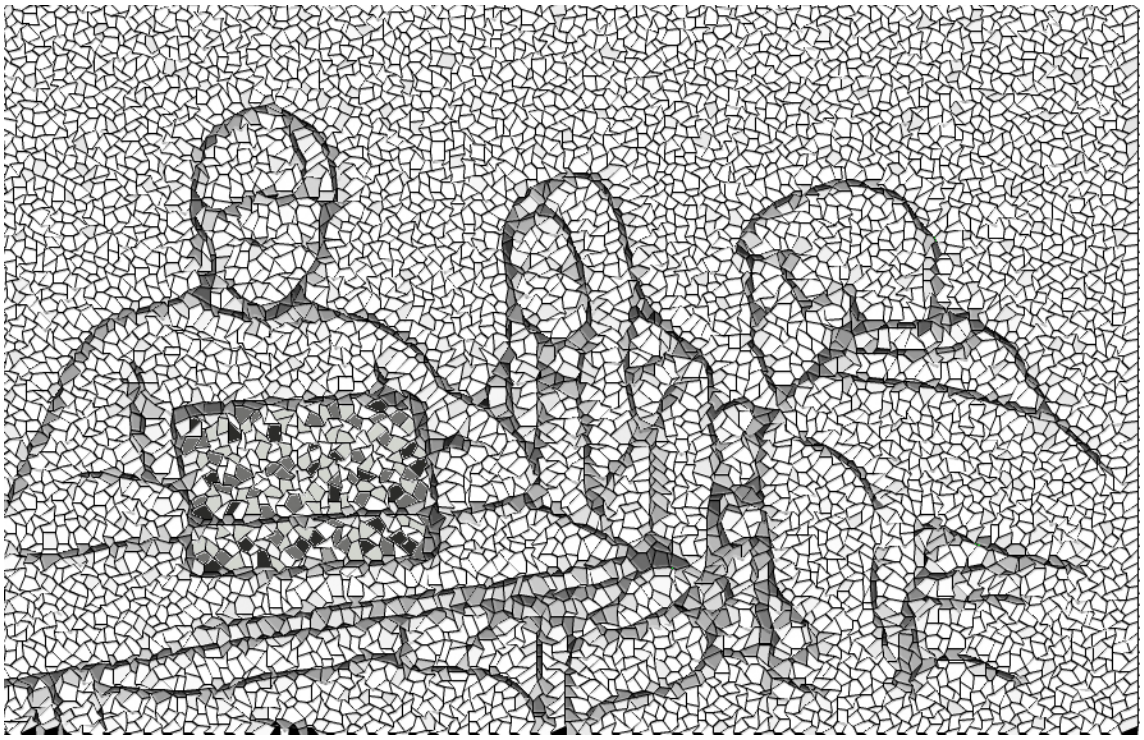
JYU DISSERTATIONS 820

Minttu Vänttinen

Resolving Trouble in Peer Interaction around Digital Technology

Multimodal Negotiations of Interactional Space in Face-to-Face and Hybrid Classrooms



UNIVERSITY OF JYVÄSKYLÄ
FACULTY OF HUMANITIES AND
SOCIAL SCIENCES

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in building Seminarium, old festival hall S212, on September 21, 2024, at 12 o'clock.

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ABSTRACT

Vänttinen, Minttu
Resolving trouble in peer interaction around digital technology: Multimodal negotiations of interactional space in face-to-face and hybrid classrooms
Jyväskylä: University of Jyväskylä, 2024, 133 p. + original articles
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Despite the ubiquitous role of technology in today's classrooms, we lack a comprehensive understanding of trouble resolutions around it. This dissertation shows how pupils resolve trouble in peer interactions around and via digital technology at Finnish comprehensive schools. It also sheds light on how (re)negotiations of interactional space, or space of mutual embodied orientation and attention, feature in trouble resolution processes. Drawing on multimodal conversation analysis and video data from English as a Foreign Language lessons, the study offers a multimodal, micro-level analysis of the verbal, embodied, material, and digital resources used to collaboratively resolve two types of trouble related to technology, tasks, and peer interaction. The first concerns asymmetric access to digital devices and to classroom interactions, which hinders beginning and participating in tasks and building shared interactional spaces. It is resolved by negotiating access to a device through multimodal resources such as body shifts or rearrangements of the material environment (Article I) and, in hybrid classrooms, by testing technological tools to contact a remote pupil (Article II). The second trouble type halts the progression of already ongoing tasks. In these cases, shifts of eye gaze are used as one of the first resources to indicate and resolve trouble with the progression of tasks and interactions (Article III), and varied embodied resources together with digital actions can be used to manage mistakes made by peers during shared tasks (Article IV). The study highlights trouble resolutions as complex multimodal achievements and offers new insights into classroom peer interactions around technology and into interactional space. It introduces the concept of *shared digital task space*, which refers to a layer of the local interactional space formed when a group of pupils work on a digital device. In addition, the dissertation has implications for pedagogical practice and technological development as it draws attention to the potential problematics of incorporating technology into classrooms.

Keywords: multimodal conversation analysis, classroom interaction, technology-rich classrooms, peer interaction, trouble resolutions, interactional space

TIIVISTELMÄ (ABSTRACT IN FINNISH)

Vänttinen, Minttu
Oppilaiden ongelmanratkaisu vertaisvuorovaikutuksessa digitaalisen teknologian äärellä: Vuorovaikutustilan multimodaalinen neuvottelu kasvokkaisissa ja hybrideissä oppimistilanteissa
Jyväskylä: Jyväskylän yliopisto, 2024, 133 s. + alkuperäiset artikkelit
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Vaikka teknologialla on keskeinen rooli nykyluokkahuoneissa, ymmärryksemme oppilaiden ongelmanratkaisusta sen äärellä on puutteellista. Tämä väitöskirja tarkastelee oppilasryhmien multimodaalista ongelmanratkaisua digitaalisen teknologian ympärillä ja välityksellä tapahtuvassa vuorovaikutuksessa suomalaisissa peruskouluissa. Se osoittaa, kuinka vuorovaikutustilan eli yhteisen kehollisen orientaation neuvottelu punoutuu osaksi ratkaisuprosessia. Tutkimus perustuu multimodaaliseen keskustelunanalyysiin ja englannin tunneilta kerättyyn videoaineistoon. Vuorovaikutuksen mikrotason analyysi keskittyy niihin verbaalisiin, kehollisiin, materiaalisiin ja digitaalisiin resursseihin, joiden avulla oppilaat yhdessä ratkovat kahdentyyppisiä teknologiaan, tehtäviin ja vuorovaikutukseen liittyviä ongelmia. Ensimmäinen ongelmatyyppi liittyy epätasa-arvoiseen pääsyyn laitteille ja luokkahuonevuorovaikutukseen. Se vaikeuttaa tehtävien aloittamista ja niihin osallistumista sekä vuorovaikutustilan rakentamista. Pääsyä laitteille neuvotellaan multimodaalisesti esimerkiksi kehonliikkein ja materiaalista ympäristöä järjestelemällä (Artikkeli I), ja hybridiopetuksessa yhteyttä etäoppilaaseen rakennetaan testaamalla teknologisia laitteita (Artikkeli II). Toinen ongelmatyyppi esiintyy jo aloitetun tehtävän keskeytyessä esimerkiksi laite- tai vuorovaikutuksen ongelman takia. Tällöin katsetta käytetään yhtenä ensimmäisistä resursseista osoittamaan ja ratkomaan ongelmia (Artikkeli III), ja kehollisia ja digitaalisia resursseja yhdistellään puututtaessa toisen tekemiin virheisiin yhteistehtävissä (Artikkeli IV). Tulokset tuovat esiin ongelmanratkaisun monitahoisen, multimodaalisen luonteen ja lisäävät ymmärrystä luokkahuoneen vertaisvuorovaikutuksesta. Tutkimuksessa esitelty uusi *jaetun digitaalisen tehtävätilan* käsite tarjoaa keinon kuvata vuorovaikutustilan kerroksisuutta ja oppilaiden jaettua orientaatiota teknologiaan. Väitöskirja osoittaa teknologian käytön mahdollisia ongelmakohtia luokkahuoneissa, joten tuloksia voidaan hyödyntää opetusmetodien ja -teknologian kehittämisessä.

Avainsanat: multimodaalinen keskustelunanalyysi, luokkahuonevuorovaikutus, teknologiarikasteiset luokkahuoneet, vertaisvuorovaikutus, ongelmanratkaisu, vuorovaikutustila

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In one of our staff meetings, Marko Siitonen, the current head of the Department of Language and Communication Studies at the University of Jyväskylä, shared an anecdote about a successful individual who had given advice on how people could change their lives for the better. This person had proclaimed that, to succeed, we should surround ourselves with people who lift us up. Marko proceeded to question this advice as it seemed quite individualistic and, frankly, opportunistic. Perhaps, he said, we should instead *be* people who lift others up, be the ones that bring out the best in those around us. While I have cherished this advice, I have recently realised that so many incredible people already do this quite naturally. People who help others achieve their goals and dreams, willingly share their expertise, and are the first to celebrate others' success and to reassure them during hardships. In the following paragraphs I would like to acknowledge some of them.

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Niemisjärvi 30.7.2024
Minttu Vänttinen

FIGURE

TABLE

CONTENTS

LIST OF ORIGINAL PUBLICATIONS

The dissertation consists of this compilation part and the following four publications, which are referred to as Article I-IV throughout the text.

I Vänttinen, Minttu (2024). Resolving asymmetry of access in peer interaction during digital tasks in EFL classrooms. *Linguistics and Education, 80*, 101287. https://doi.org/10.1016/j.linged.2024.101287

II Vänttinen, Minttu (2023). *Constructing interactional space across distant locations in a hybrid classroom* [Manuscript submitted for publication]. Department of Language and Communication Studies, University of Jyväskylä.

III Vänttinen, Minttu (2022). Eye gaze as a resource in handling trouble around mobile devices in classroom interaction. *AFinLA Yearbook, 2022*, 395–413. https://doi.org/10.30661/afinlavk.114401

IV Vänttinen, Minttu, & Kääntä, Leila (2024). Multimodal blame attributions in technology-supported peer interaction. *Classroom Discourse*. Advance online publication. https://doi.org/10.1080/19463014.2023.2292361

My contribution to Article IV is as follows: I collected and prepared the data for analysis, performed the first rounds of analysis, identified the preliminary research focus, and assembled the initial collection of cases. After a detailed collaborative analysis, I wrote the first draft of the manuscript's introduction, most of the theoretical background, and the data and methods section, which were then discussed and revised together. The analysis and the concluding section were written together. After peer review, revisions were discussed and agreed on jointly. I bore the main responsibility for revising the manuscript for publication.

1 INTRODUCTION

The ubiquitous role of technology in our society has come to be reflected in the ecology of today's classrooms. Computers, mobile devices, and smartboards, for instance, have become commonplace objects that are used for teaching and learning as well as for off-topic interactions and activities during lessons. In addition, competence in information and communication technologies is mentioned as one of the main aims for Finnish basic education in the National core curriculum (Finnish National Agency for Education, 2014). Since technological tools are widely encountered both in the workplace and everyday contexts, it is easy to understand the need for learning their use at school. The public debate, however, has been a battle of two extremes: technology is either hailed as a tool for supporting learning (e.g., Finnish National Agency for Education, 2022) or condemned as a disruption to schoolwork and classroom interaction that should be banned (e.g., Jäärni, 2023). In 2020, the global outbreak of COVID-19 forced a worldwide switch to remote and hybrid teaching, which caused widespread concern for pupils' wellbeing (e.g., Härkönen, 2021). Various studies have since reported on the challenges that the emergency online and hybrid teaching as well as school closures caused for both teachers and students (e.g., Birmingham et al., 2023; Gadermann et al., 2023; Loukomies & Juuti, 2021).

The cumulative findings of studies investigating the effects of technology on learning have been contradictory: the correlation between learning results and the use of technology tends to vary significantly from one study to another (e.g., Carhill-Poza & Chen, 2020; Hu et al., 2018; Lam et al., 2018; Petko et al., 2017). This suggests that the impact that technological devices, like any other pedagogical tools and methods, have on learning depends on how, where, and for what they are used. Recently there has therefore been a growing focus on delineating the details of the use of technology in classroom contexts rather than attempting to find a conclusive answer to whether it has pedagogical benefits or drawbacks. One approach to investigating classroom interactions from this perspective is conversation analysis (CA), which aims at understanding and describing the organisation of interaction around technology rather than learning outcomes per se. By focusing on how technology is used *in situ*, we can

understand the opportunities and challenges it creates for learning and participating in classroom interactions and activities. This knowledge can then be used to develop pedagogical practices and technologies that better support learners.

Previous CA research has revealed that technology can significantly shape participation in classroom activities (e.g., Badem-Korkmaz & Balaman, 2022; Park & Park, 2022; Sahlström et al., 2019; Veronesi et al., 2021) and that digitally performed tasks require a careful coordination of talk, embodied resources, and actions on the device (e.g., Balaman & Pekarek Doehler, 2022; Jakonen & Jauni, 2021; Jakonen & Niemi, 2020; Levy & Gardner, 2012). Yet the types of trouble that pupils encounter in technology-rich classroom contexts and the ways in which they are resolved remain understudied. In that vein, the present study sets out to investigate different kinds of interactional, technological, and task-related trouble in peer interactions that unfold either around digital devices in face-to-face classrooms or via a technological medium in hybrid lessons. Specifically, it aims to shed light on the ways in which trouble is resolved while using digital technology to perform pedagogical tasks or to participate in lessons. Drawing on multimodal CA (e.g., Hazel et al., 2014; Lilja, 2022; Mondada, 2019), I analyse video recorded English as a Foreign Language (EFL) lessons from Finnish basic education. I show how *trouble resolutions* in peer interactions impact as well as involve (re)negotiations of shared *interactional spaces* (Haddington & Oittinen, 2022; Mondada, 2013a), which are spaces of mutual attention created as participants orient their bodies towards each other and the material environment. While illustrating the dynamic and creative ways in which verbal, embodied, material, and digital resources are used and combined, the study also highlights the interactional work required from pupils as they simultaneously manage both the technology and the unfolding peer interactions.

In the present chapter, I first discuss the conceptual framework and the rationale of the study (Sections 1.1 to 1.3). I then introduce the overall aims of the dissertation as well as the research questions of the individual articles (Section 1.4). Finally, I present the organisation of the dissertation (Section 1.5).

1.1 Multimodal peer interactions in technology-rich classrooms

This dissertation views classroom interactions as actively and multimodally co-constructed by participants who have agency over how and to what extent they participate in them. It adopts a social constructionist and emic CA perspective and investigates what it is that pupils *do* in classroom interactions. The aim is to understand how interactions unfold in technology-rich classrooms, what kinds of trouble pupils encounter, and how they deal with that trouble. In this way, the dissertation can contribute to discussions on how to best support pupils' participation and engagement in classroom interactions and activities, which eventually can influence their possibilities to learn.

CA research on classrooms has shown special interest towards whole class interactions and, in particular, teachers' role in them (e.g., McHoul, 1978; Mehan, 1979; Sinclair & Coulthard, 1975). In the early days of the approach, this was perhaps partly due to the high occurrence of teacher-fronted activities in classrooms. In addition, it may have been caused by the potential practical problem of not having enough recording equipment to simultaneously capture various participants' conduct with enough detail. On the other hand, it was and still is relevant to understand teachers' practices since they have the power to decide how pedagogical activities are organised in the classroom. During the last decades, however, task-based teaching methods have gained popularity (see e.g., Walsh, 2011), adding to the complexity of classroom interactions and to pupils' possibilities to engage in peer interactions. At the same time, possibilities for producing detailed video recordings have been enhanced. Consequently, peer interactions have started to attract burgeoning interest within CA. Since interactions among pupils do not involve similar institutional power asymmetries as interactions between the teacher and pupils, they offer an interesting context for exploring how participation, roles, and task-progression are negotiated among participants of institutionally equal status.

At the same time, following the *material* (Nevile et al., 2014) and the *embodied turns* (Nevile, 2015) in research on social interaction (see Subsection 2.1.3), the focus has widened from analysing *talk-in-interaction* (Sacks, 1984) to exploring all *multimodal* resources that are used and made relevant by participants in interaction, including verbal, embodied (e.g., eye gaze, gestures, body movements, facial expressions), and spatio-material resources (e.g., objects, physical environment). The specific resources that participants use are assembled in accordance with the situated interactional context and the local activity (Mondada, 2014b). The existing body of multimodal CA research on classrooms has highlighted the situated, multimodal nature of peer interactions, where epistemics, task-progression, and social relations are explicitly and implicitly managed using locally tailored ensembles of multimodal resources (e.g., Heinonen & Tainio, 2023; Jakonen, 2014; Konzett, 2015; Kääntä & Piirainen-Marsh, 2013; Piirainen-Marsh & Kääntä, 2022; Sherman & Tůma, 2023). The current dissertation contributes to this line of research by examining the multimodal resources that pupils use in peer interactions in technology-rich classrooms.

