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Who's got the power? Unpacking three typologies of teacher practice in one-to-one computing classrooms in Finland

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ABSTRACT

This study explores teachers' practice and aims to understand the complexity of and the difference between teacher-centred teaching and student-centred learning in the one-to-one computing classroom. Generally, prior research has examined moving from teacher-centred teaching to student-centred learning. Here, we scrutinise one-to-one computing practices in Grades 1–6 in Finland by analysing how power and control emerge from the way teachers organise the physical classroom and communicate in practice. We target variations in practical classroom orchestration as well as in how teachers reason about their practice. A mixed-method analysis was conducted in two phases, including 15 classroom observations and subsequent teacher interviews. First, a quantitative analysis displayed three clusters of ways teachers distributed power and control in their classroom orchestration. Second, the clusters were integrated in a qualitative analysis of the interviews. The findings show that the variations of teacher practice depended on their beliefs and higher-order learning goals related student autonomy in the use of material resources. It also showed a variation in the way teachers scaffolded students' individual work and created collaborative learning opportunities. In the one-to-one computing classroom, this emerges from issues that teachers can control inside school regarding the use and organisation of material resources. However, another factor that made teachers adapt their practice was the integration of heterogeneous student groups into their classrooms.

1. Introduction

This study is part of a larger Nordic research project, including a series of sub-studies in Denmark, Sweden, and Finland, with a common research objective of examining teachers' practice in technology-rich classrooms (Jahnke, Bergström, Mårell-Olsson, Häll, & Kumar, 2017). The present study examines how teachers in Finland (grades 1–6) organised teaching and learning when each student had a personal computing device, referred to as one-to-one computing. This is considered a supplementary precondition, in addition to the arrangement of the classroom space, as it equips each student with a personal computing device with wireless internet connection (WiFi) (Hershkovitz & Arbelle, 2020), and cloud services for storing and retrieving information (Lim et al., 2015).

Previous research in the field of technology-enhanced learning (TEL) has included studies on teachers' decisions about the physical preconditions of how to organise the classroom space, as well as teachers' communication in practice. For example, Zandvliet and Fraser (2005) explored how both the physical environment (ergonomical aspects) and the psychosocial environment (e.g., student

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cohesiveness, involvement, autonomy) in technology-rich classrooms can impact teachers' practice, either enabling or constraining teaching methods. Another perspective was taken by [Dourish \(2006\)](#), who reflected on *space* as the geometrical arrangements that may constrain movements and interactions, as well as *place*, which informs us of how settings acquire social meaning in the course of interaction. This is similar to the two dimensions of teaching in the one-to-one computing classroom identified as teachers' enacted practice ([Bergström, 2019](#); [Bergström & Mårell-Olsson, 2018](#); [Bergström, Mårell-Olsson, & Jahnke, 2019](#)). Here, a vertical dimension concerns preconditions of the physical learning environment embodied through the arrangement of desks, use of teachers' and students' areas, relations between learning resources, and selection of software applications. A complementary horizontal dimension includes teachers' practice pertaining to their selection of content, sequence, pace, and speech space (cf. [Bernstein, 2000](#)).

The combination of different dimensions can be described as an "ecology of an emergent phenomenon" ([Carvalho & Yeoman, 2018](#)), which we use as an illustrative metaphor for teaching in a learning environment involving new physical preconditions. Historically, the move towards one-to-one computing in schools entailed a shift in the preconditions of the classroom ([Byers et al., 2018](#); [Melhuish & Falloon, 2010](#); [Zandvliet & Fraser, 2005](#)). The trend is to progress from having isolated computer labs to having one laptop or tablet per student. This change will inevitably impact teachers' practice (i.e., how they organise the classroom space and communicate to and with students in class), not seldom in terms of student-centred practices ([Powers & Musgrove, 2020](#)). Worth noting is the fact that historically teachers' practices in the Finnish context have been reported to lean towards a tradition of teacher-centred teaching ([Carlgren & Klette, 2008](#); [Sahlberg, 2007](#)). However, only a limited number of studies have considered the role of the physical preconditions of the classroom organisation in relation to teachers' practice in the one-to-one computing classroom. The aim of this study is to unpack emergent and varying practices in one-to-one computing classrooms with regard to the abovementioned vertical and horizontal dimensions. More specifically, we focus on the following research questions: 1) What variations in one-to-one computing practice emerge from teachers' organisation of the classroom space and communication in practice? 2) How can the teachers' reasoning further explain the variation of these emergent one-to-one computing practices?

2. Literature

The field of one-to-one computing research in K-12 education is reported worldwide ([Hershkovitz & Karni, 2018](#)) and covers more than 20 years of research. [Zheng et al. \(2016\)](#) and [Fleischer's \(2012\)](#) literature reviews provide a good overview of studies in the one-to-one computing classroom practice between the years 2001 and 2015. These studies indicate that most of the published research on one-to-one computing has been conducted in the USA. One major theme that spans the two literature reviews is one-to-one computing use in practice (e.g. note-taking, Internet search and gathering). Among the rich findings in [Zheng et al.'s \(2016\)](#) review covering the period 2001–2015, the theme *Teaching and learning processes* was found in 70 out of 96 articles. In this theme, [Zheng et al. \(2016\)](#) show that teachers within one-to-one computing classrooms attempt to shift from teacher-centred teaching to student-centred and project-based learning. Such methods can be understood as a catalyst for differentiated instruction where students can work more independently and with personal learning needs. The theme *Twenty-First-Century Skills* ([Zheng et al., 2016](#), p. 1072) indicate the innovative potential of the one-to-one computing environment for students' learning. Studies within this theme showed teaching practices where students used and trained collaborative learning skills for example by organising learning activities. Worth noting are findings that highlight how one-to-one computing are used in problem solving activities which can be linked to project-based learning methods. [Fleischer's \(2012\)](#) review scrutinised 18 articles within the 2006–2010 period and added, among other things, issues of professional culture, managing curricula, and the surrounding society. These themes are considered in terms of what Fleischer addresses as the *knowledge formation process* based on changed preconditions of one-to-one computing, for example through increased choices with internet-based content.

