to present the course exam.*

1 All data must be anonymized!