In this study, technology-rich classrooms[1] are defined as classrooms that utilise digital technology as a tool for task performance or as a medium of participation in a lesson. The data come both from face-to-face classrooms, where pupils use mobile digital devices to perform pedagogical tasks, and from synchronous hybrid classrooms during the COVID-19 pandemic, where a few remote pupils attend the lessons via a video-conferencing tool, while the teacher and the other pupils are co-present in a physical classroom. In both contexts, I

[1] In Article I, I also apply the term 'digitally rich classrooms' to refer to these contexts, thus emphasising the digital nature of the technologies that appear in the data. In this compilation part of the dissertation, I have decided to adhere to the term 'technology-rich', which I have used in the other articles.

focus on how peers collaboratively resolve trouble while working on or interacting via the official technological tools that the teacher has assigned for the lesson. The *affordances* and constraints of the technologies in these two contexts differ from each other in terms of the modalities available for interaction and the potential ways of participation. In the framework of this study, affordances of technology refer to the "practical uses" (Hutchby, 2014, p. 87) that the technology enables, the kinds of actions and activities it makes possible for the participants in a specific context (Gibson, 2014/1979). By design, the mobile devices used in the lessons of the data, such as tablet computers and mobile phones for example, allow a single person at a time to haptically manipulate them, enable digital learning tasks, and can be moved easily from one person to another, and so on. On the other hand, they may afford actions and activities that they were perhaps not originally intended to enable but become possible in a local context, as Article IV demonstrates.

Previous research on technology-rich educational contexts has focused especially on the (perceived) effects that technological teaching tools (e.g., Carhill-Poza & Chen, 2020; Hu et al., 2018; Lam et al., 2018; Petko et al., 2017), remote teaching (e.g., Bertoletti et al., 2023; Iglesias-Pradas et al., 2021; Means et al., 2013; Shim & Lee, 2020), and the use of personal mobile devices (e.g., Beland & Murphy, 2015; Kuznekof & Titsworth, 2013; Wei et al., 2012) may have on learning. Within the field of classroom interaction research, recent years have seen a rocketing interest in participation in video-mediated learning contexts. While numerous studies have also explored the off-task use of personal mobile devices (e.g., Rusk, 2019; Sahlström et al., 2019) and tasks performed on desktop or laptop computers (e.g. Cekaite, 2009; Gardner & Levy, 2010; Kunitz, 2018; Levy & Gardner, 2012; Musk, 2016), peer interactions of children and teenagers around mobile devices and in synchronous hybrid teaching remain understudied (but for studies on children using mobile devices at school, see Jakonen & Niemi, 2020; Niemi & Katila, 2022). In particular, we lack insights into how peers in technology-rich classrooms achieve, maintain, and transform shared attention to each other, their tasks, and the material environment. In other words, we need an understanding of how *interactional spaces* are (re)negotiated in these contexts.

1.2 Multimodal negotiations of interactional space

For people to become coparticipants in interaction, they first need to achieve joint attention to each other. The process of achieving and maintaining mutual attention does not only involve the sequentially unfolding talk but also requires an embodied and spatial orientation both to other participants and the material environment. This notion has been conceptualised by different researchers over the last decades: most notably by Erving Goffman, Adam Kendon, Charles and Marjorie Harness Goodwin, and, more recently, Lorenza Mondada.

Goffman used the terms *focused interactions* and *encounters* to refer to interactions that are characterised by a shared focus and cooperation (1963, p. 24;

1967, p. 144). Goffman describes how individuals move to a focused interaction through embodied actions, such as gaze shifts to coparticipants (1963, p. 92), and how they position themselves to form an 'eye-to-eye ecological huddle' (1963, p. 95) that enables mutual monitoring and attention to the unfolding activity. Kendon (1990), on the other hand, coined the term *F-formation* to refer to the spatial arrangement of participants' bodies in a way that permits engagement in a mutual activity. In this formation, participants direct their bodies, especially their lower bodies, towards each other or a common point of focus in a way that permits equal access to the space between them, or to the *transactional space* (1990, p. 211). Depending on the number of participants, they may orient to each other through a side-by-side or a vis-à-vis arrangement (dyads) or via a circular arrangement (multiple participants), for example.

While Goffman and Kendon focused on how participants achieve and maintain mutual attention, C. Goodwin (2000, 2007) explored the ways in which different semiotic resources, such as talk and gesture, as well as artefacts and other features of the material surroundings, can be used to make participants' actions visible and interpretable to others. In each moment, participants rely on a specific set of resources, which Goodwin called *contextual configurations*. These configurations are continuously in a state of flux, changing as the interactional needs change (C. Goodwin, 2000, p. 1490). On the other hand, C. Goodwin and M. H. Goodwin investigated the relationship between embodiment, spatiality, and participation in interaction through the concept of *participation framework* (C. Goodwin, 2000; C. Goodwin & M. H. Goodwin, 2004), originally deriving from Goffman's work on footing (1963). Participation frameworks refer to the configurations of participants in the current interaction, which are formed through how they display their orientation to others and position themselves in different roles, such as speakers and hearers.

Drawing on these notions of embodiment and spatiality, Mondada developed the concept of *interactional space* (e.g., Mondada, 2009, 2011, 2013a). It refers to the way in which participants arrange and adjust their bodies in relation to each other and the material environment to begin and maintain interaction. The concept considers the dynamic nature of this coordination of embodied actions as participants constantly monitor each other and adjust their "relative embodied positions" (Mondada, 2011, p. 291) accordingly. In addition, it highlights the role of space and participants' orientations to material objects in achieving mutual attention to a shared activity. The material space, according to Mondada (2013a, p. 250), both shapes participants' actions and is shaped by them. In this dissertation, I adopt and elaborate on the concept of interactional space to explore how pupils multimodally build, sustain, and (re)negotiate joint attention as part of their trouble resolution processes. I show how the material environment, including technological devices, and the unfolding activity dynamically shape the peer groups' needs for (re)negotiating interactional space. This allows for more flexibly accounting for the pupils' shifting orientations in the complex settings in the data, without limiting the analysis to concrete

physical territories created by participants' (lower) bodies (cf. Kendon, 1990, p. 211) or a typology of participant roles (cf. Goffman, 1963).

In addition, the current study reveals the layered nature of interactional spaces for participants. In the face-to-face classrooms of the current data, pupils work on individual and collaborative tasks performed on or with digital mobile devices, where what I call the *shared digital task space* forms an additional layer to the interactional space built in peer interaction. The term has previously been mentioned in passing in a report on augmented reality (AR) prototypes (Billinghurst & Kato, 2002, p. 66) and, although missing a definition, has been used to refer to a digital space (e.g., a screen, 3D content of AR) that can be seen by two or more participants simultaneously. Here, however, I define shared digital task space as a layer of the interactional space in peer interaction that is formed when a group of pupils work on a digital task on a technological device. This layer could be compared with Mondada's (2011) notion of inscriptional space, which is used to describe the space formed by boards that are publicly written on during participatory democratic meetings. Her notion, however, differs in an important way from my conceptualisation of the shared digital task space based on the current data. Whereas Mondada (2011) describes inscriptional space as another layer of space *in addition to* the interactional space, although intertwined with it, I view the shared digital task space as a dynamic layer of space *within* the local interactional space in peer interaction. The device is thus not conceived of as just an artefact in the physical environment but constitutes the part of the space where task activity is managed and made visible to the teacher and to other pupils. When pupils work on individual devices, the digital task space is not mutually attended to and therefore does not become part of the shared interactional space (see the right side of Figure 1). Rather, pupils manage the task space individually and participate in shared peer interactions as a type of multiactivity (see Section 2.3), where the task and the peer interaction are oriented to as two distinct activities. When peers handle a shared device or aid each other during tasks on individual devices, the digital task space is mutually attended to and forms a layer of the local interactional space (see the left side of Figure 1). While there are examples of both types of interactional space in the individual articles, the dissertation focuses especially on those moments when the digital task space becomes, or should become, part of the shared interactional space in peer interaction.

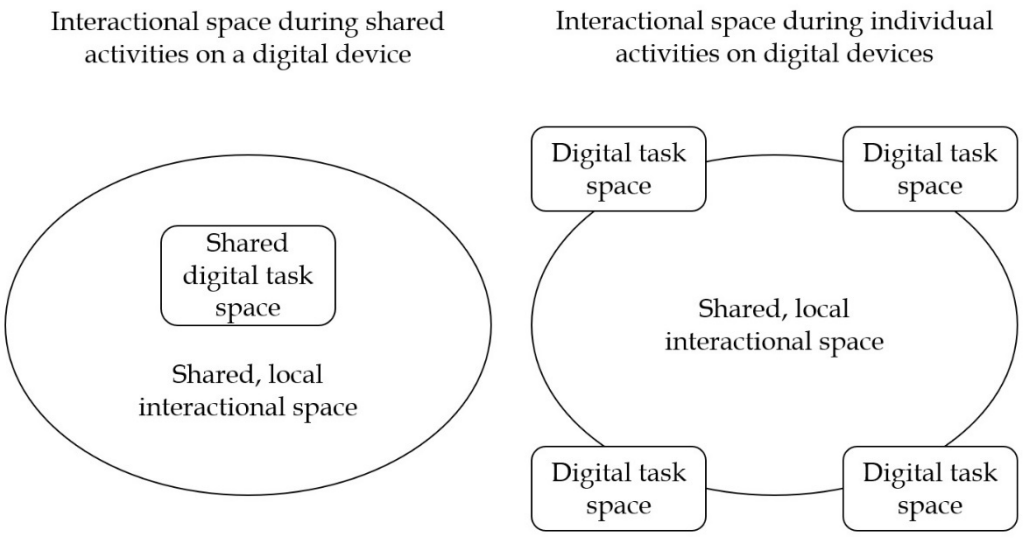

FIGURE 1 Interactional spaces in face-to-face peer interactions around digital mobile devices.

A few scholars have further elaborated on the notion of interactional space in the context of video-mediated, VR, and hybrid interactions (Haddington & Oittinen, 2022; Oittinen, 2020a; also Kohonen-Aho, 2023). They have shown how the construction of interactional space does not need to rely on physical copresence and how participants can simultaneously be involved in several, often overlapping interactional spaces, which can be private or public (e.g., the public hybrid space vs. private chats) and built among co-present participants, between remote participants, or as a hybrid space between co-present and online participants (see also Wasson, 2006). This multiplicity of spaces and the often limited access to coparticipants' visual cues require careful adjustments and coordination of talk and embodied resources to accomplish and sustain mutual attention and intersubjectivity and to avoid exclusion of some participants (e.g., Haddington & Oittinen, 2022; Oittinen, 2020a). The reconceptualization of space put forward in these studies is also relevant to the current study since part of the data are from synchronous hybrid teaching (Article II). Hybrid lessons involve participation in overlapping local, technology-mediated, and hybrid interactional spaces, where spatiality cannot be defined merely on the basis of physical surroundings and concrete objects.

Previous conceptualisations of space have also heavily emphasised visual resources for creating and maintaining joint attention. Embodiment is viewed through the visual body that is perceivable to the eye, and attention is drawn to the "special role" of sight (Goffman, 1963, p. 16) in achieving and maintaining interactional space (e.g., Mondada, 2013a). While interactional space can be managed using resources that the local context affords, even when visual access to coparticipants is limited (see Haddington & Oittinen, 2022; Oittinen, 2020a, 2020b), other modalities that are used to construct, sustain, and (re)negotiate joint

attention remain understudied. The current dissertation therefore aims at showing how hybrid interactional spaces can be achieved even when the hybrid configuration prevents participants' access to visual cues (Article II). Thus, the dissertation highlights interactional space as a locally achieved phenomenon that does not need to rely on mutual visual access but rather on the arrangement of those embodied features, such as voice, that are available to the participants *in situ*.

Negotiations of interactional space are intricate and may not always occur in a straightforward manner (e.g., Haddington & Oittinen, 2022; Oittinen & Piirainen-Marsh, 2015), thus creating moments of trouble. On the other hand, resolving other interactional trouble may require reconfigurations of interactional space. Trouble resolutions in these cases require methods that surpass those that are traditionally conceptualised in CA research on repair (e.g., Schegloff, 1987b) of interactional trouble. The trouble types and their resolutions found in the current data are discussed next in relation to the traditional notion of repair.

1.3 Multimodal trouble resolutions

This dissertation focuses on moments of trouble that are related to the progression of interaction and task-performance in technology-rich classrooms. Here, trouble refers to any issue that the participants themselves display as problematic, make visible, and attempt to resolve in social interaction. This trouble can come in the form of asymmetric access to interactions or to tasks on digital devices, inability to progress with a task due to a lack of knowledge or malfunctions of technology, and disturbances in interaction and interactional space, as well as mistakes made by peers. In terms of their scope and quality, these trouble types differ significantly from the traditional sense of interactional trouble as "problems or troubles in speaking, hearing, or understanding the talk" (Schegloff 1987a, p. 110; also Schegloff et al., 1977). In this conceptualisation of trouble, *trouble sources* or *repairables* (Schegloff et al., 1977) are specific items within a turn or single turns in talk-in-interaction. In some cases, trouble may also be related to turn-taking, as when the next speaker initiates a turn 'too early' in overlap with the current speaker (Schegloff, 1987b), or to difficulties in understanding how turns are sequentially connected (Drew, 1997). All in all, these trouble types comprise a set of rather easily recognisable problems in the production, recognition, or understanding of talk.

In the CA tradition, the methods by which such troubles can be dealt with are called *repair* (e.g., Jefferson, 1987; Sacks et al., 1974; Schegloff, 1987a, 1987b; Schegloff et al., 1977). The main goal of repair is to restore intersubjectivity, or mutual understanding, and to maintain the progressivity of interaction so that a turn or an activity can be carried out (Schegloff, 2007b, p. xiv). Repair as an interactional accomplishment involves two constituents: the initiation of repair and the actual completion of repair (Schegloff et al., 1977, p. 364; also Clift, 2016,

p. 235; Kitzinger, 2013, p. 230). Both the initiation and the actual repair may be performed by the same participant, either 'self' or 'other' (i.e., the producer of the trouble source or the recipient, respectively), or they may be realised by different participants. Self-repair is overwhelmingly given priority in interaction (Schegloff et al., 1977) but other types are also found. Self-initiated self-repair can occur, for instance, when a speaker of a turn notices trouble with what they have said, cuts off the turn, and then restarts, perhaps replacing or deleting a word or a phrase used in the original turn. Other-initiations of repair, on the other hand, can deal with not hearing what is said ("Sorry?") or not understanding a part of or the whole turn ("What do you mean?"), for example. Even after other-initiations, it is typically self who performs repair (e.g., Kitzinger, 2013, p. 231). Self-initiated and other-initiated repair also often differ with regard to their position in the sequence of interaction. Self-initiated self-repair generally occurs within the same turn as the trouble source, at points where speaker change could happen, or in the third turn, for instance after noticing in the recipient's turn that they have misunderstood the first turn (Schegloff et al., 1977, p. 366). Other-initiations, on the other hand, tend to be produced in the turn that follows after the trouble source (in the 'next turn'; Schegloff et al., 1977, p. 367; Schegloff, 2000, pp. 207–208). Some of the self-repair operations include deleting or replacing an item in the turn, inserting an item, reformatting or reordering the turn, aborting the turn, or searching for a word or a phrase (Kitzinger, 2013, p. 233). Other-repair, especially in contexts with second-language speakers or adult-child conversations, tends to involve reformulations of trouble source or direct corrections of mistakes (e.g., Hosoda, 2000; Ziglari et al., 2016).

While Schegloff et al. (1977, p. 363) note that "nothing is, in principle, excludable from the class 'repairable'", most of the repair operations that they and many after them have investigated seem to be targeted at very specific types of trouble which are related to talk and can be fixed in a rather straightforward manner, again often through talk. Some more recent work on repair has also looked at its multimodal aspects (for a review, see Saalasti et al., 2023). For example, repair can be initiated by the other through embodied noticings (Kääntä, 2014; Oittinen, 2020b; Vatanen, 2023), facial expressions and head tilts (Stolle & Pfeiffer, 2024; Wang & Li, 2024), or cupping a hand behind the ear (Mortensen, 2016). Studies on interactional trouble in video-mediated interactions have also highlighted the role of embodiment in the production and understanding of actions by showing how the limited (visual) access to embodied cues leads to problems, such as identifying artefacts that are pointed at (Luff et al., 2003). In the classroom context, Sert (2015, p. 58) defines interactional trouble as "the emergence of a temporary misalignment in the unfolding of an interactional and pedagogical activity, which is oriented to by the participants as such through verbal and nonverbal means". This definition thus attempts to widen both the scope of the notion of trouble and the modalities of repair. Sert focuses on trouble related to epistemics such as silences or verbal or embodied claims of insufficient knowledge by students after teachers' questions and considers how the ways in

which teachers deal with these trouble types may orient to increasing student participation.

While Sert (2015) and others (e.g., Oittinen, 2020b; Vatanen, 2023) have explored interactional trouble types beyond problems of speaking, hearing, and understanding, as well as the multimodal ways of dealing with them, it is clear that the concept of repair is inadequate to describe the varied multimodal work that goes into resolving different types of trouble, especially when technology is involved (see also Greiffenhagen & Watson, 2009). To address this issue, Arminen and Auvinen (2013) used the term *remedial action* to refer to repair work that targets "faulty lines of action" (p. 19). They differentiated between repair of talk and remedy of action, which often co-occur in problem-solving and are dispersed over sequences of talk and embodied action. Contributing to and broadening this multimodal view of repair and remedy, the current dissertation shows how, in addition to clearly defined trouble sources, such as a missing response or a mistake in a collaborative task, there are more encompassing and elaborate problems that may be difficult to pinpoint even in sequences of interaction and yet are ostensibly oriented to by participants. These include issues such as asymmetry of access to digital devices, restricted access to classroom interactions, technological trouble with devices, and problems with task-performance. These kinds of trouble often require more extensive, multimodally and collaboratively accomplished work, which can hardly be narrowed down to single turns or even short sequences of interaction (see also Ilomäki & Stevanovic, 2024). In addition, they tend to make relevant a (re)negotiation of interactional space as joint attention needs to be achieved or redirected. In this dissertation, I use the term *trouble resolution* (or, *resolving trouble*) instead of repair or remedy to refer to the multimodal, situated interactional work that participants perform when dealing with the problems they encounter in their peer interactions around and via technology. I suggest that trouble resolution is a process in which talk and embodied actions cannot be separated in terms of their function or aim but instead mutually work towards solving the issue at hand.