Within the 2016–2020 period, a great number of studies still draw attention to change, or transformation, of teachers' practice from teacher-centred teaching to student-centred learning ([Blikstad-Balas & Klette, 2020](#); [Hershkovitz & Arbelle, 2020](#); [Ceratto Pargman, 2019](#); [Byers et al., 2018](#); [Hershkovitz & Karni, 2018](#); [Prince, 2018](#); [Zhai et al., 2018](#); [Henderson-Rosser & Sauers, 2017](#); [Lu et al., 2017](#); [Lindsay, 2016](#)), but also studies on implementation and integration of one-to-one computing from a technical perspective (e.g. [Peterson & Schraber, 2017](#)), from teachers' perspective ([Kim et al., 2019](#); [Frazier et al., 2019](#); [Heath, 2017](#)), and students' perspective ([Stone, 2017](#)). Studies focus also on students' learning in one-to-one computing classrooms (e.g. [Kirkpatrick et al., 2018](#)). The strong discourse of transformation, or shift, from teacher-centred teaching to student-centred learning can be considered from both (1) preconditions of the physical learning environment and (2) teachers' practice. First, the materials of one-to-one computing are reported to restructure the traditional classroom space where schools from the previous century were not designed for student-centred learning practices ([Higgins & BuShell, 2019](#); [Merchant, 2017](#)). Among the many elements in a classroom space, is the use of Wireless Internet access (WiFi) pointed out as one restructuring element that expands the classroom space beyond the materiality's of walls, desks and buildings ([Higgins & BuShell, 2019](#)). Another restructuring element for teacher-centred teaching are new forms of content. Studies report how textbooks strong material position has been challenged in steps, first from textbooks in PDF-format and recently from collaborative digital textbooks (cDTB) ([Kempe & Grönlund, 2019](#); [Grönlund et al., 2018](#)). cDTBs are more platform like, due to possibilities of communication, feedback and sharing of materials.

Regarding the second, teachers' practice, highlight the teacher-centred teaching and student-centred learning perspectives. Teacher-centred practices in the one-to-one computing classroom report on a status quo condition where practices remain unchanged ([Blikstad-Balas & Klette, 2020](#); [Hershkovitz & Arbelle, 2020](#); [Tømte et al., 2020](#); [Ceratto Pargman, 2019](#); [Hershkovitz & Karni, 2018](#); [Zhai et al., 2018](#)). Reasons for unchanged practices embrace several components such as technical and bureaucratic barriers ([Heath, 2017](#)), barriers in the physical classroom space where teachers miss the potential of one-to-one computing ([Byers et al., 2018](#)) and a need for teachers' professional development in student-centred learning practices ([Doron & Spector-Levy, 2019](#); [Kim et al., 2019](#)).

However, research shows that the context for the student-centred learning practice is significant for its conceptualisation (Schweisfurth, 2015). Thus, student-centred learning can vary between contexts. Differentiated instruction is reported as one type of student-centred learning practice in the one-to-one computing classroom (Frazier et al., 2019; Hershkovitz & Karni, 2018), while in other studies, student-centred learning practices concern a re-definition of the current teacher-centred practice (Tømte et al., 2020). But what does a re-definition mean in a practice perspective? For teachers, research report that a re-definition is connected to teachers' use of control in practice where the control is either hold by the teacher through teacher-centred methods or dislocated to the students in attempts for student-centred learning (Doron & Spector-Levy, 2019; Lu et al., 2017). Thus, in radical terms student-centred learning has been expressed as teachers giving up their control (Doron & Spector-Levy, 2019), but can also increase the unpredictability in students learning (Bergström, 2019; Bergström, Mårell-Olsson, & Jahnke, 2019). In a meta-study covering 299 studies on student-centred learning, Bernard et al. (2019) highlight particularly how control was either retained by the teacher (e.g., when lecturing) or distributed to the students (e.g., when the teacher acts as a facilitator who clarifies and encourages). By targeting four specific categories—1) the teacher's role, 2) flexibility, 3) pace, and 4) adaptability—they found that control in communication shifts. The teachers' role spans from being authoritative to being an equal partner. Flexibility indicates to what extent the control is distributed from the teacher to the students in terms of how students are involved in course design, selecting study materials, and stating learning objectives. Pace indicates to what extent teachers or students control how fast a task should be carried through. Adaptability indicates degrees of manipulation of the learning environment, materials, and activities that make teaching practices more student-centred (Bernard et al., 2019, p. 1). We build on this approach by exploring, first, how power relations emerge in the organisation of one-to-one computing classrooms, and second, how control of communication occurs.

2.1. Theoretical framework

In the introduction, teaching was referred to as an ecology of an emergent phenomenon (Carvalho & Yeoman, 2018). Carvalho and Yeoman (2018) described the concept of emergent as a relationship between two or more elements, which affects the outcome of a possible action. Similarly, but from the sociology of teaching perspective, Bernstein (2000) reasoned about elements for power and control. Power and control are not static. Both power and control can change from one classroom, or teacher, to another. As described in the following, and illustrated in Table 1, Bernstein's operationalisation of power and control is used as a theoretical framework in the present study. This operationalisation is used to analyse emergent practices in the ecology of classroom organisation and communicative practice.

2.1.1. Classification: upon whom power is conferred

Bernstein's (2000) concept of classification (C) informs us about power relations between elements in a classroom. This indicates that the choices made in organising a classroom create different preconditions for symbolic power. A positive (C+) or negative (C-) classification value informs us about the relations between different categories of elements in a room (e.g., desks). A positive classification value indicates that the teacher holds power, whereas negative classification value indicates students' empowerment. Power will be revealed in any attempt to change the setting. This way of thinking about how relations can be understood between different categories informs us about whom power is conferred upon in the classroom space, which consequently impacts the communicative practice.

2.1.2. Framing: who controls what

Framing refers to the locus of control, or "who controls what" (Bernstein, 2000, p. 12). In a communicative classroom practice, Bernstein identified the following categories of framing: *selection of content*, *sequence*, *pacing*, *evaluation*, and the hierarchy in *teacher-student* communication. Framing (F) is a relative concept and, similarly to the concept of classification, valued as either positive (F+) or negative (F-). For instance, in the *selection of content* category, a positive framing value refer to the teacher making the decisions about what content will be learned. In contrast, a negative framing value is when the teacher allows students to make their own choices about content. Framing achieve, however, a less negative value if students choose from a list of topics preselected by the teacher.

Table 1
Categories and subcategories operationalising Bernstein's theory of power and control.