In the context of technology-rich face-to-face classrooms, a few previous studies have focused on how trouble is oriented to in peer interactions. The studies present a limited number of trouble types, such as mistakes with spelling (Cekaite, 2009; Musk, 2016; Norén et al., 2022) and trouble handling a device (Oloff, 2021). Research on video-mediated interactions has explored topics such as constrained access to materials and interactions as well as asymmetry of participation (e.g., Jakonen & Jauni, 2021, 2022; Oittinen, 2022), but these studies are from contexts with (young) adult participants. The current dissertation seeks to widen the scope of our understanding of trouble resolution in peer interactions in technology-rich classrooms in two important ways. First, it adds to our knowledge of the kinds of trouble that pupils face in peer interactions while performing digital tasks or interacting in a hybrid lesson, and how they are resolved. Second, it offers a new perspective on analysing resolutions of trouble

in classroom peer interactions by illustrating how these resolutions make establishing, maintaining, and (re)negotiating interactional spaces relevant.

1.4 Aims and research questions

This doctoral dissertation aims at contributing to our understanding of how different kinds of trouble are dealt with in peer interactions in technology-rich classrooms. More specifically, it investigates the multimodal (see e.g., Deppermann, 2013; Lilja, 2022; Mondada, 2014b, 2019) resources that are used to display aspects of interaction or activity as problematic and to resolve the problems through (re)negotiations of interactional space. Drawing on multimodal conversation analysis (CA) and data from face-to-face and hybrid EFL classrooms in Finnish basic education, I explore the following research problem:

- What types of trouble do pupils encounter in their peer interactions in technology-rich classrooms, and how are these troubles resolved?

This research problem can be further divided into the following two research questions:

1. How and through what kinds of multimodal resources do pupils collaboratively resolve trouble in peer interactions in technology-rich classrooms?
2. How are interactional spaces (re)negotiated in the processes of trouble resolution?

These research questions are addressed in all the individual articles through a micro-level multimodal analysis of the processes of trouble resolutions. Each article deals with different trouble types and describes the processes through which they are resolved. The aim is not to produce an exhaustive list of all the problems potentially encountered in technology-rich classrooms but to explore trouble types that are often oriented to in the current data. In addition, all articles consider how interactional spaces are (re)negotiated during these processes, although to varying degrees of emphasis (see Table 1). The articles are ordered thematically rather than chronologically so that Articles I and II address trouble of access whereas Articles III and IV investigate issues related to task accomplishment.

TABLE 1 Original articles and their research questions

Article	**Research questions**
Vänttinen, Minttu (2024). Resolving asymmetry of access in peer interaction during digital tasks in EFL classrooms. *Linguistics and Education, 80*, 101287. https://doi.org/10.1016/j.linged.2024.101287	1. How is mutual visual and/or aural access to a digital device negotiated when it is held or handled by a peer? 2. What kinds of preferences for multimodal resources are displayed in the access negotiations? 3. What kinds of local roles and authority are reflected in the access negotiations?
Vänttinen, Minttu (2023). *Constructing interactional space across distant locations in a hybrid classroom* [Manuscript submitted for publication]. Department of Language and Communication Studies, University of Jyväskylä.	1. How do pupils use the affordances of the hybrid classroom setting to build a shared hybrid interactional space? 2. How does the process of building a shared hybrid interactional space promote the engagement of the remote participant in peer and teacher-pupil interactions?
Vänttinen, Minttu (2022). Eye gaze as a resource in handling trouble around mobile devices in classroom interaction. *AFinLA Yearbook, 2022*, 395–413. https://doi.org/10.30661/afinlavk.114401	1. How is eye gaze used to display and deal with trouble in peer interactions during learning tasks on mobile devices? 2. Specifically, how is eye gaze used as a resource in recruiting assistance or pursuing a response?
Vänttinen, Minttu, & Kääntä, Leila (2024). Multimodal blame attributions in technology-supported peer interaction. *Classroom Discourse*. Advance online publication. https://doi.org/10.1080/19463014.2023.2292361	1. How are multimodal resources used in blame attributions that address mistakes made by peers during digital tasks? 2. What is the role of technology in the emergence and resolution of the blaming sequence?

Article I investigates trouble related to accessing devices used for tasks, the preference for certain resources to resolve that trouble, and how these preferences seem to reflect the local roles of the peers. Article II considers problems of access to classroom interactions in a hybrid setting through a single case analysis of a geographically distributed pupil dyad. Article III focuses on how eye gaze is used in multimodal trouble resolutions when the progression of a digital task is halted due to technological problems or insufficient knowledge or due to a missing response from a peer. Finally, Article IV examines how mistakes made by peers during collaborative digital tasks are addressed and resolved through multimodally constructed blaming sequences. The articles

form a narrative of the types of trouble encountered at different phases of peer interactions. Articles I and II deal with trouble types that hinder pupils from starting or participating in peer activities and thus address problems related to negotiating shared interactional spaces. Articles III and IV, on the other hand, focus on troubles that arise when task activity is already on the way. These troubles make relevant renegotiations of interactional space to enable a collaborative trouble resolution process. Together these articles aim at increasing our understanding of peer interactions in technology-rich classrooms.

1.5 Organisation of the study

This article-based dissertation comprises four original articles and this compilation part, which is organised into five chapters. Chapter 1 introduces the context and the main concepts used in the study. In addition, it presents the overall aims and research questions. Chapter 2 situates the study within the theoretical and methodological framework of CA, presenting the basic organisations of interaction as well as the concepts and lines of CA research that are relevant for the current study. Chapter 3 describes the participants, the data, and the methods of the study. Chapter 4 summarises the findings of each research article. Finally, Chapter 5 discusses how the findings answer the research questions of the dissertation in addition to considering the contributions of the study as a whole and its overall theoretical and practical implications. The limitations of the study and suggestions for future research are also discussed in the final chapter.

2 THE THEORETICAL AND METHODOLOGICAL FRAMEWORK

This doctoral dissertation is situated within the theoretical and methodological traditions of multimodal conversation analysis as well as within classroom interaction research. In this chapter, the origins and fundamental principles of conversation analysis are introduced, followed by descriptions of the basic organisations of interaction studied in CA as well as of some current trends in the field (Section 2.1). Then, a brief review of conversation analytic research on classroom interaction is offered, focusing especially on findings related to peer interaction and multimodality (Section 2.2). Finally, the role of technology in classroom interactions is considered through an exploration of recent studies in the field (Section 2.3).

2.1 The conversation analytic approach

Multimodal conversation analysis is a development within conversation analysis (CA) that is interested in how talk as well as embodied (e.g., eye gaze, gestures, and body movement) and material resources (e.g., objects in the physical environment, technology) are organised to build mutual understanding in interaction. CA developed as a distinct analytic approach for studying social interaction in the 1960s and 1970s, focusing overwhelmingly on structures of *talk* and their employment in producing social actions. Ontologically, CA views social reality as co-constructed by participants in and through interaction, and those participants as "mutually orienting to, and collaborating in order to achieve, orderly and meaningful communication" (Hutchby & Wooffitt, 2008, p. 1). Interaction is thus a collaborative and situated achievement, which aims at reaching shared understandings, or *intersubjectivity* (Schegloff, 1992b; Sorjonen et al., 2021, p. 1), and involves a structural organisation that is both oriented to and produced by participants.

Methodologically, CA is a qualitative approach that involves an inductive, micro-level analysis of the details of naturally occurring interaction, which differentiates it from other approaches interested in social interaction, such as ethnography, discourse analysis, or quantitative methods and experiments within social psychology. Focusing on what is uttered and done in actual interactions, CA aims to show the dynamic role of the participants in building not only interactions but also their roles and relations in them, their identities, and even entire social institutions. This emic and social constructionist view is apparent also in this dissertation, where the focus is on the active collaboration of classroom peers and how they dynamically resolve the issues and troubles that they encounter during their interactions in technology-rich classrooms.

To understand the theoretical underpinnings of the dissertation more thoroughly, a brief account of the origins of CA follows next.

2.1.1 Historical and intellectual origins of CA

While CA can be regarded as an interdisciplinary approach, its roots are found in sociology. Three people are generally credited for laying the foundations for CA: Harvey Sacks, Emanuel Schegloff, and Gail Jefferson. Their groundbreaking work within sociology in the 1960s and 1970s established CA as a methodological approach and an "analytic mentality" (Schenkein, 1978) that could address and challenge prevailing trends within the discipline at the time (see e.g., Hutchby & Wooffit, 2008, p. 21; Maynard, 2013). The intellectual underpinnings of CA are rooted, however, in even earlier work in sociology from the 1950s and 1960s, particularly that by Harold Garfinkel and Erving Goffman.

Garfinkel's ethnomethodology, with its focus on the details of everyday social actions, was influential in the development of CA, and the two approaches still have a close relationship, as evidenced in their frequent use as a combined analytic framework (see Haddington et al., 2024). Garfinkel's work challenged sociological research traditions and "top-down" theories by developing a bottom-up approach to studying social structure. In particular, ethnomethodology diverged from functionalism and Talcott Parsons' theorisations of members' sensemaking as based on subordination to internalised norms and structures within society (Clayman & Maynard, 1995, p. 3; Eilittä et al., 2024, p. 1; Maynard & Clayman, 2003, p. 175). Instead of starting with abstract theoretical concepts to frame studies of social order, ethnomethodology takes as its central concern members' local sensemaking, which is considered to rely on shared methods and practices, i.e. ethno-methods (e.g., Arminen, 2006; Clayman & Maynard, 1995; Hutchby & Wooffitt, 2008; Maynard & Clayman, 2003), and "the moment-by-moment management of contingent detail through sequential orderings" (Rawls, 2008, pp. 702–703). Members of society are considered competent actors who are able to produce and understand intelligible action – and it is in their local actions in real-life situations where social order can be seen and which should therefore be empirically studied (Garfinkel, 1984/1967; see also e.g., Clayman & Maynard, 1995; vom Lehn, 2014, 2019). Alignment with views from ethnomethodology and its criticism of mainstream sociology is

visible in Sacks' insistence that the use of natural language itself is a worthwhile topic of investigation and that this should be done through a bottom-up approach to understand members' accountably produced social actions (Clayman & Maynard, 1995, pp. 3–4; Maynard, 2013, p. 14). CA thus shares ethnomethodology's interests in the ordinary and in the organisation and order of everyday social interaction.

Another scholar who influenced CA during its nascence was Erving Goffman, who sparked interest in face-to-face interaction within sociology (Hutchby & Wooffitt, 2008; Maynard, 2013, p. 16). As Goffman's students, Sacks and Schegloff (see e.g., Schegloff, 1988) were introduced to many of his ventures and ideas, which they later developed further to lay the ground for CA. Goffman developed topics such as 'social ritualization' (e.g., Goffman, 1983), the social order of interaction, and the 'ritual' and 'system properties' of talk (see e.g., Hutchby & Wooffitt, 2008, p. 25; Maynard, 2013, p. 17). While ritual properties referred to aspects of interaction such as protecting 'face' and politeness, the system properties included structural aspects such as turn-taking and sequencing. Sacks was more concerned with the system properties (Maynard, 2013, p. 17) but he also showed how the two properties could often not be separated in interaction (Sacks, 1975; see Hutchby & Wooffitt, 2008, p. 25). Goffman's (1983) idea of *interaction order* being "a social institution in its own right" (Heritage & Stivers, 2013, p. 663) and, as such, worthy of social analysis (Arminen, 2005, p. 11) has in many ways become the *raison d'être* of CA.

While Garfinkel and Goffman are often named as the main inspirations for Sacks and his colleagues, their thinking was also influenced by various other academics and traditions from different fields, such as Freud's psychoanalysis, Wittgenstein's ordinary language philosophy, Chomsky's transformational grammar, ethnography, and anthropology (Clayman & Maynard, 1995; Maynard, 2013). In addition, instead of simply following the footsteps of those before, Sacks, Schegloff, and Jefferson created an approach that differed in important ways from both ethnomethodology and Goffman's form of sociological inquiry. One of the basic differences is that, from the beginning, Sacks sought to build a systematic, formal method for analysing naturally occurring instances of interaction (Arminen, 2006; Hutchby & Wooffitt, 2008, p. 27). For CA, this came to mean the use of recordings to capture interactions as they occur in real time and to perform micro-analysis on them. Both Goffman's methods and those in ethnomethodology for collecting data and analysing social order, were more varied, however, and Garfinkel's rather hermeneutic or phenomenological leanings (Hutchby & Wooffitt, 2008, p. 30) differed from CA's striving for "a natural observational science" (Sacks, 1984, p. 21) of social life. The emphasis on "unmotivated" (Sacks, 1984, p. 27) observation of data and the striving for objective findings based on evidence have sometimes sparked criticisms of CA's seemingly naïve positivist epistemology that contrasts with its social constructionist underpinnings (Svennevig & Skovholt, 2005). But as Svennevig and Skovholt (2005) point out, these criticisms relate more than anything to the rhetoric of Harvey Sacks, rather than to actual methodological procedures. In my

view, the methodological emphasis seems to stem largely from the fact that Sacks and his colleagues wanted to reject the idea of members of society simply internalising and performing predetermined social structures, a theorisation that was dominant in sociology of the time. Instead, the data-driven approach emphasises the importance of starting the analytical process with actual occurrences of interaction so it can account for the active role of participants in constructing social interaction.

Through its initiation as a separate programme in the 1960s and 1970s, CA became a distinct approach to studying social interaction as constructed by participants. Investigations were – and still are – done through the collection of recordings of naturally occurring interactions that are transcribed in detail (Jefferson, 2004) and analysed from an emic perspective. This participants' perspective is sought through the preliminary process of the "unmotivated examination" (Sacks, 1984, p. 27) of collected data, whereby interesting features of interactions that participants themselves observably orient to can be noticed. Another important aspect of this emic perspective is that no detail of interaction can be ruled out of the analysis *a priori* (e.g., Heritage & Atkinson, 1984, p. 4). The central question guiding the analysis is "why that now?" (Schegloff & Sacks, 1973), which reflects two basic assumptions in CA: that all interaction is accountable and that "there is order at all points" (Sacks, 1984, p. 22). Furthermore, this order is "oriented to by the participants as normatively oriented-to grounds for inference and action" (Heritage & Atkinson, 1984, p. 2). In other words, participants interpret each other's actions as accountable contributions in relation to the ongoing interaction, relying on the organisation of that interaction as a basis for their interpretation.

Instead, then, of merely describing utterances in talk and how these are ordered in the unfolding interaction, Sacks and his colleagues aimed at showing how actions and meanings are produced through talk and how they become understood as specific actions by others. CA thus constitutes a shift from a focus on analysing the meaning of a speaker's utterances to inspecting how turns at talk are oriented to by coparticipants (Maynard, 2013, p. 15). This has become one of the overarching ideas and methodological tools in CA, the *next-turn proof procedure*, where the analysis of a turn is based on what is observably displayed in the next turn by the recipient (Sacks et al., 1974, pp. 728–729). This procedure also reflects the specific understanding of meaning and context in CA as produced through the sequential organisation of interaction (e.g., Heritage, 2005, p. 105; also Jefferson, 1972; Jefferson, 1978; Schegloff, 2007b). In other words, previous actions become the context for the interpretation of next actions for participants. Previous actions can also make certain types of next actions relevant and are oriented to by coparticipants when producing their next actions. Hence, actions are both shaped by the context and context-renewing (e.g., Heritage, 1984, 2005).

While CA was initially launched as an approach to doing sociological research *within* sociology, its interdisciplinary nature was evident already in its early collaborations with other disciplines such as linguistics and anthropology

– in fact many of the early papers appeared in publications outside of sociology (Stivers & Sidnell, 2013). In addition to the diversity found in disciplines that use CA in their analytic endeavours, the approach has been employed for a wide array of research contexts, both in everyday and institutional settings. Although ordinary conversation has in many ways been seen as "the fundamental form of talk-in-interaction…the primordial site of human sociality" (Schegloff, 1987a, p. 101; see also Heritage, 1984, pp. 238–240), CA has from early on been applied to contexts of work and institutions. CA work on institutional interaction has focused especially on comparing the specialised contexts with the organisation of everyday conversations. Research has described diverse settings, such as telephone calls to a suicide help line (Sacks, 1992) and to the police (Schegloff, 1968), courtrooms (e.g., Atkinson & Drew, 1979), and healthcare contexts and surgical operations (e.g., Haakana, 2001; Mondada, 2014a; Peräkylä, 1998; Robinson & Heritage, 2005), as well as news and media (e.g., Clayman & Heritage, 2002; Greatbatch, 1988; Heritage, 1985). Although CA has aimed at finding the unique "fingerprint" (e.g., Arminen, 2005, p. 44) or the formal characteristics of each specialised institutional context, the findings have revealed that many institutional interactions can in fact be quite similar to everyday interactions and that distinctions tend to be rather limited and formal in nature (see e.g. Arminen, 2005, p. 45). Nevertheless, institutional contexts do share some general features that distinguish them from mundane contexts: they are generally characterised by specific task or goal orientations, asymmetric roles between participants, constraints on what kinds of actions are allowed, and particular "inferential frameworks" for each context (Drew & Heritage, 1992; also Arminen, 2005; Heritage, 2005). These features are also visible in classroom interaction, which has been a popular topic in CA for decades (e.g., Jacknick, 2021; Markee, 2015; McHoul, 1978; Mehan, 1979; Sert, 2015; see Section 2.2). It is this line of CA that the current dissertation contributes to by shedding light on the organisation of peer interaction in specific technology-rich classroom contexts.

Next (Subsection 2.1.2) I present the central concepts and principles that have traditionally built the core of CA analyses. After that (Section 2.1.3), recent developments and trends in CA are discussed.

2.1.2 Basic organisations of interaction in CA

> What we are interested in is, what is it that people seem to know and use. (Sacks, as quoted in Hill & Crittenden, 1968, p. 13)

The central aim of conversation analysis has from the beginning been to unveil the structures of social interaction that seem to be 'known' and oriented to by participants both in producing and interpreting actions. In CA terminology, *social actions* are produced through *turns* in interaction. Turns are composed of different combinations of talk and/or embodied resources that are designed to produce specific actions. *Turn design* refers to how participants construct their turns through these different combinations, how they relate the turn to the previous turns by others, and what the turn is designed to do in the unfolding interaction. The different components making up the turn are called *turn-*

constructional units (TCUs; Sacks et al., 1974) and can be realised for example as sentences, phrases, or single words, and can involve embodied resources in their construction, including non-lexical vocalisations, gestures, or other body movements (e.g., Clayman, 2013; Drew, 2013; Keevallik, 2018). Each TCU constitutes a coherent, independent unit, and a turn can consist of one or several TCUs. As a TCU is completed, it creates a possible *transition-relevance place* (TRP), or a moment in which a speaker change can occur (e.g., Clayman, 2013). TRPs are projected during the production of the current TCU through varied methods, such as syntactical choices, prosody, and gaze (Clayman, 2013), that inform coparticipants of the potential speaker change. At their occurrence, *turn allocation* can be achieved by the current speaker selecting the next speaker or by another participant self-selecting – in the case that the current speaker does not continue their turn (Sacks et al., 1974).

The turn-constructional and the turn-allocation component discussed above are the two main components that Sacks, Schegloff, and Jefferson mention as relevant for the organisation of *turn-taking* in their seminal paper (1974). By following the rules of turn allocation, participants in interaction achieve that generally only one participant speaks at a time and that long overlaps as well as gaps between turns are avoided. Turns generally show *contiguity* (e.g., Sacks, 1987) which means that they temporally follow each other quite closely. These rules are not meant as prescriptive in nature but are observed in interactions as being 'known' and used by the participants to make sense of each other's actions and to produce relevant next actions. It is noteworthy that the paper discusses turn-taking predominantly as a verbal phenomenon, realised through talk rather than embodied behaviour, and that later studies have found embodied resources, such as eye gaze (e.g., Auer, 2021; Rossano, 2013) and gestures (e.g., Mondada, 2007; Schegloff, 1984), to be consequential for turn allocation. The paper also deals with turn-taking in the context of everyday conversations, where turn order and length are not predetermined, and the relative distribution of turns can vary. By contrast, turn-taking organisation in institutional contexts can be rather fixed, and the rules of ordinary conversation may not apply (see e.g., Drew & Heritage, 1992; Heritage, 2005).

Since turn-taking organisation does not imply an automatic, fixed order and distribution of turns but rather provides a set of mechanisms with which participants locally and in context-sensitive ways manage turns and intersubjectivity, it follows that turn-taking is also vulnerable to problems, such as overlap and confusion over next selected speakers. To address trouble with the organisation of turns and to restore intersubjectivity participants have the mechanism of *repair* at their disposal (Sacks et al., 1974; Schegloff, 1987a, 1987b; Schegloff et al., 1977). Repair devices can be used to address various kinds of interactional trouble, but repair organisation traditionally has been conceptualised as dealing with specific trouble sources within a previous turn or with the previous turn as whole and as concerning issues of producing, hearing, or understanding talk (Schegloff et al., 1977, Schegloff, 1997; also Drew, 1997). Repair can be both initiated and performed by either the speaker themselves or,

less frequently, by others so that there may be self-initiated or other-initiated self- and other-repair. Since maintaining intersubjectivity is critical for interaction to succeed, repair can displace any next turn that is expected to follow and thus gain priority over other actions (Sacks et al. 1974, p. 720; Schegloff, 2007b, p. 102).

A fundamental feature of turn-taking is that turns are not random outputs during allocated slots but rather exhibit a reflexive relationship with each other. This idea of 'nextness' (Stivers, 2013) is crystallised in how turns produced one after another form coherent sequences. *Sequence organisation* refers to how turns in interaction are positioned as "meaningful successions" that together accomplish courses of action (Schegloff, 2007b, p. 2). In other words, a turn can be produced to start a new sequence or positioned as a response to a prior turn that has already initiated a sequence (Stivers, 2013), and together the unfolding series of turns forms a meaningful, coherent social activity, where each turn or turn-constructional unit contributes to its meaning.

A minimal sequence comprises two turns that together form an *adjacency pair*, or a pair of turns produced one after another by different participants where producing the first turn, or a first-pair part, makes responding through a second-pair part "conditionally relevant" (Schegloff, 1968, p. 1083). These turns are "relatively ordered" and "pair-type related" (Schegloff, 2007b, p. 13). The former property refers to the normative expectation that a first-pair part is followed by a second-pair part, rather than the other way around (e.g., questions precede answers). The latter property is observed in the fact that the pairs of turns form pair types, where certain first-pair parts make certain types of responses relevant. For instance, a greeting by the first speaker makes a greeting also by the recipient conditionally relevant, an invitation is typically responded to with an acceptance or a decline, and a summons (see Schegloff, 1968) is paired with an answer by the recipient. While they constitute the basic form of sequencing, adjacency pairs, as well as other sequences, can also be expanded through pre-, insert, and post-sequences (Stivers, 2013). Pre-sequences are typically preliminary in the sense that they prepare for the actual actions. For example, a pre-request sets the stage for the request proper, and openings of conversation can be preceded by pre-beginning work (e.g., Schegloff, 1979, p. 34), whereby the possibility for interaction is ensured and the availability of the other is checked. Insert sequences are inserted between the first-pair and the second-pair parts and are typically designed to address an issue with responding to the first-pair part (Schegloff, 2007b, p. 99; Stivers, 2013, pp. 194–196). Post-expansions, on the other hand, are produced after second-pair parts and can serve several different purposes, such as reacting to the second-pair parts or repairing problems with them (e.g., Stivers, 2013, p. 200).

While sequence organisation is relevant for all types of interactions, institutional settings are often characterised by specific types of sequences. In classroom interactions, for example, a typical sequence that occurs during plenary teaching is the Initiation-Response-Evaluation (IRE) sequence (Mehan, 1979), which involves a question by the teacher (i.e., an initiation of the sequence) responded to by a pupil or a student. This response is then evaluated by the

teacher, whereby the sequence is closed, unless an expansion of the sequence occurs.

Sequence organisation is but one type of *sequential organisation* (Schegloff, 2007b, p. 2), which more generally refers to how different units of interaction are positioned in relation to each other and how this positioning is used to produce and sustain intersubjectivity (see also Heritage, 1984, p. 259). This includes several levels of organisation, such as ordering the turns of specific speakers (turn-taking) and producing certain types of actions during specific phases of conversation (overall structural organisation of interaction). The *overall structural organisation* of interaction has often been used to describe the organisation of whole conversations or interactional events, such as a lesson or a news interview, but it can also be analysed on the level of other interactional units, such as single social activities or episodes of interaction (Robinson, 2013; Schegloff, 2011). Investigations revolve around how participants themselves demonstrably orient to the structural organisation and coherence of the activity or event. This is particularly interesting in institutional settings, such as classrooms, where participants seem to share an expectation of certain types of structure for the whole lesson (e.g., opening phase, plenary teaching, group activity, closing) or for particular activities within the lesson (e.g., transition to group interaction, preparing for task, performing the task, moving out of the group).

One more fundamental concept in CA investigations is *preference organisation*, which is relevant on different levels of interaction, such as turn design, turn-taking, sequence organisation, and repair. In essence, preference means that, in interaction, certain actions take priority over others. It is not a question of personal choice but of certain principles that are displayed in participants' conduct. There are two types of evidence for the existence of preference in interaction: first, certain types of actions are generally "avoided, withheld, or delayed", and second, preferred and dispreferred actions tend to be designed in distinct ways (Atkinson & Heritage, 1984, p. 53). Whereas preferred actions and activities are often direct and produced without delay, their dispreferred counterparts typically involve delay, mitigation and indirectness (Sacks, 1987; Atkinson & Heritage, 1984). Generally, there seems to be a preference for agreement (Sacks, 1987), or aligning with coparticipants' lines of actions. Pomerantz (1984a), for example, has shown that assessments in everyday conversations tend to be responded to with agreeing turns. In the case that the coparticipant produces a disagreement, it is done in a way that partially agrees with the assessment, thus minimising the disagreement. As Pomerantz and Heritage (2013) point out, however, preference organisation may vary across cultures, and some studies have shown that children can produce their disagreements and blamings in rather direct and unmitigated manner (e.g., Church, 2009; M. H. Goodwin, 1983, 1990).

Having now laid out the most basic concepts and organisations of interaction that CA interests itself in, I now turn to some of the more recent developments in the field that are also relevant for the current study.

2.1.3 Recent developments of CA

The birth of CA coincided with and became part of what has been called the 'linguistic turn' of the 20th century, which was characterised by philosophical and scientific interest in language and its use in society (Arminen, 2005, p. 9). In this way, language became studied not just as a separate, abstract structure but as a central form of social conduct. The influence of the linguistic turn on CA was visible in its focus on *talk* in its investigations, although language as such was not the main object of analysis – instead, analyses aimed at revealing how talk-in-interaction was collaboratively organised to produce meaningful social actions.

During the early years, the overwhelming focus on verbal behaviour was also partly explained by the type of data that was available to the pioneers in the field. Sacks, for instance, used audio recordings (e.g., Hutchby & Wooffitt, 2008, p. 16) that enabled the transcription and analysis of talk as a verbal phenomenon. From early on, however, transcripts would include phenomena such as prosody, pauses, and emphasis, in addition to representing the words that were uttered. Other multimodal aspects of interaction, such as eye gaze, gestures, and body movement, also received interest already during the 1980s when scholars such as Marjorie Harness Goodwin (1980; also M. H. Goodwin & C. Goodwin, 1986), Charles Goodwin (1980, 1981), Christian Heath (1982, 1984, 1986), and Emanuel Schegloff (1984) published research based on analyses of video recordings from diverse settings, such as picnics, block parties, meat markets, dinner table conversations, and medical consultations. This interest in the embodied features of interaction was not exclusive to CA, however, and insights had also been gained from other fields, such as gesture studies (e.g., Kendon, 1970; see also Mondada, 2019).

As video recordings became more widely available especially during the early 21st century, it enabled what has been called by Mondada (2013c) the *visual turn* in social sciences, or the increase in the use of video data for research purposes. Consequently, this led to the *embodied turn* (Nevile, 2015), or the wider interest in understanding the role of the body in the co-construction of meaning. CA, among other fields, started to view the division between language and the body as artificial (Mondada, 2019, pp. 48–49), and instead the focus has shifted to how different resources, such as lexis, syntax, prosody, facial expressions, gestures, body movement, and manipulations of material objects, in different combinations, or as 'complex multimodal Gestalts' (Mondada, 2014b), are employed to accomplish social actions. An important motivation behind studying *multimodality* (see e.g., Deppermann, 2013) is that the relationship between different modalities is not hierarchical but rather, any resource and detail of interaction can become consequential for interaction and its analysis, and different activities and contexts may favour the use of certain modalities (Mondada, 2016, p. 341). What follows from this is that turns, and thus actions, may be realised without a verbal component altogether, and instead, rely on embodied and material sources. On the other hand, as the whole body has become an object for CA studies, analyses of its movements in the material space have inspired conceptualisations of spatiality, such as interactional space (e.g.,

Mondada, 2009, 2013a; see Section 1.2), which aim at describing how the material space is involved in but also shaped through interaction.

Related to the rise of multimodality and the concept of the body in the material space, the field has witnessed a *material turn* (Nevile et al., 2014) as well as a growing interest in *sensoriality* (e.g., Cekaite, 2015; Meyer, 2021; Mondada, 2019, 2023). Materiality refers to different objects, artefacts, tools, and materials, including technology, that are encountered, manipulated, and formed during and through social interaction (Mondada, 2019; Nevile et al., 2014). Objects can function as resources for the organisation of interaction and for the accomplishment of activities (e.g., Day & Wagner, 2014, 2019; C. Goodwin, 1994), or as foci of interaction (e.g., De Stefani, 2014), or they can be produced and shaped in interaction, such as pieces of writing or other inscriptions (Mondada & Svinhufvud, 2016; Streeck & Kallmeyer, 2001; see also Nevile et al., 2014). Object manipulations, or the production of an object, can also take different roles and functions in social interaction. They can be the main activity that is mutually monitored, occur in parallel with talk-in-interaction around the object, or be treated as a private activity (Mondada & Svinhufvud, 2016, pp. 37–38). Alternatively, they can be integrated into interaction as turn-constructional units (Streeck & Kallmeyer, 2001, pp. 484–488). Recent studies have drawn attention to the less researched topic of how *sensing* different materials through touching, smelling, and tasting (e.g., Mondada, 2021, 2023) or physical sensations (e.g., Keevallik & Hofstetter, 2023; Weatherall et al., 2021) can be made relevant in interaction, both as tools and resources for intersubjectivity and as shared sensorial experiences.

Another important area of study within contemporary CA is interaction in technology-rich or technology-mediated contexts. This line of research has offered new insights into multimodality through investigations of how technological devices are used in or during social interaction and how interaction is accomplished via technology, such as videoconferencing, in mundane settings (e.g., Brown et al., 2013: Laurier et al., 2016; Licoppe & Morel, 2012), and workplaces (e.g., Oittinen, 2020b; Olbertz-Siitonen & Piirainen-Marsh, 2021; Suchman, 1987), as well as other institutional settings, including pedagogical contexts (e.g., Badem-Korkmaz & Balaman, 2022; Jakonen & Niemi, 2021, 2022; Thorne et al., 2015). It has been shown, for instance, that interactions including the use of digital devices are complex, multi-layered ecologies with multiple involvements (cf. Goffman, 1963) and often with asymmetric access to device screens (e.g., Avgustis & Oloff, 2023; Brown et al., 2013; Mantere, 2022) and that video-mediated interactions are characterised by limited and asymmetric access to the surroundings and embodied actions of coparticipants (e.g., Heath & Luff, 1992; Licoppe & Morel, 2012: Luff et al., 2003). Recently, different virtual reality (VR) environments have also received interest (e.g., Haddington et al., 2023; Hindmarsh et al., 2006; Kohonen-Aho & Vatanen, 2021; Olbertz-Siitonen & Piirainen-Marsh, 2023), raising the question of the boundaries between the embodied and the virtual. Work on text-based digital interaction has also provoked discussions on how to apply CA concepts, including the fundamental

notions of turn-taking and sequence organisation, to written digital interactions, such as text messaging, group chats, and emails (see e.g., Koivisto et al., 2023).

One consequence of the focus on multimodality, including materiality, technology, and sensoriality, has been the recognition of interaction being not only sequentially but also *temporally* ordered. Turns are not always produced in a linear manner, one after another, but sequentiality might be realised "in parallel flows of action" (Mondada, 2016, p. 346) as embodied actions, object manipulations, and shared sensorial experiences coincide and alternate with talk and each other. The widened focus from turns-at-talk to the sequentially and temporally organised multimodal actions has also sparked an interest in *multiactivity*, or participants "doing more than one thing at a time" (Haddington et al., 2014, p. 11). Research on multiactivity has shown how different resources need to be distributed between different activities, such as talk for conversation and hand movements for simultaneous manipulations of a digital device, and how the management of multiple activities requires collaboration and careful coordination of participants' actions (Haddington et al., 2014; Mondada, 2019).

In addition to offering new discoveries and a wider scope of studied contexts, the recent developments, generally labelled as 'multimodal conversation analysis', have even challenged some core concepts in CA. For example, how can sequentiality be applied to multiactivity involving several simultaneous or overlapping engagements, perhaps even "additional" layers created by technology, or to interactions characterised by shared sensory experiences? Can contributions to text-based chats be labelled as turns or turn-constructional units, and how can we analyse digital conventions, such as 'likes' and emojis, as constituents in interaction (see Koivisto et al., 2023)? Importantly for the present study, the notion of repair organisation seems insufficient as applied to the various types of interactional trouble that can occur in the complex ecologies studied in recent multimodal CA research. Especially in the context of human-computer interactions, the visual dimension of trouble and the blurred boundary between the self and the other can be problematic for the concept of repair (Greiffenhagen & Watson, 2009). In general, interactional trouble does not only include such relatively straightforward repairables as for example problems of hearing a turn or mistakes in the production of talk. It can also be extended to complex phenomena, such as problems of participating in an activity due to lack of access to a digital device or to the interaction itself or dealing with a coparticipant's mistake in a collaborative task. It is these kinds of trouble and the interactional work engaged in to resolve trouble that the current dissertation aims to unravel, thus contributing to the recent CA developments focused on multimodality and complexity in technology-rich contexts. In this study, these questions are addressed in the context of classroom interactions.