Theoretical concepts	Classification (Power)	Framing (Control)
Main categories	Classroom organisation	Communicative practice
Subcategories	<ul style="list-style-type: none"> – desks – whose space – inside and outside the classroom – learning resources – software applications – teacher-student – student-student 	<ul style="list-style-type: none"> – selection of content – sequence – pacing – evaluation – hierarchy in teacher-student communication

3. Method

This study was a mixed methods study, including several types of data collected to create a full picture of the complex practice involved in a classroom setting. These multiple types of data allowed both quantitative and qualitative analysis with opportunities for data comparison and integration during the analysis process (Johnson & Onwuegbuzie, 2004), which provided deeper insights into both how and why teachers made choices in their teaching. Thus, data integration was in line with the aims and research questions of this study (Bazeley & Kemp, 2012).

3.1. Selection, participants, and data collection

The selection was based on the Denscombe's principle of "particular characteristics" (Denscombe, 2010, p. 182). In this case, the one-to-one computing characteristic was considered in both the selection of schools and teachers. Hence, we asked primary school leaders where teachers and students had used one-to-one computing for at least 6 months. Based on this criterion, we were invited to four primary schools. Accordingly, participants were selected following a criteria-based selection process (Denscombe, 2010) where participating teachers should be recognised as users of one-to-one computing in their teaching. Informants were selected by the school principals, which could have somewhat biased the selection because we cannot underestimate the principals' influence in cases where teachers might have, for instance, been reluctant to participate. The informants, a heterogeneous group of teachers (nine females; six males), had between 2 and 30 years of work experience and ranged in age from 25 to 53. The data consisted of 15 classroom observations (grades 1–6) and transcripts from 15 subsequent teacher interviews. All data were collected during a 2-week period in 2016.

During the classroom observations, various types of data were collected: audio recordings, field notes, wide angled photographs of the classroom setting, and detailed photos of teachers' instructions and students' work. All teachers wore a microphone during the 45-min lessons, which resulted in 11 h and 15 min of audio recordings. Furthermore, semistructured teacher interviews were conducted after each classroom observation. The interview guide (appendix 1) was developed from our experience of interviewing 45 teachers in the greater Nordic research project. The classroom observations provided a common frame of reference for the subsequent interviews. These also enabled the identification of decisions and beliefs in teaching, which were discussed to explore teachers' motivations. The interviews focused on three themes: teachers' thoughts about the one-to-one computing initiative, teachers' planning, and teachers' beliefs about practice. Hattie (2009) emphasised the latter as an essential part of understanding teacher practice. The interview material amounted to 15 h of audio recordings. All audio recordings were transcribed verbatim. From the audio recordings of the classroom observations, only the teachers' communication was transcribed. The Finnish portions of the transcripts were translated into Swedish.

3.2. Analysis

The criterion for a mixed method study is that both quantitative and qualitative data are integrated during the analysis phase and before drawing conclusions (Bazeley, 2007; Johnson & Onwuegbuzie, 2004). Table 2 illustrates the data preparation and analysis steps carried out, which will be thoroughly described in the following.

3.2.1. Quantitative analysis

3.2.1.1. Data reduction. As illustrated in Table 2 and in the first column, the quantitative analysis began with reduction of the classroom observation data, which was achieved using a theory-driven coding process (Braun & Clark, 2006) where we first analysed the classroom organisation and then the communicative practice (Table 1). In the analysis of the classroom organisation, Table 3 shows the theory-based theme of *classification*, including the seven main categories and two subcategories (C+, C-) used for coding. For

Table 2

Mixed method analysis: Steps in data preparation and analysis.

Quantitative Analysis		Qualitative Analysis	
Observational data	Steps to prepare and analyse the data	Interview data	Steps to prepare and analyse the data
Data reduction	Transcription of audio recordings; theory-driven coding and categorisation based on the two theoretical concepts (classification and framing) and their subcategories	Data reduction	Data-driven thematic coding and categorisation
Interrater reliability check	Calculating interrater agreement of the two researchers' interpretations of coding in data reduction	Data comparison	Quantitative and qualitative data were compared
Data transformation	Summarising number of coded items per category per person; converting qualitative data into quantitative data for statistical analysis	Data integration	Interview coding was analysed in accordance with clusters found in the quantitative analysis
Data reduction	Reducing the number of coded items per category into mean values per teacher for each of the two theoretical concepts	Data display	Clusters and themes were organised in a matrix to display hierarchical themes
Data display	Plotting mean values in a matrix to visualise clusters		

Table 3
Classification categories of teachers' organisation of the classroom space.

Categories	C+	C-	Data source
1. Desks	From front to back: desks in straight lines, corridors From left to right: separation of students	From front to back: desks in groups, no clear path From left to right: affordances of student-student interaction	Photographs
2. Whose space	Use of the teacher's desk	The teacher sits among the students	Field notes, Photographs
3. Classroom – outside classroom	Students study only in the classroom	Students study both inside and outside the classroom	Field notes
4. Digital resources and other resources	The teacher separates textbooks and digital material	The teacher integrates digital material on the same basis as textbook material	Audio recordings, Field notes
5. Selection of software applications (apps)	Subject-specific apps are used in the majority of activities (e.g., a game in mathematics)	Generic apps are used in the majority of activities (e.g., apps for making films)	Audio recordings, Field notes
6. Teacher-student	The teacher's communication strongly monitors students	The teacher's communication is dialogical	Audio recordings
7. Student-student	Activities are organised as individual studies	Activities are organised as peer or group studies	Photographs, Field notes

instance, in the *desk* category, each case was coded based on how desks were arranged within the classroom and the way this placement either separated students or afforded them opportunities to interact freely. Table 3 also shows further descriptions of the coding variations within subcategories.

In the analysis of the communicative practice, Table 4 shows the theory-based theme of *framing*, but for the sake of brevity, only one of the main categories, *selection of content*, is depicted. The rest of the framing categories used for analysis are *sequence*, *spacing*, *evaluation*, and the hierarchical *teacher-student relationship*. The subcategories used for coding (F++, F+, F-, F--) involve a qualitative variation used for assessing and coding teachers' communication in class. This qualitative variation is shown in Table 4 in relation to illustrative excerpts.