2.2 Classroom interaction

For decades, CA has been used as a methodological approach for studying classroom interactions in different fields, ranging from applied linguistics and second language acquisition (SLA) research to the field of education. CA approaches classroom interactions as "locally accomplished" (Pekarek Doehler & Fasel Lauzon, 2015, p. 409) achievements that can shed light on the learning opportunities that are collaboratively created and on the learning trajectories that are displayed through observable actions. In addition, classroom interaction is seen as an inherently institutional form of interaction. Classroom interactions as institutional processes are discussed next in Subsection 2.2.1.

2.2.1 Classroom interaction as an institutional context

Classroom interaction is characterised by its *institutional core goal* (Seedhouse, 2015, p. 376) of teaching and learning specific subjects and skills. Participants in classrooms also have specific institutional roles (i.e., traditionally, teachers and students/pupils), by which they interpret each other's conduct. Other features that reveal the institutional nature of classroom interaction are the asymmetry of knowledge and power that the different roles involve and the constraints on the types of actions the participants can produce in the setting (Arminen, 2005; Drew & Heritage, 1992; Heritage, 2005; ten Have, 2007).

The institutional characteristics of classrooms can be observed in six dimensions of interaction (for extensive accounts of these dimensions in institutional contexts, see e.g., Drew & Heritage, 1992; Drew & Sorjonen, 1997; Heritage, 1997). First, the overall structural organisation of classroom interactions typically differentiates them from both mundane conversations and other institutional contexts. Lessons represent the basic type of classroom interactions, and they traditionally include an opening phase, followed by teacher-fronted plenary teaching, some form of task interactions, and a closing phase. The structure of individual lessons can vary, of course, but institutionality is witnessed in the role and authority of the teacher who presides over it.

Second, each of the different phases of interaction tends to involve specific types of sequence organisation. Within CA, the most rigorously studied sequence in classrooms is the IRE sequence (Mehan, 1979), also known as the IRF sequence (Initiation-Response-Follow-up/Feedback; Sinclair & Coulthard, 1975; Hellermann, 2003) which is built out of three 'moves' or turns (Hellermann, 2003). The first is produced by the teacher, who typically asks a display question that they already know the answer to and that is performed for pedagogical purposes such as checking and evaluating pupils' understanding. The second move, a pupil's response to the question, is evaluated as either appropriate or inappropriate in the third turn, performed by the teacher through verbal (e.g., Margutti & Drew, 2014; Mehan, 1979) or multimodal resources, such as gaze and material objects (e.g., Kääntä, 2010, 2015).

Third, while many conversations in the classroom reveal an organisation of turn-taking that is similar to ordinary conversations (e.g., off-topic chats among peers; see Seedhouse, 2015, p. 376), turn-taking during interactions that have a pedagogical goal reflects the participants' asymmetric power relationship. At a transition-relevance place, it is typically the teacher who selects the next speaker(s), unless they continue themselves (McHoul, 1978; Markee, 2000). In the case of IRE, for instance, there is turn-type pre-allocation (Heritage & Clayman, 2010, pp. 37–38). That is, it is predetermined that the teacher asks the questions and pupils respond. Furthermore, teachers overwhelmingly produce more and longer turns than pupils.

Fourth and fifth, turn design and lexical choice often reflect the institutional context through specialised vocabulary, for example, or through allusions to the institutional roles that are made when choosing ways of performing specific actions (see Heritage, 1997; Heritage & Clayman, 2010).

Finally, the institutional nature of classrooms can be witnessed in how epistemic and power asymmetries are displayed in and through all the different organisations of interaction and in the participation of teachers and pupils (Thornborrow, 2002). Although today's classrooms certainly afford pupils a greater freedom than many traditional classrooms, asymmetries are still displayed in the different types of contributions through which teachers and pupils participate in classroom interactions and in their asymmetric access to knowledge. For example, the teacher has the knowledge and power to evaluate pupils' answers and the right to control turn-taking and the overall structural organisation of interaction, whereas pupils' participation is interpreted through their roles as participants with less power and knowledge.

While participants in classrooms orient to their institutional roles, power relations, and the corresponding activities that are linked with them, or *category-bound actions* (see e.g., Sacks, 1992; Schegloff, 1992a, 2007a; Stokoe, 2012), it is important to note that they are not inescapable or static categories that dictate participants' conduct. Rather, participants dynamically construct the roles in each situated context and can negotiate "expected" category-bound actions on a local basis (a point that was already highlighted in the lectures by Sacks, 1992). It has been shown, for example, that teachers can orient to roles besides their situated institutional identity and, through these orientations, negotiate their relationship with learners and offer possibilities for more symmetric conversational roles (Richards, 2006). On the other hand, pupils may renegotiate the institutionality of the context by changing the ways in which they address their teacher, using the term 'teacher' or alternatively the first name, for instance (Lehtimaja, 2011). For pupils, other roles and identities besides 'pupil' may also become relevant and dynamically co-constructed through and during peer interactions, as can be seen in the articles of this dissertation (see Section 4.1). For example, peers can orient to each other as team members, device-owners, or as 'people who know English' who are thus positioned as epistemically more knowledgeable than their peers in tasks that involve skills in that language.

In the context of the dissertation, participants in peer interactions also orient to themselves and each other as 'learners of English'. Language learning has been studied in a specific branch of CA called Conversation Analysis for Second Language Acquisition (Markee & Kasper, 2004), or *CA-SLA*. Abiding by the central principles of CA, CA-SLA takes an emic approach to epistemics (Markee & Kasper, 2004, p. 493) and sees language learning as a social, locally constructed process rather than a cognitive product formed in the individual's mind (e.g., Larsen-Freeman, 2004). Within the branch, there are different views on whether CA investigations can in fact demonstrate learning (see e.g., Markee & Kunitz, 2015), and, as a response to the criticism concerning the limitations of CA in showing evidence for learning, some practitioners have adopted forms of longitudinal CA (see e.g., Skogmyr Marian & Balaman, 2018) to study the development of learners' skills as displayed in interaction. In general, CA procedures are used to analyse how pupils actively 'do learning' (e.g. Firth & Wagner, 2007; Markee et al., 2021) as well as create *opportunities* for learning. In that vein, the current dissertation explores pupils as active participants in classroom interactions, although it does not investigate language learning processes *per se*.

Seedhouse (2015) states that the institutional core goal of second language (L2) classrooms (i.e., teaching learners the L2) leads to three properties specific to this context. First, the target language has a dual role as both the language of instruction and the target of learning; second, there is a "reflexive relationship" between pedagogy and interaction; and third, anything that "learners produce in the L2 [is] potentially subject to evaluation by the teacher" (pp. 377–378). The reflexive relationship between the pedagogical focus and interaction refers to the idea that L2 classroom interactions are influenced by the four types of contexts that, according to Seedhouse (2004, p.102), are typically found in these classrooms: form-and-accuracy context, meaning-and-fluency context, task-oriented context, and procedural context. The focus, goals, and interactional organisation tend to vary between the contexts. The data analysed in the four articles of the current dissertation come from the task-oriented context, where the focus is on completing tasks and interactions are influenced by task types. Generally, the task-oriented context is also characterised by minimal, indexical turns by learners, and an abundance of negotiations of meaning, realised through confirmation checks, clarification requests, comprehension checks, questions and candidate answers, and evaluations of the answers given by others (Seedhouse, 2004, pp. 125–128; Sert, 2015, pp. 29–30).

Over the decades, the interests and topics of CA research on classroom interactions have shown tendencies similar to the developments of CA in other research contexts. Three of these developments are of particular relevance for the current dissertation. First, there has been a widening of focus from the dyadic relationship between the teacher and pupils as a cohort to more complex conceptualisations of participation in classrooms. Second, classroom interactions have come to be studied through the lens of multimodality, instead of a narrower focus on verbal turns. Third, concurrently with the evolution of the material

ecology of classrooms, we have seen an upsurge in interest in technology-rich classrooms. The first two developments are discussed next in Subsections 2.2.2 and 2.2.3. Relevant topics in research on interactions around and via technology are presented in Section 2.3.

2.2.2 From dyadic perspectives to complex classroom configurations

Early work on classroom interactions was primarily concerned with the dyadic relationship between a teacher, on one hand, and pupils or students as a collective participant, a "Student Cohort" (Sahlström, 1999; also Hellermann, 2008), on the other. Classroom interaction was conceived of as a unified activity that involved a two-party exchange system between the teacher and the pupils. Individual pupils who, for example, responded to teacher questions were seen as representatives of the whole pupil cohort. Hence, studies tended to revolve around topics that mirrored this idea of dyadic interaction. These topics included the different levels of structural organisation, such as turn-taking, sequence organisation, and the overall organisation of lessons (e.g., McHoul, 1978; Mehan, 1979; Sinclair & Coulthard, 1975). Teachers were overwhelmingly the object of analysis, and this teacher-centred view of the classroom has still been observable quite recently, for instance in the way that the institutional goal, "*the teacher will teach the learners*" (Seedhouse, 2015, p. 377, emphasis in the original), has been described only from the teacher's perspective.

Research focusing on the teacher and on the 'two-party interactions' of classrooms has revealed important structures of pedagogical interactions, such as the famous three-part instructional sequence IRE, and has in many ways laid the groundwork for analyses of social interaction in classroom contexts. In addition, the focus on the teacher has been pedagogically justified – after all, we do need to understand what the teacher does and how that affords possibilities for learning. Later research has diversified the topics investigated, however, and further developed our understanding of the interactional organisation of classrooms. Partly, this has been due to the evolving technology that has enabled more detailed views of the classroom to be recorded. Consequently, there has been a move towards a visualisation of classrooms as complex, dynamic multiparty settings. For instance, instead of visualising teacher-fronted interactions as occurring between dyads, Schwab (2011) describes them as multi-party interactions or *multilogues*, where any participant (teacher or pupil) can initiate interactions and simultaneously address all the classroom participants rather than a single recipient. Other studies have shown these settings to involve multiple, often simultaneous interactions (e.g., Koole, 2007; Rampton, 2006; Sahlström, 1999), not just between the teacher and pupils but also among pupils. At the same time, the CA conceptualisation of learning as social participation has emphasised pupils' active role in classrooms: learners are credited with having agency (Larsen-Freeman, 2004, p. 604) instead of "being individuals to whom change merely happens" (Jakonen, 2018a, p. 761).

The conceptualisation of classrooms as multiparty settings involving a variety of potential interactions also suggests that there are multiple possible

participation frameworks available for pupils (e.g., C. Goodwin, 1981; C. Goodwin, 2000; C. Goodwin & M. H. Goodwin, 2004). In other words, they can position themselves and each other in different roles, such as speakers, addressed or unaddressed hearers, or overhearers, in varied interactions. In the traditional dyadic view of classrooms, the teacher was always seen to be either the ratified speaker or the ratified hearer (see e.g., Jacknick, 2021, p. 43), with pupils' contributions either nicely fitting the turns allocated to them by the teacher or violating the rules of participation. It has been shown, however, that pupils can also take on more active roles as participants, for example by initiating sequences through questions (Jacknick, 2009; Markee, 1995) and thus reversing the teacher's and the pupils' roles as initiators and responders. Studies investigating overlapping classroom interactions, on the other hand, have focused particularly on pupils' actions that occur simultaneously with teacher-led activities (e.g., Koole, 2007; Sahlström, 1999; also Jacknick, 2021) and are used to locally (re)negotiate pupils' participant roles. Sahlström (1999), for example, describes how students quietly talk to each other during a teacher-fronted activity and thus display non-recipiency to the whole class interaction. Koole (2007) uses the term *parallel activities* to describe student-student activities occurring simultaneously with the teacher-led 'main' activity. Koole shows that students can participate in multiple activities at the same time, while still orienting to the teacher-led activity as the main activity of the classroom.

Importantly for the current dissertation, pupils also engage in peer interactions during tasks that are pedagogically designed to involve collaboration. During these task activities, it is peer interaction that is treated as the main activity, which makes relevant forms of participation that differ from those found in teacher-pupil interactions. Previous studies on peer interactions during tasks have touched on various questions related to, for instance, task organisation and progression, turn allocation, epistemics, and moral order. These studies have shown how task progression in peer groups, for example, requires negotiations of participation frameworks and speakership as well as task distribution (e.g., Kääntä & Piirainen-Marsh, 2013; Lee, 2017; Piirainen-Marsh & Kääntä, 2022). Moreover, intersubjectivity as well as rights and responsibilities related to the tasks are maintained by carefully coordinating and balancing epistemic relationships, potentially impacting peers' possibilities to participate in the task activity (Jakonen, 2014; Jakonen & Morton, 2015; Kämäräinen et al., 2019; Rusk et al., 2016). While peer interactions do not involve asymmetries of institutional authority in the same way as the hierarchical relationship between teachers and pupils, several studies have illustrated how peers constantly orient to their respective rights and responsibilities as members of peer groups, manage issues of morality, and establish boundaries between 'us' and others through their participation during peer group activities (Jakonen & Niemi, 2020; Heinonen & Tainio, 2023; Niemi & Katila, 2022).

An interactional context that has not received much attention in recent CA research on classrooms – but appears frequently in the current data – is the task-related interaction between peers during individually performed tasks. This may

occur when pupils recruit assistance from each other or negotiate answers to individually assigned tasks jointly, for instance. Interactions in these cases require a careful balancing of individual task progression and collaborative interaction, and require a renegotiation of the interactional space, as a shift from individual trajectories to joint attention is needed. This is yet another layer in the complex configuration of overlapping participation frameworks that are created and negotiated in classrooms.

Participation in classroom interactions is dynamically and locally negotiated and involves a careful coordination of actions by all participants. Appropriate and timely participation therefore requires varied kinds of competence from pupils. Specifically in L2 and foreign language (FL) classrooms, L2/FL *interactional competence* (IC; e.g., Pekarek Doehler & Pochon-Berger, 2015), or the ability to perform social actions in the target language, is needed for successful participation in whole class and group interactions, as well as for task-progression (e.g., Mondada & Pekarek Doehler, 2004; Pekarek Doehler & Pochon-Berger, 2011; Tůma et al., 2023). In addition, however, pupils need to develop *classroom interactional competence* (CIC; Walsh, 2011, 2012; also Sert, 2015, pp. 54–56), which refers to "[t]eachers' and learners' ability to use interaction as a tool for mediating and assisting learning" (Walsh, 2011, p. 158; see also Walsh, 2006). In other words, classrooms as institutional settings often involve distinct ways of using language (both in L1 and in L2) and of behaving, and pupils need to learn how to appropriately participate in interactions in order to enable learning. The ways of participating vary between different activities, such as teacher-fronted activities and groupwork, and CIC therefore also includes the ability to identify these different local contexts and the participation frameworks involved in them as well as to adjust one's contributions according to these different needs.

In addition to showing the complexity of classrooms in terms of participation frameworks, CA studies have revealed their inherently multimodal nature. A brief review of studies using multimodal CA to investigate classroom interactions follows next in Subsection 2.2.3.

2.2.3 Multimodality in classroom interaction

All the articles in this dissertation address classroom interactions as highly multimodal achievements, investigating how talk, embodied resources, technology, and other materials in the classroom are employed to resolve trouble. Multimodal CA research on classrooms has generally focused more on teachers' embodied conduct than on peer interactions, but we are currently witnessing a rapidly increasing interest in peer groups and how they multimodally manage their participation and relationships in classrooms. Embodied resources have received particular interest, while studies on the spatio-material aspects of interaction are less frequent – with the notable exception of research on technology in classrooms (see Section 2.3).

Various studies have explored how teachers multimodally manage turn allocation and pupils' participation in classroom interaction. Gaze shifts,

pointing gestures, and head nods, for example, can be used to select the next speaker among pupils, either as purely embodied actions or accompanied with talk (Fasel Lauzon & Berger, 2015; Ishino, 2022; Kääntä, 2010, 2012). Teachers may also display their listenership – and that pupils may continue to hold the floor – through gaze behaviour, smiles, and laughter, or even by drinking coffee at transition-relevance places (Willemsen et al., 2020). To manage students' participation, teachers can also employ multimodal resources such as gaze and laughter (Duran & Jacknick, 2020) or ear-cupping gestures (Mortensen, 2016; also Amar, 2022) to pursue a response or to initiate repair. Gaze shifts from an individual pupil to the whole class can also be employed to shift the participation framework and to re-engage the class in the ongoing activity (Waring & Carpenter, 2019), and gestures can function as devices to get pupils' attention (Matsumoto, 2019). Furthermore, classroom management can be performed through tactile practices, whereby touch is used to correct and control pupils' actions and participation in the classroom (Cekaite & Bergnehr, 2023; Heinonen et al., 2020).

Multimodality also becomes relevant for building mutual understanding in teacher-fronted activities. For instance, teachers use gestures, manipulations of objects, and other visual and material resources during vocabulary explanations (Kääntä et al., 2018; Sert, 2015; Waring et al., 2013) and task instructions (Jakonen, 2018b; Kupetz, 2021). On the other hand, multimodal corrections and repair involving talk and gestures can aid in restoring intersubjectivity between the teacher and pupils (Sert, 2015).

During teacher-led whole class activities, pupils display their participation and engagement in the ongoing interaction through multimodal resources. While verbally contributing to classroom discussion at appropriate times has traditionally been regarded as one of the main criteria for assessing pupils' participation, Jacknick (2021) shows that pupils in fact display their participation in a variety of ways, not least through embodied resources. Jacknick differentiates between *participation*, or the alignment of pupils' actions with the pedagogical goal and the classroom interaction, and *engagement*, which refers to pupils' actions being not only in alignment with the teacher's agenda but also appropriately timed due to careful monitoring of the ongoing interaction. Participation and engagement can be displayed, for instance, through gazing at the teacher or relevant materials, raising a hand at the right time, joining in whole-group choral responses, or writing in the notebook. Consequently, pupils display their participation (or non-participation) at all times through their embodied behaviour, even when they do not contribute verbally. In addition, pupils have been shown to have an active role in turn allocation. For example, they can self-select to volunteer responses or to initiate new sequences (e.g., Jacknick, 2009; Waring, 2011). Even when the teacher allocates a turn to a particular pupil, the collaborative nature of the action is displayed in the fact that it is often preceded by the pupil's embodied displays of willingness to participate, such as gazing at the teacher or raising a hand (e.g., Fasel Lauzon & Berger, 2015;

Mortensen, 2008). Unwillingness or inability to answer may also be displayed through aversion of gaze, smiles, or headshakes (Sert, 2013).

Peer interactions are perhaps the context where pupils have the most leeway to manage their participation and to take different roles. While peer groups are receiving growing interest in multimodal CA research on classrooms, we still know comparatively little about how participation, collaboration, and task performance are multimodally managed in these contexts. The existing body of research highlights the local tailoring of multimodal resources to manage task progression. For example, participation frameworks during tasks that require object manipulations (e.g., tasks on mobile devices, board games, physics experiments) are coordinated through resources such as gaze shifts, handling objects (e.g., picking up and rolling a dice), and human-to-human touch (Jakonen & Niemi, 2020; Konzett, 2015; Kääntä & Piirainen-Marsh, 2013; Piirainen-Marsh & Kääntä, 2022). During discussion tasks, on the other hand, participants can use gaze shifts, gestures, facial expressions, and body posture for purposes of turn allocation (Lee, 2017).

In terms of managing task performance and epistemic relations, peers can claim insufficient knowledge through resources such as gaze shifts to task materials, gaze aversion from peers, or gestures (Sherman & Tůma, 2023). They can also recruit a potentially knowing participant through multimodal recruitments that often involve gaze shifts to the recruited peer in addition to or instead of verbal requests (Jakonen, 2014; Johnson, 2017). Peer correction, on the other hand, follows a careful monitoring of a peer's performance and, in addition to verbal utterances, can include a variety of embodied and material resources that depend on the local context: facial expressions, headshakes, pointing at materials or screens, manually guiding peers' manipulations of objects, or taking over the keyboard to type a correct spelling on the computer (Johnson, 2017; Kääntä & Piirainen-Marsh, 2013; Musk, 2016).

While roles, rights, and responsibilities in and between peer groups can be agreed on explicitly and verbally, they can also be constructed, displayed, and alluded to in and through pupils' embodied conduct as well as negotiated through the employment of spatio-material resources. 'We-ness' can be constructed and displayed through physical proximity to each other, such as through leaning against a peer ('leaning touch') or via mutual gaze, whereby other participants can also be excluded from the participation framework (Heinonen & Tainio, 2023). This kind of local, embodied construction of peer relationships is also observable in the way that peers can build boundaries between 'us' and 'them' not only through the physical configuration of their bodies but also through how the objects they are handling, such as their technological devices, are held and positioned to allow or hinder another pupil's access to them (Niemi & Katila, 2022). When such 'territories' constructed by peers are violated, questions of moral order become relevant, and violators are held accountable for their actions. It seems, then, that embodied and material resources become especially relevant when membership, inclusion and exclusion

as well as the moral order of the classroom are negotiated and displayed in peer interactions – a point that is also observable in the current dissertation.

Studies on peer interactions in classrooms have touched on several types of task-related trouble, such as insufficient knowledge to continue with a task, peer performance that needs correction, or negotiations of group membership. What is still missing from these accounts is an exploration of how interactional spaces are constructed, sustained, and (re)negotiated in interactions that are aimed at resolving different types of trouble. Building such spaces becomes especially complex in interactions around and via digital technology, where digital applications and devices create additional layers to the spatial configurations of peer interactions.

The next section (Section 2.3) will summarise the findings of relevant CA research on interactions in technology-rich (classroom) contexts and situate the current dissertation within that line of research.

2.3 Digital technology in (classroom) interactions

The longstanding CA tradition of studying technology-rich contexts started perhaps accidentally through the type of data that Harvey Sacks and his colleagues had available during the early years of the approach: tape recordings of telephone calls. A myriad of studies has since unravelled structures of interactions in a variety of technology-rich settings, from mundane to institutional contexts. In a social constructionist spirit, CA studies tend to see the role of technology as constructed by participants *in situ* and made relevant as needed, instead of viewing it as a determining factor in the organisation of interaction. As Rintel (2015, p. 123) notes, "[t]he affordances of technology are materially inescapable but their relevance as a semiotic resource is a matter for participants". The current study also adopts the view that while technology can enable and restrict certain interactional practices and activities as well as pose challenges for its users, it is ultimately the participants who decide how to use its affordances. Therefore, as analysts, we need to show how technological devices and media "accountably shape" and become "relevant and consequential" for participants in interaction (Arminen et al., 2016, p. 292).

Previous research on technology-rich contexts has, to varying degrees of explicitness, framed the relationship between technology and social interaction in multiple different ways. Digital devices, for example, can be visualised as objects that can be employed as resources for interaction and for activities (Nevile et al., 2014). Such object-centred interactions can involve diverse social actions and activities, such as mobile phone showings (e.g., Avgustis & Oloff, 2023) or pedagogical tasks performed on computers (e.g., Cekaite, 2009; Musk, 2016). Technology can thus be embedded in social interaction, or interaction can occur around technology. The use of technology and interaction can also become integrative parts of the activity at hand. In either case, interactions involve (re)negotiations of shared interactional space as a shift of joint attention to the

technology is required to successfully manage the activity. In most cases analysed in the current study, digital devices and activities performed on them become part of the interactional space, a part which I refer to as the shared digital task space. This occurs during collaborative tasks or when peers assist each other to resolve trouble on the device, for instance. In these instances, actions on a device are coordinated with the peer interaction around it and vice versa, requiring a careful monitoring of the shared digital task space.

A slightly different view is taken in research on multiactivity (e.g. Haddington et al., 2014), which focuses on the use of technology as a separate activity from the surrounding interaction. In the context of the present study, instances of conversations or recruitments during individual tasks perhaps serve as the best examples of this. During such multiactivity, pupils are required to manage both their task and peer interaction, and that means that they need to split their embodied resources between the two activities (see also e.g., Haddington & Rauniomaa, 2011; Nishizaka, 2014). For example, pupils can continue performing their individual tasks on their digital devices while at the same time participating in off-topic conversations, thus engaging in *parallel* activities (Mondada, 2014c, pp. 47–50). On the other hand, they may need to adjust different activities that are intertwined, or performed in an *embedded* order (Mondada, 2014c, pp. 50–64). When pupils need to suspend their ongoing task activity to assist a peer, for instance, the new activity is accomplished in an *exclusive* order (Mondada, 2014c, pp. 64–68).

In some cases, the boundary between embodied human interaction and actions on technological devices becomes obscured. Due and Toft (2021) introduce the concept of *phygitality* by showing how the action of highlighting text on a computer screen is in fact a merge of the manual action of moving a mouse and the digital cursor movements on the screen. The physical and the digital thus form a single phygital action that cannot be separated from each other. In Article IV, Leila Kääntä and I propose that this phygitality does not only occur on the level of isolated actions but also on the level of sequences, such as when actions on the digital applications become used as parts of blaming sequences.

Technology has also been studied as a medium for social interaction. Starting with telephone calls (e.g., Schegloff, 1968, 1979), CA studies have since focused on diverse technology-mediated contexts, such as Skype calls (e.g., Licoppe & Morel, 2012) and video-mediated and hybrid meetings (e.g., Büyükgüzel & Balaman, 2023; Oittinen, 2020a, 2020b; Oittinen & Piirainen-Marsh, 2015), as well as remote and hybrid teaching and learning settings (e.g., Badem-Korkmaz & Balaman, 2022; Jakonen & Jauni, 2021, 2022; Sert & Balaman, 2018). This research has focused on how the mediation of interaction through technology shapes interaction and is oriented to by participants, and how it affords and constrains participation as well as challenges the building of shared interactional spaces. In hybrid interactions, where some participants share the local space while others participate remotely, interactional spaces become especially complex, with the potential to participate in multiple (overlapping)

public (e.g., video call) and private (e.g., a private text-based chat) spaces (Büyükgüzel & Balaman, 2022; Kohonen-Aho, 2023; Oittinen, 2018; Wasson, 2006). This complexity can also result in the exclusion of remote participants as interactions become centred on the local space (e.g., Saatçi et al., 2020).

Finally, in their study on mobile phone usage in mundane settings, Brown et al. (2013) draw attention to the *convergent* and *divergent* use of technological devices, and whether they are used as part of the ongoing social interaction (convergent use) or as a separate activity from the interaction with others (divergent; see also Avgustis & Oloff, 2023). Convergent use is thus characterised by collaboration and requires joint attention to the digital device, as is illustrated also by the articles in this dissertation. On the other hand, participants may become accountable for their divergent use of devices during interaction (see e.g., DiDomenico & Boase, 2013).

This dissertation focuses on two types of technology-rich classroom contexts: face-to-face classrooms where digital mobile devices are used for pedagogical purposes, and synchronous hybrid classrooms with co-present and remote participants. While hybrid and video-mediated interactions have received rapidly increasing attention in CA, both in mundane and institutional settings, studies investigating the use of mobile digital devices is surprisingly rare, especially in classroom contexts. In the following subsections, I will discuss the use of technology in both face-to-face (2.3.1) and hybrid (2.3.2) classrooms.

2.3.1 Digital devices in face-to-face classrooms

Research exploring the role of digital devices in classroom interactions can be roughly divided into two lines: studies that are interested in off-task uses of digital technology, and those that look at digital devices used as tools for learning. The first line of research has focused in particular on the use of personal smartphones. Despite the ongoing debate about the disruptiveness of mobile phones in classrooms, studies have suggested that they tend to be used in ways that do not disturb the flow of the lesson, even when they are used quite openly (e.g., Olin-Scheller & Tanner, 2015; Sahlström et al., 2019). Although teachers may not always orient to smartphone use in their lessons as problematic, their use poses challenges as they tend to divert pupils' attention away from instruction, delay participation in whole class discussions, and hinder teachers' possibilities to support pupils' learning processes when they cannot monitor what pupils are engaged with on their devices (Asplund et al., 2018; Olin-Scheller & Tanner, 2015; Salhström et al. 2019). On the other hand, smartphones and applications on them provide pupils with opportunities for independent information searches, wider participation possibilities, and a way to display and construct multilingual identities (Asplund et al., 2018; Rusk, 2019; Sahlström et al., 2019). Most studies on the off-task use of digital devices have focused on its effects on the flow of whole class activities and on pupils' participation in them. Kontio and Asplund (2019), however, show how mobile phone use in peer groups is negotiated and displayed either as an individual or a shared activity through gaze, posture, and body movements.

Research on the use of digital devices for pedagogical purposes has shown that pupils can use technological devices in ways that deviate from the teacher's pedagogical intentions, the 'task-as-plan' (Dooly, 2018), as well as from the usage they have been designed for. Similar findings have been reported in studies on the situated use of technology in organisations where design features of technological applications and devices often get implemented in unpredicted ways (e.g., Orlikowski, 2000; Salomaa & Lehtinen, 2023; Vyas et al., 2017). For instance since mobile devices have been designed mainly for individual use (see Article I), their collaborative usage in classrooms can both engender trouble and inspire creative local ways of overcoming that trouble and employing them for joint activities (see also Jakonen et al., 2022).

Generally, research on the use of technology for tasks has explored the coordination of talk, embodied resources, and actions on the technology (e.g., Gardner & Levy, 2010; Levy & Gardner, 2012). A few studies have investigated moments of trouble in technology-rich classrooms and how they are multimodally displayed and resolved. For instance, trouble can be displayed through verbal trouble reports or requests for help, head shakes and facial expressions, and gaze shifts to the teacher or peers (Råman & Oloff, 2022; Oloff, 2021; Tuncer et al., 2022), or by manipulating a mobile device to indicate inability to move on with a task (Juvonen et al., 2019). As peers then offer their assistance, they display an orientation away from their devices and towards the trouble source in embodied ways, as when they move towards the participant experiencing trouble and point towards their device (Oloff, 2021). On the other hand, technological applications, such as spellcheckers and synthetic voicing, can be relied on to notice and correct mistakes when writing on digital devices (Cekaite, 2009; Musk, 2016; Norén et al., 2022). Overall, however, research on trouble in peer interactions during digital tasks is still relatively scarce and focuses on few trouble types, mainly problems related to spelling (Cekaite, 2009; Musk, 2016; Norén et al., 2022) or resulting from lack of technical skills in contexts with adult learners (Råman & Oloff, 2022; Oloff, 2021).

When working on shared digital devices, pupils need to constantly manage their participation framework and their joint attention to the device. In the case of (very) young learners, teachers may play an important role in guiding turn-taking on the device (Theobald et al., 2016) but Jakonen and Niemi (2020), for instance, show how participation and haptic access to a shared device can be controlled within the peer group by blocking others through human-to-human touch. In the context of a pedagogical task performed outside of the classroom, Thorne et al. (2015) also show how joint attention to the device is negotiated multimodally though gaze, gestures, moving as a group, and verbal requests. While these studies highlight the maintenance and management of access to a digital device as a highly multimodal enterprise, they do not discuss how access to a digital device is negotiated in the first place. In a rare study, Råman (2021) illustrates how a teacher negotiates visual and haptic access to students' devices in an adult learning setting, but negotiations of access to digital devices in peer classroom interactions, especially among children and teenagers, have been

neglected in previous research. This kind of research is needed since, as we will see in Article I, asymmetric access to a device can result in a situation that resembles the fractured ecologies (Luff et al., 2003) of video-mediated contexts, where participants do not share access to all multimodal cues relevant for understanding the task and the ongoing social interaction. Eventually, access to the device will have consequences for participation in peer groups and in task activities as well as for learning.

Peer interactions around digital devices also involve explicit or implicit negotiations of roles, rights, and responsibilities. While the institutional authority of teachers may give them the rights to manage pupils' participation and to access their devices (Råman, 2022; Theobald et al., 2016), pupils' rights and responsibilities are more susceptible to change and local negotiations. Thorne et al. (2015) suggest that device-holders have deontic authority over the devices they hold and manipulate. Thus, they may also possess the privilege – and the responsibility – to decide over the progression of the task. This finding has also been supported by evidence from Cekaite's (2009) and Musk's (2016) studies, which show that the pupil handling the mouse and the keyboard of a desktop computer also has the final say about corrections made to collaboratively produced texts. In addition, Jakonen and Niemi (2020) show how the current device-holder can block a peer's access to the shared device without it being displayed as problematic by others, implying that the pupils in the data also orient to the device-holder as having the deontic authority over the device. When a peer resists the block, however, we could infer this as oriented to the peer group's shared rights to handle the device and the joint responsibility regarding the progression of the task.

In sum, interactions around digital devices in face-to-face classrooms have gained some attention in CA research in recent years. Importantly for the current study, however, there are several gaps that still need to be addressed. First, many of the studies are from contexts with adult learners, and further insights into multimodal trouble resolutions among children and teenagers are still needed. Second, we still need to deepen our understanding of different trouble types related to task-accomplishment on or with digital devices. Specifically, we know little about the ways in which asymmetric access to digital devices is resolved in classroom peer interactions and how trouble with the progression of interaction around technology is displayed and dealt with. Third, we lack an understanding of how actions on digital devices become used and interpreted as parts of interactional sequences during trouble resolutions. Finally, further evidence is needed on how issues of moral order and authority play out in peer interactions while solving trouble during digital tasks. The current study aims at shedding light on these topics.

2.3.2 Synchronous hybrid classrooms

In addition to face-to-face classrooms, the current dissertation explores peer interactions in synchronous hybrid lessons, where both co-present and remote pupils attend the same lesson. While recent years have seen an exponential

increase in attention towards video-mediated interactions, hybrid classrooms, especially those with child and teenage participants, remain understudied.

Numerous studies have explored the constraints of video-mediated classroom interactions, where the 'talking heads' (Licoppe & Morel, 2012) configuration of participants on a screen leads to reduced access to others' embodied cues and material surroundings. In addition, video-mediated contexts are often vulnerable to delay, which further jeopardises intersubjectivity. For teachers, this may mean fewer opportunities to monitor and support pupils' learning. For instance, studies have indicated that teachers can display trouble in checking pupils' understanding, selecting next speakers, identifying current speakers, and generally eliciting pupils' participation, since many of the embodied cues available in face-to-face classrooms, such as mutual gaze, are missing (Badem-Korkmaz & Balaman, 2022; Park & Park, 2022; Veronesi et al., 2021). In addition, the context involves an asymmetric access to materials needed for tasks, such as books, making joint orientation to and a shared understanding of tasks more challenging than in face-to-face encounters (e.g., Melander Bowden & Svahn, 2020). On the other hand, teachers have created new ways of dealing with these problems, exploiting the affordances of the technology and those embodied resources that are accessible via video. For instance, intersubjectivity can be enhanced and participation encouraged through facial expressions (Malabarba et al., 2022), sharing screens (Badem-Korkmaz & Balaman, 2022; Park & Park, 2022), typing in text-based chats (Wigham & Satar, 2021), and increased use of hinting behaviours and other verbal ways to mobilise a response that are also found in face-to-face classrooms, such as designedly incomplete utterances and addressing single pupils by name (Park & Park, 2022; Veronesi et al., 2021).