3.2.1.2. Interrater reliability check. The analysis described above involved several steps of coding, categorizing, and typologizing each case of teachers' practice. Furthermore, it included all data gathered around the separate cases. Moreover, as the second step, a reliability check was conducted by calculating the inter-rater agreement of the authors using a coding sample from the classroom observations. The analysis showed a 93% interrater agreement and a Kappa value of 0.48 (Krippendorf, 2004).

3.3. Data transformation, data reduction, and data display

The aim of the quantitative analysis was to display the data (Johnson & Onwuegbuzie, 2004) by plotting each classroom observation in relation to the vertical and horizontal dimensions in a power and control matrix (Fig. 1; Bergström, 2019; Bergström, Mårell-Olsson, & Jahnke, 2019). Data display was achieved through data transformation, where qualitative data were converted into quantitative data for the purpose of statistical analysis, and then converted through data reduction based on the number of coded items per subcategory and person for both the *classification* and *framing* dimensions.

In the two-dimensional matrix, the vertical dimension shows the variation of power represented in the *classroom organisation* (see Table 1 for a description of the categories: *desk*, *whose space*, *inside and outside the classroom*, *learning resources*, *software applications*, *teacher-student*, and *student-student*). The variation illustrates either a teacher's power (C+) or how the teacher distributed power to the students (C-). Hence, the transformed data were plot into a matrix. For this, each of the seven categories was scored on a 2-point

Table 4
The first framing category, "Selection of content".

Range of variation	F++ (mostly teacher control)	F+ (some teacher control)	F- (some student control)	F-- (mostly student control)
Descriptions of variations within the subcategory selection of content (excerpts illustrating subcategories)	Teachers provide a fixed frame of mandatory content for the students. "Okay, take page 42. We go through the task, which was very difficult because both are in the same column". [ID14]	Teachers provide a fixed frame of mandatory content for the students, accepting students' suggestions. "In task 1, you must think on your own, in pairs or groups, which type of electronic communication is used most in your home. Do you use TV, radio, or mobile phone the most? Think about it and write the answer in Book Creator". [ID20]	Teachers provide different content to choose from without referring to priorities and ask students to select. "Yes, and if you want more information, you can find it on Wikipedia, for example. But then you must remember ... Did you remember to write source material at the end of the factual text? If the source is a book, for example, from the book you get information about the vegetation zones ...". [ID28]	Teachers ask students to suggest a selection (of content). "Yes, but you add your own slides. Ron has at least chosen one area that he should write about, so go and agree ...". [ID26]

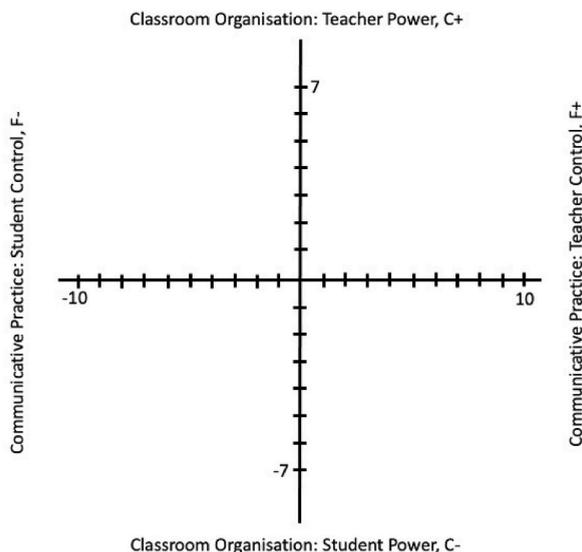


Fig. 1. The matrix of classification and framing.

scale, where C+ was given +1 and C- was given -1, providing a maximum of +7 and -7 on the vertical axis.

The horizontal dimension of the matrix shows the *communicative practice*, representing variation in how control in the teaching and learning practice was either maintained by the teacher (F+, F++) or distributed to the students (F-, F--). Framing, represents five categories: *selection of content, sequence, pace, evaluation, and teacher-student relationship* (see Table 4 for an example of the *selection of content* category). Similar to the data transformation described above, each of the five categories was scored on a 4-point scale, where F++ was given +2 and F-- was given -2, providing a maximum of +10 and -10 among the five framing categories on the horizontal axis.

Furthermore, to plot the cases within the matrix, the data had to be reduced (Johnson & Onwuegbuzie, 2004). Thus, the sum of the codes and mean values for each case were calculated. The objective was to find clusters of teacher practice cases. Each teacher's practice was plotted based on his or her summarised mean values in relation to both *classification* and *framing*. The matrix thus provides a visual summary and is the fifth step in Table 2 regarding data display of how the teachers organised their classroom and how they communicated in relation to Bernstein's theorizing about power and control.

3.3.1. Qualitative analysis

The second column in Table 2, shows the qualitative analysis on the interview data. The objective was to reach a new data display

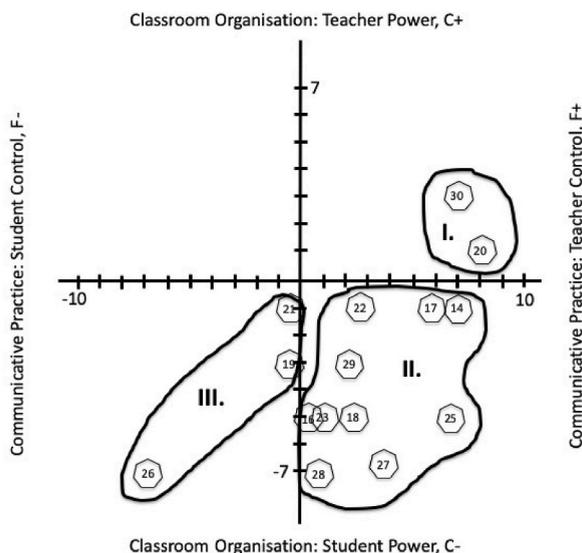


Fig. 2. Three clusters illustrating typologies of emergent teacher practice.

based on work with data reduction, data comparison and data integration. To reduce data, an explorative thematic analysis was conducted (Braun & Clark, 2006). The thematic analysis resulted into new insights, for example how teachers compared homogeneity and heterogeneity in student groups over time. Thereafter, quantitative, and qualitative data were compared and integrated based on how the teachers, in their explanations of their teaching practice, were corroborating clusters found in the quantitative analysis of the observational data. The qualitative analysis continued by clustering the teacher interviews in accordance with the placement of each case in the matrix (see Figs. 1 and 2). Thereafter, both within and between typologies in the matrix, the interview data were compared in search of contrastive thinking and episodes (Denscombe, 2010). The data was interpreted in terms of what the interviewee was explicitly or implicitly saying. From the units of text, an applied process of “seeing” was employed by identifying descriptive themes (Denscombe, 2010). Because the aim of this study was to unpack the emergent practices in the one-to-one computing classroom, the theory was again brought in through a process of “seeing as” by adding Bernstein’s theoretical raster on the descriptive themes (Denscombe, 2010). The construction of themes involved both what was observed in the classroom observations and how teachers talked about, and reflected upon, their practice. As illustrated in Table 5, a new data display was achieved.

4. Results

This first phase of analysis resulted in three clusters encircled in Fig. 2, which we refer to as typologies of emergent teacher practice. A typology is a classification of types of something according to common characteristics, which in this case refers to teacher practice in one-to-one computing classrooms. In the following, we first describe the emergent practices in each typology and how these are connected to Bernstein’s (2000) theory. Thereafter, we provide a deeper understanding of these three typologies by presenting how these compare to two overarching themes found in the teacher interviews.

4.1. Three typologies of emergent teacher practice

This section indicates the emergent practices based on the quantitative analysis of the observational data. The findings demonstrate teachers’ practice in three typologies of emergent teacher practice in one-to-one computing classrooms: I) teacher power and control, II) mixed distribution of power and control, and III) student power and control.

4.1.1. Typology I: teacher power and control

The first typology in Fig. 2, including two teachers, is defined by a strong distinction between a majority of the seven subcategories of the classroom organisation (cf. Bernstein) and strong teacher control in the five communication in practice subcategories. This indicates that the teacher maintains power and control through the classroom organisation (e.g., by having students work mainly individually and by controlling the communication regarding, for example, selection of content, sequence, and pace).

4.1.2. Typology II: mixed distribution of power and control

The second typology in Fig. 2, including 10 teachers, is defined through blurred distinction between a majority of the seven categories of classroom organisation and teacher control in the five communication in practice subcategories. This indicates that power is distributed from the teachers to the students (e.g., by using a mix of both tablet resources and textbooks). In these teachers’ communication, almost all teachers maintained control of sequence and pace.

4.1.3. Typology III: student power and control

The third typology in Fig. 2, including three teachers, is defined through a distribution of power and control to students. These three teacher practices, indicate a practice that reaches beyond the classroom, and where the communicative practice is based on students’ control through group work.

4.2. A deeper understanding of the variation of emergent practice

In the second phase of the analysis, two predominant themes emerged from the teacher interviews across the three typologies: 1) material resources and student autonomy and 2) students’ work organisation and collaboration. These themes were found to vary in terms of how teachers within the three typologies described their teaching practice, which is illustrated in Table 5 and further elaborated on in the following using interview excerpts to demonstrate the variations found.

Table 5
Overarching themes depicting variations of power and control in teacher practice.

	Theme 1: Material resources and student autonomy	Theme 2: Student work organisation and collaboration
Typology I: Teacher Power and Control	Material resources are used in a way that limits students’ autonomy	Practice that tends to direct students to work individually
Typology II: Mixed Power and Control	Strategically scaffolding students towards autonomy in using material resources	Strategically scaffolding students in heterogeneous group work
Typology III: Student Power and Control	Using material resources for student autonomy while the teacher is a guide on the side	Fostering collaborative practice to increase positive relationships and responsibility

4.2.1. Theme 1: how material resources are used with regard to student autonomy

Three variations were found regarding how teachers expressed their beliefs on this theme depending on which power and control typology they fell into. The more power and control the students received, the greater their autonomy in how they could use material resources.

4.2.1.1. Students' limited autonomy based on use of material resources. In Typology I, representing teacher power and control, the two teachers found gave limited autonomy to students with regard to how material resources were used. Although these teachers differed significantly in terms of work experience (30 years compared to 2 years), there were similarities in how they expressed their thoughts and beliefs about their teaching. Students' limited autonomy, based on the use of material resources, was observed in the frequent textbook use and expressed in the teacher interviews. These two teachers conveyed a strong belief in textbooks, which indicated strong borders between the use of tablets and other resources, as ID20 said, "the Bookcreator app (combine text, audio, images and video into e.g., a book) is also very common in my teaching it's just an electronic notebook". In class, both teachers followed the structure of the textbook chapters, as ID30 said,

"I have this book which we follow and should be by the curriculum, so that is my starting point. I used one exercise from the activity book, that is the first one which they did. [...] So I choose things they had to study during the lesson".

ID30's excerpt indicates the observed strong control in two framing categories regarding sequence and the selection of content. The teacher explicitly states that the teacher chooses the content.

Furthermore, ID20 was not as convinced about one-to-one computing as ID30, where ID20 argued that one-to-one computing could be replaced with a dolly of tablets for reservation since *he*, as a teacher, used tablets "1–3 times a day". ID30, however, spoke more in terms of *we*, here interpreted as referring to the teacher-student relationship when using the tablets. Even though ID30 asked for a more structured organisation of students, and possibly practice, students were observed to record audio on the tablet by moving from the desk to the back of the classroom and turning their face into a corner. Students were not allowed to go outside the classroom. The observed individual student activity of recording audio on the tablet to some extent contradicted the teacher's wish to keep students in line, which in Bernstein's terminology is an example of power being distributed through the activity of recording audio. Such an activity in this setting was interpreted as increasing student autonomy.

4.2.1.2. Strategically scaffolding students towards autonomy of using material resources. The second variation of Theme 1 in relation to Typology II showed that these teachers tended to strategically scaffold students towards autonomy of using material resources. Here, teachers chose a varying use of both analogue material and one-to-one computing in supporting students' own creation of content. For instance, when students used tablets to produce content, the teachers used software applications by which students could combine different media. As ID29 said, "I thought they can use [both] speech and photos [in the app Explain Everything (collaborative whiteboard platform)]". Furthermore, the use of audio was frequently commented upon, for example, in reading tasks for home assignments in the app ShowBie (used for communication and handing in and out of material). The assemblage of the tablets and other learning resources impacted the teacher-student relationship. As ID27, who has 20 years of teaching experience, said, "iPads have changed much of my work in the direction that it is the child who [does] much of the work, while I am more monitoring the direction". This change can be described as mixing the traditional with the new (i.e., one-to-one computing). One teacher, ID28, who had access to e-books and mixed both traditional books and tablet resources, said,

"When we have history and we study ancient Egypt, we can go to Google Maps and visit the pyramids and see what they look like nowadays. I like the idea that it is like a tool to work with it. Not ..., I don't like the e-books, you know, these are not so good yet. But I like to work with this as a tool".