Similar troubles of interaction and participation have been identified in video-mediated peer interactions. Peer contexts have mainly been studied in telecollaboration and intercultural exchange contexts, where a group of co-present students interact with another group via a video-conferencing tool. These settings are vulnerable to exclusion of participants as well as disruptions to intersubjectivity and task-progression. To sustain interactional spaces, students in Oittinen's (2022) study, for instance, use talk and gestures that are explicitly directed at remote participants. Interactional and task-related trouble can also be addressed and resolved using the affordances of the technological configuration, such as writing on text chats, showing phone screens to the camera, sending screenshots, sharing links, and manipulating shared documents (Çimenli et al., 2022; Dooly & Davitova, 2018; Dooly & Tudini, 2022). While the studies illustrate the creative and locally tailored nature of trouble resolutions in video-mediated peer interactions, they also expose the constant orientation of the participants to the technology-mediated context and the different kind of spatiality that it involves as compared to a shared physical, local space. The context demands new ways and modes of creating, maintaining, and restoring intersubjectivity and enhanced embodied and digital work to sustain shared interactional spaces.

Hybrid teaching contexts place even more demands on the participants than video-mediated lessons, since they require continuous management of

various spaces: the local, the video-mediated, and the hybrid interactional spaces. These contexts have yet to be studied extensively but the work by Jakonen and Jauni (2021, 2022) offers important insights into participation in hybrid lessons. The context in their study involves a higher education language class with one participant attending via a telepresence robot, which can be moved in the physical classroom by the remote participant and affords them visual and aural access to interactions. Jakonen and Jauni (2022) show how transitions between different activities become challenging in the hybrid context where a renegotiation of participation frameworks requires moving the robot and sometimes assistance from the other classroom participants. In addition, participants orient to the remote student's access to visual materials as potentially constrained by the video-technology by performing visibility checks and by showing materials to the robot (Jakonen & Jauni, 2021). These findings illustrate that hybrid teaching and learning contexts are susceptible to the exclusion of remote participants and are asymmetric in terms of access to interactions and to the material ecology of the physical classroom. To manage participation, participants need to monitor each other and the technological platform attentively and to coordinate their actions carefully. On the other hand, the telepresence robot affords the remote participant independent movement in the local space to resolve access issues or to join groups of students – an affordance that is missing from most other hybrid contexts, including the hybrid lessons in the current data.

In sum, video-mediated and synchronous hybrid classrooms are characterised by asymmetric access to the embodied cues of coparticipants, to the material resources in different spaces, and, generally to classroom interactions. These features can pose challenges for the construction of interactional spaces, maintenance of intersubjectivity, participation, and task progression. On the other hand, trouble resolutions are realised through innovative, locally tailored multimodal resources, exploiting the affordances of the technology and bypassing its constraints. While previous research has shed light on these aspects particularly in remote lessons in higher education, hybrid lessons with child and teenage pupils have thus far been neglected. The present dissertation aims at filling this gap by exploring how pupils in a synchronous hybrid lesson within the Finnish basic education system construct a shared, hybrid interactional space despite their asymmetric participation possibilities in the classroom interactions (Article II).

3 DATA AND METHODS

In this chapter, I introduce the research process and the reasoning behind my methodological choices. The chapter begins with a description of the participants and the research setting (Section 3.1), followed by an account of the data collection process and the two types of data used for analysis, video-audio and screen recordings (Section 3.2). The transcription process and the analytic procedures (Section 3.3) are then described, and the chapter concludes with ethical considerations (Section 3.4) as well as with notes on the effects of the researcher on the data (Section 3.5).

3.1 Participants and setting

The data for the study were collected in seven English as a Foreign Language (EFL) classrooms at four Finnish comprehensive schools (Table 2). The participating groups were from 4th to 9th grades, meaning that the pupils' ages ranged from 10 to 15 years. All participating teachers, assistant teachers, and pupils spoke Finnish as one of their languages, and the pupils studied English as a foreign language. Since Finnish was the shared language in all the recorded classrooms, the majority of the interactions took place in Finnish. The teachers often used English for official classroom talk, however, such as the ritualistic beginnings of the lessons ("Good morning! How are you today?") and certain task instructions (e.g., stating the page numbers to be found in a book). Pupils, on the other hand, used English mainly for tasks that required speaking the target language or to suggest answers to collaboratively negotiated tasks. Managing tasks and social relations was done mainly in Finnish.

In each of the four schools, one English language teacher and one or two groups taught by that teacher participated in the research. As seen in Table 2, the groups were rather small, with the number of pupils ranging from 12 to 22. In none of the groups did all the pupils participate in the study, due to either a lack of consent from their guardian, their own decision to withdraw from the study

despite the guardian's consent, or their absence from school on the day(s) of the recording. Due to the COVID-19 pandemic, the rate of absences was particularly high. The number of participating pupils in each lesson ranged from two to ten pupils. In addition to the teachers and the pupils, there was an assistant teacher present in three groups (Schools B and D; Table 2).

TABLE 2 Participants, lessons, and digital devices used.

School	Group / grade	Age of pupils	Teacher	Lesson	Lesson length	Number of participating pupils	Digital Devices used
School A	8th grade	13–14	Teacher A	1	45 min	4	Pupils' personal mobile phones
				2	45 min	3	
				3	45 min	4	
				4	45 min	4	
	9th grade	14–15	Teacher A	1	90 min	3	School's hybrid laptops & pupils' personal mobile phones
				2	90 min	2	School's hybrid laptops
School B	5th grade	10–11	Teacher B Assistant teacher B	1	45 min	5	School's tablet computers
				2	45 min	5	
				3	45 min	6	
				4	45 min	8	
School C	7th grade	12–13	Teacher C	1	45 min	7	Pupils´ personal mobile phones
	8th grade	13–14	Teacher C	1 Hybrid	45 min	6 (2 of which remote)	Pupils' personal mobile phones
				2 Hybrid	45 min	6 (1 of which remote)	
				3 Hybrid	45 min	6 (1 of which remote)	
				4	45 min	5	
School D	4th grade	10–11	Teacher D Assistant teacher D	1	45 min	10	School's tablet computers
				2	45 min	10	
		11–12		1	45 min	7	

School	Group / grade	Age of pupils	Teacher	Lesson	Lesson length	Number of participating pupils	Digital Devices used
	5th grade		Teacher D Assistant teacher D	2	45 min	5	School's tablet computers
Total	**7 groups**	**Ages between 10 and 15 years**	**4 teachers**	**19 lessons**	**15 h 45 min of lessons / Ca. 51.5 hours of video data**	**47 pupils**	

My aim was to gain data from settings where pupils used digital devices for task-related purposes. I therefore recorded lessons for which the participating teachers had planned activities performed on or with such devices. The extent to which different digital devices were used varied between schools and lessons. In two of the schools, School A and School B, there were two lessons in each, where the pupils spent almost the entire lesson working on or with the help of digital devices, whereas the other lessons involved shorter periods of time spent on digital activities. In School C the pupils spent the least amount of time using technology for pedagogical purposes, with brief singular digital tasks or games. School D fell between the two extremes, with slightly more than half of the lesson time spent performing digital tasks. As to the type of digital devices used in performing pedagogical tasks, the pupils in Schools B and D borrowed school-owned tablet-computers in each lesson, whereas pupils in Schools A and C used their own mobile phones, with the exception of the two 9th grade lessons in School A, where they also worked on school-owned hybrid laptops.

In addition to the variation regarding the time spent on devices and the types of devices used, there were differences in the types of tasks that were performed. Digital games were particularly frequent in the data: all the teachers had planned at least one lesson that included game-like activities involving the use of digital applications, such as Kahoot!, Blooket, or Socrative. These applications offered the possibility to practise language skills through games, and often involved playing as a team and/or in competition with others. In other lessons, quiz-like tasks to check pupils' homework or understanding of specific topics were performed on similar applications or on digital learning platforms that were either publicly available (e.g., Google Classroom) or offered by the publisher of the book series that the school used. Pupils also used digital devices to seek information online, to use translation tools, and to watch video clips for which the teacher had prepared study questions. In one lesson in School A, the 9th grade pupils wrote essays on the hybrid laptops, and in an 8th grade lesson in School C the participants created a Padlet page together, with words, expressions, and pictures related to Christmas. In sum, then, the data included varied examples of how digital technology can be used for pedagogical purposes. In

addition, however, some pupils used their personal mobile phones for personal off-task purposes, such as reading and sending messages or watching video clips not related to the lesson agenda.

The analytical focus arose from the data. During the first steps of the analytical process (see Section 3.3), I noticed that collaborations among peers during digital activities involved complex multimodal negotiations, and the use of eye gaze, in particular, caught my attention as an interesting phenomenon. During the analysis, then, I started to pay attention to how gaze shifts to coparticipants featured in collaborative resolutions of different types of trouble related to interaction, devices, and/or tasks. The data offered an abundance of such instances of collaboration, since in the majority of the lessons pupils were either required to work as teams to perform the tasks or encouraged by the teachers to negotiate answers to them together. In School D, for instance, all the recorded lessons included games or quizzes accomplished in pairs or small groups on a single, shared device. In School B, two of the four lessons were spent conducting project work where pairs or small groups co-operated in searching for information on a sport online and preparing a short presentation on it. Other lessons in School B as well as many of the lessons in School A incorporated individual tasks on individual devices, where pupils were nevertheless advised to negotiate answers together. Many of the tasks in School A and School C were performed as individual work, however, and collaboration in these tasks mostly occurred when one of the pupils recruited others to assist in cases of trouble. Quite surprisingly, the data included few instances of off-task *peer* interactions that revolved around technology, so the extracts analysed in the current study are mainly from on-task interactions, with the exception of Article II.

While all the other lessons in the data are face-to-face lessons in a physical classroom, three of the 8th grade lessons recorded in School C are hybrid lessons. In these lessons, the teacher and most of the pupils were present in the classroom, with a varying number of remote pupils participating via a videoconferencing platform. The platform was visible only on the teacher's laptop at their desk, and the remote pupils and the teacher had turned off their cameras. The remote participants therefore had no visual access to the classroom and could see only the digital materials shared by the teacher on the video call, such as the digital version of their book and web pages. As to aural access, most of the teacher's talk that was directed at the whole class could be heard on the video call, as was also the case for louder voices and sounds, especially from the vicinity of the teacher's laptop. Quieter speech by the classroom participants was inaccessible to the remote pupils. These features created interactional problems and positioned the remote pupils as outsiders, as discussed in Article II.

3.2 Data collection

As I initiated the data collection process amidst the COVID19-pandemic, careful planning was critical, yet in many cases the plans proved conclusively impossible

to achieve. As I started recruiting prospective participants in the spring of 2020, the future had become unpredictable, and the overburdened teachers were hesitant to participate in an additional distraction. By contacting different schools, municipalities, and teachers, and by posting an advertisement on social media groups for teachers, I was however able to find six schools with teachers willing to participate in the research and obtained permissions from the schools and/or the municipalities to conduct research in them. Due to the fluctuating pandemic and the changing restrictions in the schools, I finally collected data in only four schools during 2020 and the spring of 2021.

Owing to the restrictions during the pandemic, the data collection process relied on cooperation with the staff at the participating schools. As outsiders were not allowed in the classrooms of School A and School C (see Table 2), my possibilities for doing "proto-analysis" (see Mondada, 2013b, p. 38) were restricted. In other words, I was not able to familiarise myself with the classroom contexts in depth before data collection, and that made decisions regarding practicalities such as the placement of video recording equipment more difficult. Eventually, being able to visit one of the classrooms in School A outside school hours helped me plan the placement of cameras and microphones in that room. I provided the teachers in Schools A and C with the recording equipment and instructed them on how to position the cameras and microphones. The final placement varied because of situational reasons, however, such as how many of the participating pupils were absent from each lesson and how the teachers needed the space to be organised for tasks. In School B I was allowed to place the video cameras and the microphones in the classroom myself during breaktime but had to leave the classroom for the duration of the lessons due to the restrictive measures in the school. In School D, the data collection was performed in the spring of 2021, and I was able to set up the equipment, start the screen recording application on the tablet computers during the lessons, and to stay and observe as the interactions unfolded. While this offered a more in-depth view of the organisation of the lessons, it also generated questions related to a potentially increased observer effect on the interactions – although it can be argued that the presence of the video cameras alone would inevitably have affected interactions in the classroom (see Section 3.5).

In deciding on the schedule for data collection, I paid attention to ensuring the data were as naturalistic as possible (though see Section 3.5) within the restrictions in force during the time, and to minimising the burden on the participants. The recording sessions were scheduled together with the teachers for when they were planning to use digital devices in the lessons, meaning that the recorded lessons were not always successive. In terms of planning, the hybrid lessons in School C were particularly problematic. Because of the rapidly changing situations in the school and in the classroom, it was only shortly before each lesson when I – and the teacher – knew whether there would be remote participants attending online and who they were and, therefore, which of the participants would be in the classroom on that day.

3.2.1 Video and audio recordings

Since the motivation behind conversation analytic research is to understand the organisation of social interaction, video and audio recordings of naturally occurring social encounters form the core data in the research design (e.g., Mondada, 2013b; ten Have, 2007). In the early days of CA, data collection often relied on audio recordings due to easier access to equipment, but nowadays video recordings are an indispensable part of the research methodology.

For the purposes of analysing multimodality, then, it was vital for the present study to gain video recordings that would capture as much of the embodiment and use of the material resources by the participants as possible. Within the limitations portrayed above (Section 3.2), I planned the placement of the video cameras so that they would record the actions of the participating pupils with enough detail without being too intrusive. The lessons in Schools B, C, and D (Table 2) were recorded with three fixed video cameras with inbuilt microphones and three external microphones, one of which also recorded the teacher in addition to capturing some of the pupils. The second lesson recorded in the 5th grade classroom in School D, however, was recorded with only two cameras since the third had broken down. Further, in School A the teacher had decided to record the lessons with only two cameras, since so many of the participating pupils were either absent or withdrew from the study. Officially, the lessons lasted 45 minutes, except for the 9th grade lessons in School A, which lasted 90 minutes. The lengths of the video recordings, however, depended on when the recording equipment had been turned on.

As an example, Figure 2 illustrates the layout of the 5th grade classroom in School B during the fourth recorded lesson. Camera 1 was placed so that it captured the pupils in the front and middle rows, and Camera 2 recorded the middle and back rows. Camera 3 captured the participants from a different angle, including the teacher. The camera angles excluded interactions among the non-participating pupils seated at the desks marked with an X. In addition, Cameras 1 and 2 were placed at a low level behind empty desks and Camera 3 was placed at the back of the classroom so that they would not hinder movement in the classroom or pupils' visual access to the board. One of the three separate external microphones was placed on the teacher's desk, with two on pupils' desks.

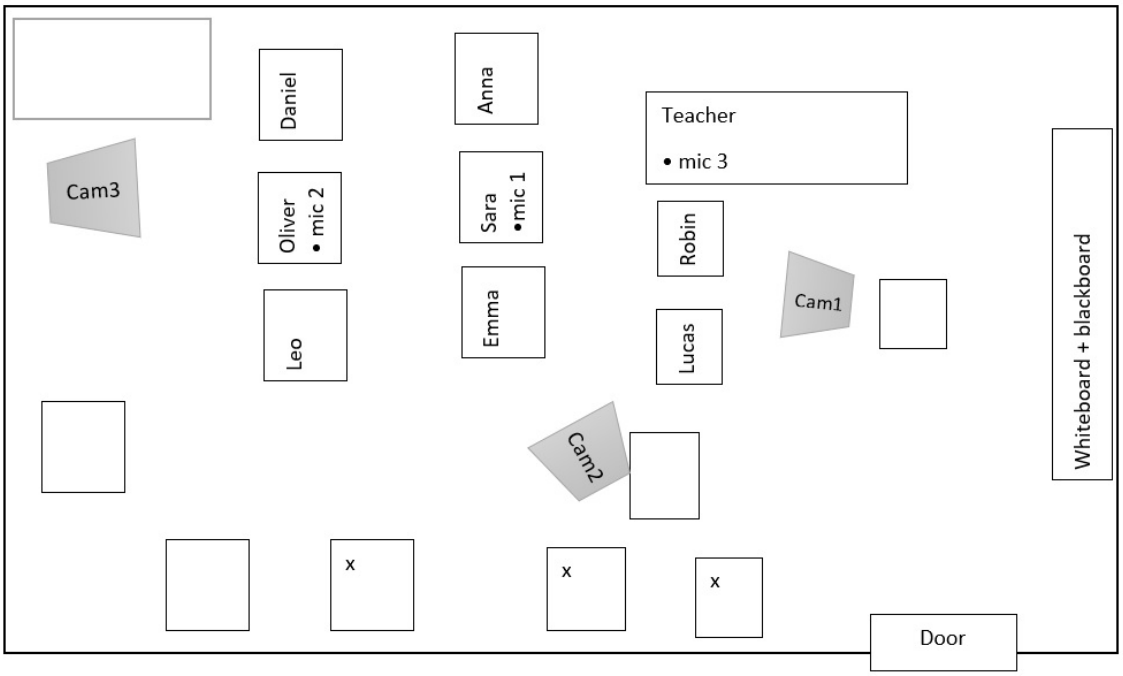

FIGURE 2 The layout of the 5th grade classroom in School B (not to scale).