This excerpt demonstrates how these teachers adopted, reasoned, and used the tablets in relation to other resources.

4.2.1.3. Using material resources for student autonomy with the teacher as a guide on the side. The third variation of Theme 1 in relation to Typology III showed that these teachers used material resources for student autonomy, while they themselves acted as a guide on the side. This was indicated through the distribution of control from the teacher to the students. During the observed lesson, ID26's students were involved in the task of producing a video on the tablet. Thus, many groups of students were observed crafting green screens with green paper at different locations in the school, often near the classroom. The teacher was observed circulating among students to obtain updates on their performance and obstacles. ID26 communicated how different resources were used (framing category *students' selection of content*). In the interviews, these teachers provided information on thematic work beyond the observed lesson. For instance, ID26 said,

"They started with the Google Docs document where they wrote up everything and gathered information from the schoolbooks and online. Say Wikipedia is the most popular [source]. I went through all the texts, so I'm pretty much up to date with what they have summarised, who has been writing and what. But they decide what they write and there are some guidelines that I told them that I want to see in their work".

The first section of the excerpt demonstrates the use of both tablet resources and textbooks. The last sentence indicates that the teacher gave students criteria. This can be understood as a frame for the task within which the students have the possibility to select sources. When students selected sources, the teachers observed from the side and intervened only when it was necessary, which indicates strong student power and control (Bernstein, 2000).

4.2.2. Theme 2: how student work is organised regarding collaboration

Within the second theme, three variations were found regarding how teachers expressed their beliefs on the theme depending on which power and control typology they fell into. The excerpts below illustrate the variation in teacher practice pertaining to how student work was organised with regard to strategies for guiding them towards collaboration and higher goals for working together.

4.2.2.1. Students working individually. The first variation of Theme 2 showed that teachers that fell into Typology I tended to give instructions that directed students to work individually. However, these two teachers' classroom organisations differed. ID30 had a majority of students in straight rows and a few in groups, whereas ID20 organised the students in groups based on the need to keep order among "active boys". ID20 said, "if you noticed there [was] one boy and three girls [...] so they can't see each other". Furthermore, ID30's classroom was long and narrow, which constrained how the teacher could organise the desks. ID30 said,

"it is a difficult shape of the classroom. I would like to allow them to sit like this, four kids in a row, not in groups because they can work in groups even though they are sitting like this, but they all face the blackboard at the front".

The classroom observations indicated individual work, which the teachers confirmed in the interview. ID20 said,

"I say to them that you can talk with the group if you want, when they were thinking on electronic communication [task in textbook] [...] [but] I think they just know the answers, so they didn't want to talk, they don't want to talk".

Accordingly, even if students were not separated in lines of desks, limited student-student interaction was observed, which the two teacher excerpts above indicate.

4.2.2.2. Strategically scaffolding students working in heterogeneous groups. The second variation in Theme 2 in relation to Typology II pertains to how students were scaffolded into working in heterogeneous student groups. This emerged from what teachers said they were doing in the observed lessons, as well as from longitudinal reflections on 20 years of experience. For instance, all teachers in Typology II organised student desks in groups. ID29 said, "We are sitting in groups from the 1st grade". Furthermore, almost all teachers assigned activities in which students worked together. When scrutinising the reasoning behind this practice, ID22, another teacher with 20 years of experience, described that "the greatest change in the classroom has been the integration of students with special needs". Various teachers handled this differently. One example was ID16, who crafted a flexible learning environment for students, where they could sit on the floor or in a cosy corner in the back of the classroom. They were also able to record audio outside the classroom. However, as ID16 said, "Routines are very important. You need to find routines for working, and I think it works quite well here, especially when we have many students with both cognitive and concentration disabilities". Despite the emphasis on routines, this shift from a homogeneous to a heterogeneous student group demonstrates blurred symbolic borders, where power was distributed from teacher to student.

Furthermore, ID28 emphasised the space students need for discussion and sharing: "When you have this project work, they have to have their own space to discuss with their peers what we are doing, what we have done, what we will be doing now. And they can do it". ID28 further said that students need to "learn teamwork". This indicates a blurred border of classification, and, implicitly, a belief that students need to learn strategies to work and study in their own space. In the classroom observation of ID27, a strong example of a teamwork methodology was demonstrated, as physics students made mind maps in group work. This was the teacher's approach to fostering students to be part of heterogeneous student groups, where tablets had a natural role. ID27 said,

"I talk a lot with them about teamwork and, therefore, it is always present, the iPad. It makes things easier and it encourages knowledge they will need as adults: to be able to take care of each other, to ask someone if they don't know, to be able to ask for help, to be able to collaborate with everyone, although they can be very different".

One action to handle both thematic studies and heterogeneous groups was teachers' control of pacing, where ID18 "fostered them in this process the whole year – for them learn to use their time. I find it most important". On the other hand, we saw that the tasks students accomplished on the tablets involved increased student control regarding selection of content (framing subcategory). ID23 said, "I had some idea, but I said that if they have other ideas they can use [them]". Thus, in thematic work, there can be both strong teacher control over pacing as well as student control in the selection of content. Another example of how teachers in this typology scaffolded students was ID18, who had developed a simple paper-based artefact called "the self-thinking machine". This artefact was built to work like a scale, on which students placed clothes pegs on the colours green, yellow, orange, or red, indicating their need for the teacher "to assess things, to show individual performance, [and] have I used my time efficiently?" (ID18). This scale was a method for the teacher to catch up with students who needed more support, which was helpful in a classroom including heterogeneous groups of students.

4.2.2.3. Fostering collaboration to increase positive relationships and responsibility. The third variation of Theme 2 in relation to teachers' beliefs in Typology III showed how teachers demonstrated higher goals in fostering student collaboration. Here, students working in groups was aimed at building positive relationships, facilitating student responsibility and autonomy. The three teachers in this typology expressed a strong belief in group work. ID26 started to use group work to decrease turbulence between students in the class:

"This class, I started with them when they were in 3rd grade and there was a lot of, if I say fighting, but they didn't come along too well. There were too many times that I had to spend a whole lesson on solving something some fights or bad words that had happened during the breaks, and then I thought that group work would be the best way to integrate the group [of students]

together, so that they can work with everybody, everyone with everybody. And so, there is almost some group work going all the time on something”.

In the excerpt above, ID26 emphasises the long-term effort of strengthening relationships in the classroom through continuous and strategic group work. Making such a shift changed the teaching practice fundamentally. ID26 said, “before, I told [them] everything from point A to point B and everything in between and they did some exercises only. Now I’m trying to involve them in the whole process”. However, group work and increased student control involves teachers being observant of the situation. As ID19 said,

“each desk is individually adjusted [for each student]. Thus, it is difficult to sit beside each other when one desk is taller than the other. So, they sit one and one, but they are quite free when working. You are allowed to be on the floor, sit with a friend. I have an idea of responsibility and freedom, and if you can handle the responsibility, you have the freedom”

This teacher noted the constraints imposed by the desk design, which made the teacher organise students individually. However, this did not limit students’ freedom to choose another place to work, as long as they acted responsibly. This seemed to be a mutual agreement between the teacher and the students. According to the interview, such design was explicitly or implicitly related to the teacher’s practice, where control was slightly or highly distributed to the students.

5. Discussion

In this article, we have examined emergent and varying practices of 15 teachers’ one-to-one computing practices in years 1–6 in four schools in Finland. Unpacking these practices was accomplished through quantitative and qualitative analysis of mixed data. First, the observations of the classroom practices were quantitatively analysed, resulting in three typologies of emergent practices (Carvalho & Yeoman, 2018) based on how power and control were either held by the teacher or distributed to the students. Second, these three typologies of teacher practice were verified by qualitative analysis of the teacher interviews. From the latter analysis, two overarching themes surfaced. These showed distinct variations across the three typologies, which further opened up the understanding of how power and control distribution in the classroom varies, and how new digital tools become part of this distribution.

5.1. Variations in emergent one-to-one computing practice

Regarding the first research question about variations in one-to-one computing practice emerging from teachers’ organisation of the classroom space and communication in practice, the three typologies in Fig. 2 provide answers. The three typologies range from teachers maintaining most of the power and control to teachers distributing power and control to the students. These typologies indicate the span of diverse practices reported in previous studies, ranging from one-to-one computing use in teacher-centred practices to student-centred learning practices (e.g. Blikstad-Balas & Klette, 2020; Ceratto Pargman, 2019; Doron & Spector-Levy, 2019; Fleischer, 2012; Hershkovitz & Karni, 2018). Similar to Bernard et al.’s (2019) findings on what make a practice either teacher-centred or student-centred, this study used Bernstein’s concepts for power and control to unpack variations in practice. In Bernstein’s (2000) terminology, any attempts to challenge the specialisation of a practice will lead to a destabilisation of the current practice, which we use to discuss how the variations in this study resulted in the practice remaining stable or destabilised the practice.

5.2. Teachers’ reasoning about emergent one-to-one computing practices

The second research question, regarding the teachers’ reasoning behind the emergent one-to-one computing practices, further contributes to unpacking the one-to-one computing classroom practices. The two overarching themes and variations in Table 4 contribute to answering the question of why teachers’ one-to-one computing practice fell into the three typologies. Typology I indicates a stable practice of teacher-centred teaching (Carlgrén & Klette, 2008; Sahlberg, 2007), because neither power nor control is distributed to the students. This further emphasises how these teachers’ beliefs and decisions about limited student autonomy and individual work contribute to their strong power and control in the one-to-one computing practice. These findings relate to a status quo where practice remain unchanged (Blikstad-Balas & Klette, 2020; Hershkovitz & Arbelle, 2020; Ceratto Pargman, 2019). These teachers use one-to-one computing for convenience issues (e.g. sharing documents), and misses thereby the potential of one-to-one computing in students learning (Byers et al., 2018).

In the second typology, ten emergent teacher practices showed a mixed distribution of power between teacher and students, which is interpreted as moderate destabilisation of teacher practice (Bernstein, 2000). However, these teachers still maintained control of the classroom communication. In the interviews, these teachers’ beliefs and decision-making regarding their teacher practice showed that strategic scaffolding was part of this new situation of destabilisation. For instance, the first subtheme showed that teachers strategically scaffold students towards autonomy through the use of material resources, which demonstrates the use of tablets for student-centred learning (Doron & Spector-Levy, 2019; Lu et al., 2017). Similarly, in Bernard et al.’s (2019) terminology, the shift from the first to the second typology involves manipulation of the learning environment from both the use of one-to-one computing and students’ organisation in groups. The destabilisation of practice based on the distribution of power creates a new precondition for knowledge formation (Fleischer, 2012). For example, the use of a mix of internet-based content and other resources (e.g. textbooks in PDF-format) (Kempe & Grönlund, 2019; Grönlund et al., 2018) increases unpredictability for students in their learning process (Bergström, Mårnell-Olsson, & Jahnke, 2019; Bergström, 2019; Higgins & BuShell, 2019). Furthermore, the second subtheme similarly showed that teachers in Typology II strategically scaffolded heterogeneous group work. Working in heterogeneous groups in the classroom contributed further to this destabilisation. This change of power, and thereby destabilisation, occurred because the traditional practice

was based on a specialisation of teaching homogeneous student groups. Teaching from the teacher's desk (homogeneous teaching to many students) becomes a challenge when teachers use differentiated teaching (Frazier et al., 2019; Hershkovitz & Karni, 2018; Zheng et al., 2016). This is based on the belief that it is more difficult to practice desk teaching for all when teachers also have integrated students with cognitive and concentration disabilities to take care of. Prior studies have discussed differentiated teaching (Frazier et al., 2019; Hershkovitz & Karni, 2018; Zheng et al., 2016), but not in the context of student groups becoming increasingly heterogeneous. This could explain the observed flexibility (Bernard et al., 2019), where teachers allow students to be involved in the selection of content, and where pacing is scaffolded through, for example, the use of simple artefacts to control both student and teacher. However, the latter is an example how the use of mixed control distribution becomes a scaffold that supports learners in becoming autonomous. In general, one-to-one computing and the heterogeneous student group, but also that teachers created a variation of learning spaces using simple means, indicate manipulation of the learning environment (Bernard et al., 2019), which showed increased destabilisation of practice in the second typology.

The third typology indicated the strongest destabilisation (Bernstein, 2000) of practice based on teachers distributing both power and control to the students. This demonstrates a move towards student-centred learning in the Finnish context (Schweisfurth, 2015). Such teaching was based on teachers' strategies of using material resources in a way that increased student autonomy, while they acted more as a guide on the side. It also demonstrates an emphasis on fostering positive relationships and increased autonomy through personal responsibility as higher-order goals for group work and student collaboration. Regarding the material use, one-to-one computing and, in this case, tablets, became an even more dynamic partner in students' learning, as well as influencing how the students manipulated the learning environment (Bernard et al., 2019). Thus, in the third quadrant, the practice indicates a redefinition of previous teacher-centred practices (Tømte et al., 2020). In the second typology, one major factor for the change in teacher practice was the heterogeneous student group. This was also evident in the interviews with the teachers represented in the third typology. However, their beliefs regarding their practice leaned more towards a discourse about students acquiring so-called 21st-century skills (Carvalho & Yeoman, 2018). Students in these practices were observed to be more active knowledge recipients, rather than passive receivers, as they were encouraged to construct knowledge through collaboration and critical thinking. Furthermore, when control was distributed to the students, they could negotiate with each other in the group. This also indicates destabilisation and redefinition in the traditional teacher and student roles (Bernard et al., 2019), as students were allowed to control more aspects of the practice. Too much freedom is not necessarily always constructive in a classroom setting. However, because these teachers acted as a guide on the side, they were still actively taking part in the students' learning processes.

6. Conclusion

The takeaway from this study is the importance of teachers' ability to adapt and use new tools for higher-order goals as well as to balance the preconditions with the needs of the students (e.g., by fostering and scaffolding them as they increase their responsibility and autonomy). "Who's got the power?" is perhaps not the right question to ask. Rather, we need to ask how power and control are balanced dialogically with students, in which prerequisites of tools being used are discussed in relation to abilities, needs, and a mutual understanding of higher-order goals of learning. We could see that the way tablets were used in the one-to-one computing classroom contributed to the destabilisation and redefinition of traditional teacher practice. However, the findings also highlight that teachers' beliefs are key to how they implement new digital tools in their classrooms. Disregarding classroom shape or access to modern applications, the teacher is still the key figure who influences the culture of power and control created in the classroom. Any preconditions can be used either for destabilising traditional power structures or for maintaining old ones. This study, although not aiming at generalizable results from a statistical perspective, reports a broad variety of teaching practices in the Finnish Grade 1–6 context. Earlier studies depicted Finnish teachers as having a tendency towards teacher-centred teaching. However, because only two out of the 15 teachers in this study were found in Typology I, the cluster pertaining to teacher-centred teaching, such arguments might need further consideration.

Credit author statement

Peter Bergström: Methodology, Investigation, Formal analysis, Writing Annika Wiklund-Engblom: Validation, Writing, Visualization

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Appendix A

Interview guide

Teacher ID:

Date of interview (day/time):

Location of the interview (city/school):

Before you start with the interview, report about the project:

- “Thank you very much for having us here. We want to study how media tablets are used in classrooms and to understand the teacher’s perspective.”
- “We would like to record the interview so that we can hear it again. Do you agree? Thanks.”

Turn on the recorder: two devices, one as backup.

Introduction.

- Year of birth
- Gender
- Years of teaching experience -Subjects
- Teacher exam year
- Other schools at which you worked
- Experience of a school without iPads

Thoughts about the one-to-one computing initiative

Tell us about the first “thought” you had when it was clear your school would implement iPads. What did you expect?

Teaching (planning, structuring, and carrying through the lesson with iPads)

Planning.

- Please describe your thought process when you plan a lesson in general.
 - o How did you plan the observed lesson?
- Please tell us about the lesson we observed. What parts of the following list would apply?
 - o Regarding the content, describe what you started from (e.g., textbook, internet-based content, or e-book)
 - o Lesson purpose and goals (criteria)
 - o Lesson structure: how activities were divided in the observed lesson
 - o Lesson outcome: did the outcome turn out as you expected (better/worse)?
 - o Furniture in the classroom: Tell us how you organised the furniture the classroom
 - o How often do students use iPads in your teaching?
- Please reflect upon your career as a teacher. Have you experienced any turning points (i.e., changes that have taken place)? Tell us about them.
- Please reflect on your practice in relation to the curriculum.

Structure.

- Tell us your reasoning about what you have to carry through as a teacher during a semester (textbook vs. curriculum, local and national)
 - o Can you refer to a typical episode?
 - o What guides the amount of content you need to cover in your teaching (content)?
- Please tell us whether you use any support for lesson planning and lesson design and structure
 - o Digital support (e.g., software with various resources from which to select)

Your teaching practice.

- Tell us about typical iPad activities in your practice.
- Tell us about the content students will produce. Do you know the outcome in advance?
- If you reflect upon possibilities in the practice when all students have an iPad, what can you then tell us about the teaching practice?
- Reflecting upon limitations in the practice when all students have an iPad, what can you then tell us about the teaching practice?

Teachers’ beliefs about practice.

- Can you tell us what is important in your teaching based on your starting point?
 - o Can you give us an example of how you teach based on what is important in your teaching?
 - o Can you tell us how much you work individually and in collaboration with others in your teaching?
- Can you tell us how you create challenges for your students?

- o Can you tell us how to make challenges suitable for students (e.g., when you plan and when you are in the classroom with students)?
- Are you using the iPad for this? If you use the iPad for this, can you give examples of when you used the iPad to create appropriate challenges for students?
 - Tell us about how you support the students when they learn. Is there collaboration between students? Tell us more.
 - What advice you would give to teachers who want to start using iPads in their teaching for them to be successful?

Final point.

- Based on the observed lesson and the topics we discussed during the interview, would you like to add information on something we may have overlooked?

Appendix B. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.compedu.2021.104396>.

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