All together, the data collection yielded circa 51.5 hours of recorded data. Out of these, circa 42.25 hours were audio-video recordings from the classrooms, and the rest were screen recordings.

3.2.2 Screen recordings

The data include two types of screen recordings which enabled an in-depth view of the unfolding interactions around and through technology. While the use of screen-capture software for collecting data has become a frequent practice in CA research on online and hybrid classrooms (e.g., Badem-Korkmaz & Balaman, 2022; Balaman & Pekarek Doehler, 2022; Gudmundsen, 2023; Jakonen & Jauni, 2022; Oittinen, 2022), recording the screens of mobile devices used by pupils in physical classrooms has hitherto been less frequent (but see e.g., Sahlström et al., 2019; Valasmo et al., 2023). After collecting the data from Schools A and B, it became clear to me that capturing the screens of the devices that the pupils used would allow me to understand aspects of the interactions around them better. I therefore decided to record the screens of the mobile devices used for learning tasks in School D, since the pupils there used school-owned devices for learning tasks. This was ethically less problematic than recording personal devices, on which unintentionally capturing sensitive and intimate material would have been more likely. The recordings were made on the built-in screen capture software on the tablet computers and engendered circa 6 hours of data. They became crucial for analysing how talk, embodiment, and actions performed on and by the digital device alternate and co-occur in the unfolding task interaction.

The second type of screen recordings were from the hybrid lessons in School C. On my laptop, by using a free screen capture tool available online, I

recorded the videoconferencing calls through which the remote pupils attended the lessons. The teacher sent me the links to the calls in advance, and I joined the lessons as an observer, with the video and microphone switched off, and started the recorder slightly before the lesson officially began. The recordings amounted all told to circa 3.5 hours of data which enabled me to view the lessons from the remote pupils' perspective and to see which aspects of the classroom interaction were shared with them.

3.3 Transcription and analytic process

To investigate how social interaction is sequentially and temporally organised and locally co-constructed by participants (e.g., Clift, 2016; Lilja, 2022; Mondada, 2012, 2013b; ten Have, 2007), the analytical process in CA typically involves several rounds of observing the recordings. During the initial observations of the data, I approached each data set without *a priori* expectations regarding what I would focus on, even though I had the tentative idea of analysing peer interactions. As I watched the data for the first time, I wrote a logbook for each lesson, noting down the overall structure of the lesson, the participants, the layout of the classroom, the tasks performed, and the devices used, as well as interesting details of the interactions. These initial 'noticings' (Schegloff, 1996, p. 172) later guided my analysis toward the specific features of peer interactions analysed in the four articles. In the subsequent observation rounds I prepared preliminary transcripts of the peer interactions around digital devices to be used as tools in the analysis process. I used the conventions developed by Gail Jefferson (2004) to document participants' talk, prosodic features, and pauses and overlaps, as well as other features such as laughter and singing. Because of the multimodal view of participants' actions consisting of more than talk, I adapted the conventions of multimodal transcription developed by Lorenza Mondada (2022) to show how talk, embodied actions, and material and digital resources are mobilised in the meaning formation in peer interactions. In addition, drawings depicting the embodied actions of the participants and screenshots of the digital devices were inserted in the transcripts to help the reader gain access to the nuances of interactions.

Although the aim of the transcripts is to document and display all central details of interaction to aid in the analysis and to ensure reliability (e.g. Seedhouse, 2005), the transcription process and what was included in the transcripts was ultimately guided by the foci of analysis during the research process. One important challenge of the process was balancing between the robustness and the readability of the transcripts, especially since the *polyfocality* (Thorne & Hellermann, 2022), or the presence of several different foci of attention, in the technology-rich contexts meant that varied modalities were to be transcribed and analysed. The selectiveness and the continuous evolution of transcription during the analysis process can be witnessed in the differences between the transcripts in the four articles included in the dissertation, which all

showcase and highlight different aspects of interaction. The transcripts focus especially on the position and movement of the head and the body in Article I, and on eye-gaze in Article III, whereas in Article IV the actions on and by the digital application are highlighted in addition to the talk and embodied conduct of the participants. In Article II the focus is both on embodiment and the use of digital devices by the focal classroom participant.

Through multiple observations of the data, I started to pay attention to patterns of gaze shifts in the pupils' interactions around digital technology. One of the basic analytic procedures in CA is the collection of cases (e.g., Hutchby & Wooffitt, 2008, p. 88; Sidnell, 2013), and I started to collect the instances of gaze shifts to coparticipants found in the data. During this process I noticed that these gaze shifts occurred as one of the first resources used to indicate that a participant was experiencing trouble with a task, a device, or peer interaction, and was the first step in resolving this trouble. This revelation became the analytical focus of Article III, which was the first article I wrote, and I began investigating the actions for which gaze was used in the process of problem-solving. Eventually it also became evident that eye gaze featured as a prominent resource in negotiations of interactional space, and the role of interactional space in the processes of resolving trouble became one of the main foci of analysis. A similar process of forming collections of interactional phenomena occurred in the analysis for Articles I and IV, where instances of negotiating access to digital devices and blaming peers for mistakes, respectively, were collected and analysed. The next step was to "produce a formal description" (Hutchby & Wooffitt, 2008, p. 104; also Sidnell, 2013) of one illustrative case of each phenomenon and to then compare this account with the other cases in the collection, to gradually arrive at a description that would generally apply to the collection as a whole. Deviant cases were also analysed and accounted for during the process, such as the cases in Article IV where the deviant blame attribution types are described and the ways in which they in fact support the main arguments of the paper are reported on.

Article II differs from the other articles in the study, since it presents a single case analysis of an extended interactional sequence from one of the recorded hybrid lessons. The purposes of conversation analytic single case analysis vary from trying and showcasing the potential of CA analytic tools to providing understanding of specific phenomena for professionals (Hutchby & Wooffitt, 2008; Schegloff, 1987a, 1999; Waring, 2009), and in the case of Article II, the aim was to take a first step to further an understanding of the phenomenon of building interactional spaces in the hybrid classroom context with no visual access to and by the remote participants. In this single case, a pupil in the physical classroom displays interest and eventually succeeds in interacting with one of the remote pupils who participates via a videoconferencing platform opened only on the teacher's laptop. The gradual negotiation of a mutual interactional space between the two participants and the creative use of the affordances of the context intrigued me, and I analysed the case in detail, delineating the strategies used in building the interactional space. The resulting analysis and description

of the single instance in Article II can work towards a discovery of general patterns and structures of hybrid interactions (see also Hutchby & Wooffitt, 2008).

3.4 Ethical considerations

Research with human participants always entails ethical questions, particularly in contexts with children. This study has followed the ethical guidelines of the University of Jyväskylä as well as the Finnish code of conduct for research integrity (Finnish National Board on Research Integrity, 2023) and the European Code of Conduct for Research Integrity (All European Academies, 2023) during the whole research process. In practice, this has meant considering ethical aspects in gaining consent from the participants, collecting and storing the data, as well as analysing and presenting the data. The University of Jyväskylä did not require an ethics approval for the study. In collecting and handling personal data, I have adhered to the EU General Data Protection Regulation.

During data collection, the aim was for the research process to have as little impact on the participants as possible (see also Rapley, 2018), and the voluntary nature of participation was emphasised. The main tools for informing prospective participants about the research and their rights during the process were an information sheet and a privacy notice, which were also sent to the schools and, in some cases, the municipalities before starting to collect data. I also arranged information sessions, which participants and their guardians could attend mostly online due to the COVID-19 restrictions. I gained permissions to conduct research from the participating schools and, when needed, also from the municipality, after which an informed consent to participate was collected from the adult participants and from the guardians of the underaged participants.

During the data collection, the participants were reminded that they were free to withdraw from the study without stating a reason at any point of the process. This was vital, since the consent for the underaged pupils to participate was given by their guardians, and I wanted to ensure that none of the pupils participated against their own will. As a result, a few pupils withdrew during the process, by orally informing me or the teacher that they did not want to be recorded during a lesson. The video and audio recording equipment were placed in the classrooms in a way that permitted capturing the interactions among the research participants, while excluding the non-participants from the recordings. Any non-participants that accidentally entered the classroom space during the recording were deleted or anonymised from the data immediately after the recording session and have not been included in the transcripts nor in the analysis. Besides the audio and video recordings, no other personal data were collected from the participants besides the names in the consent forms, which were stored separately from the research data.

The data have been stored at a network drive of the University of Jyväskylä protected by a username and a password as well as on a locked-up, crypted external hard drive. Access to the data has been confined to myself as the

responsible researcher and my supervisors, who have a restricted access to the data through me. To ensure confidentiality, any data clips presented to others in data sessions, presentations, and talks have been pseudonymised by altering participants' voices and using sketch filters on the video. In addition, the participants have been given pseudonyms and any mentions of names and locations of the participants and of the school have been deleted from the data. Although most of the participants or their guardians gave their consent for showing the recordings publicly without anonymisation, I decided, particularly due to the vulnerability of the underaged participants, that I needed to protect their privacy by editing all the data that have been presented to others.

Similarly, pseudonyms have been used in the transcripts, and drawings of participants have been used instead of still pictures from the video recordings. Confidentiality has also been sought by the decision to offer only limited descriptions and information on the participating groups in this dissertation.

3.5 Researcher effect and positionality

While the aim of data collection in CA is to produce recordings of "*naturally occurring activities*" (Mondada, 2013b, p. 34; emphasis in the original), a note on the researcher effect and the researcher's positionality is necessary here.

The 'naturality' of the data in CA research refers to the fact that the recordings have been made in a "naturally organized" (Lynch, 2002) setting, which exists prior to and regardless of the research. In this sense, the classrooms in the present study constitute natural settings, and the interactions that unfold in them are natural since they would have taken place without me as the researcher or the recording equipment being present. As discussed in Mondada (2013b), however, CA has been criticised on the grounds of the observers' paradox (Labov, 1972), which in essence means that no recorded data can be natural since the research process, including the equipment and the possible presence of the researcher in the situation, will always influence the context. According to Mondada (2013b), this criticism has usually been responded to by minimising the disturbance caused by the recording equipment. This was also considered in the types of equipment used and their placement in the present study. In addition, another solution in CA has been "the identification of observable moments in which participants orient to recording devices" (Mondada, 2013b, p. 34). In other words, Mondada suggests that it is possible to notice the instances when the recording equipment becomes relevant for the participants, since they visibly display their orientation to it. While the observable actions of participants are the main object of study for CA, I suggest that the situation is more complicated than that, since we cannot for certain prove that participants would act and interactions would unfold in a similar way if the cameras were not present.

Another question altogether is whether the researcher's presence in the studied context should be avoided completely. While handbooks on conducting

CA and other video-based studies have generally guided researchers to ensure the natural flow of interactions by distancing themselves and cameras from the recorded situations as carefully as possible (e.g., Heath et al., 2009; ten Have, 2007; see also Hofstetter, 2021), Hofstetter (2021, p. 1) argues that participating in the recorded activities can be beneficial as it affords the researcher a member's view of even those practices that would otherwise be difficult to access. In addition, Hofstetter points out that "everything is natural of *something*" (p. 14, emphasis in the original), referring to the fact that all recorded interactions provide us with evidence of how the participants in those particular instances locally construct and make sense of the situation.

While I began the research process with the 'traditional' mentality of ensuring the natural flow of interactions by withdrawing myself from the recorded classrooms, I have later come to acknowledge – and to embrace – several issues that have influenced the data. First, there is the question of how much the teacher's knowledge of the research topic influenced the overall lesson structures. To minimise the potential effect on the lessons, we had agreed on scheduling the data collection for days on which the teachers had in any case been planning to include digital tasks and activities in the lesson plan. The knowledge of the study centring around the use of technology may still have affected the amount and type of technology use in the lessons. Although this could be seen as a potential threat to the validity of the study, I argue that the recordings are still evidence of how the participants interact with the technology that is implemented in the classroom, regardless of the reason why it has been introduced. Second, my presence in the lessons I observed at School D (see Table 2 in Section 3.1) perceivably influenced some instances of interaction, and my role in the classroom fluctuated as it was locally negotiated in cooperation with the classroom participants (e.g., Goico, 2021; Pehkonen et al., 2021). For instance, pupils occasionally asked me for help with the digital devices and a few were interested in the cameras, asking me questions about them. In these moments, my participation status was spontaneously and momentarily shifted from an observer to a member in the ongoing activities. At the same time, I gained first-hand knowledge of handling the devices, for instance, and was able to observe what the participants oriented to during the activities and what kinds of problems they encountered. Finally, my third concern with the researcher's effect on the data collection concerned the recording equipment. There are occasions in the video data where pupils display their orientation to the cameras and microphones and in a few cases perform for the cameras, receiving attention and laughter from others. While these cases are brief moments within the recordings, they remind us of the effect that the research process may have on the participants even without the researcher's presence. Article II is a case in point. The microphones used for research purposes together with the equipment that the teacher uses for broadcasting the lesson to the remote pupils create confusion in the classroom. The focal classroom participant first attempts to contact one of the remote participants through the microphone attached to the camera, before realising that they can use the teacher's laptop for interacting with each other.

The research process therefore clearly influences the trajectory of the classroom participant's attempts at solving the problem. As discussed in Article II, however, what the participant does and in what way is not prompted by the researcher. Instead, the motivations for contacting the remote participant and the actions in achieving this rise from the focal pupils and how they construct the situational context. In other words, the data from these instances are natural in the context that the participants find themselves in and show how they make sense of and resolve the situation.

Lastly, a final note on researcher positionality. My background as an EFL teacher was one of the motivations for conducting research in a language classroom context. My initial worry was that this history would lead to a biased analysis of the data. This history has also provided me with important background knowledge, however, as well as a professional perspective on the institutional activities I recorded, and this can be argued to have improved the analysis (Arminen, 2005, pp. 61–62). In other words, my membership of the category 'language teacher in the Finnish educational system' has also allowed me to make sense of the classroom interactions from a position very different from someone not acquainted with today's pedagogical contexts. Familiarity with many of the pedagogical activities and the motivations behind them has made some of the "members' practices more readily observable" (Pehkonen et al., 2021, p. 21) to me, particularly in the lessons where I was able to observe and to some extent participate in the situated activities. Although the accumulated member's knowledge affords deeper understanding of the context, it is still the emic focus on the observable details of the video recorded interactions that has guided the analytical process.

4 FINDINGS

In this chapter, I present the main findings of this doctoral dissertation. First, I introduce the four peer-reviewed articles that the study is based on and discuss their findings (Section 4.1). The focus is on how pupils multimodally resolve trouble when performing tasks on digital devices or attempting to interact via a technological medium. At the end of the chapter, I briefly summarise the main findings in relation to the overall research questions of the dissertation (Section 4.2).

4.1 Multimodally resolving trouble in peer interactions around digital technology

This section presents the main themes and findings of the four articles, which explore the overarching research questions of the dissertation from different perspectives. The overall aim of the present study is to understand and describe the types of trouble that are encountered in contexts where digital technology forms a part of the official classroom configuration and how pupils multimodally orient to and collaboratively resolve this trouble. Each article also considers how negotiations of interactional space feature in the resolutions of trouble or become the trouble source. Three of the articles address the research questions in the context of face-to-face classrooms, where digital devices are used to achieve pedagogical goals, both through individual and collaborative tasks (Articles I, III, and IV). Article II discusses problem-solving in peer interaction during synchronous hybrid teaching, where the trouble lies in finding a way to communicate with a participant in a different physical location.

The four articles are ordered according to their themes. Articles I and II focus on trouble with access to interactions and to devices that are relevant for the task activity. Trouble described in these articles thus affects participants' possibilities to interact with one another or to participate in tasks. At the same time, this creates a problem of constructing and renegotiating a shared

interactional space. In Article I, the focus is on how pupils negotiate access to digital devices in face-to-face classrooms, whereas Article II describes the trajectory of opening a conversation between a local classroom pupil and a remote participant. Thus the two articles inspect how joint attention and interaction are achieved in peer interaction in technology-rich classroom contexts and how the interactional ecology shapes the possibilities to (begin to) perform shared activities.

Articles III and IV, on the other hand, explore trouble cases that arise during digital task performance. Article III focuses on the use of eye gaze in resolving trouble related to digital tasks and to the progression of peer interaction through recruitments and response pursuits. Article IV illustrates the multimodal design of blame attributions that are used to resolve the issue of mistakes made by peers during collaborative digital tasks. These two articles contribute to our understanding of multimodally designed social actions in trouble resolutions and of how renegotiations of interactional space feature in resolution processes.

4.1.1 Article I: Resolving asymmetry of access to devices through multimodal resources

Vänttinen, Minttu (2024). Resolving asymmetry of access in peer interaction during digital tasks in EFL classrooms. *Linguistics and Education, 80*, 101287. https://doi.org/10.1016/j.linged.2024.101287

Negotiations of access to digital devices have received little attention within CA research on classroom contexts (see, however, Jakonen & Niemi, 2020; Råman, 2022). It has been shown, however, that classroom objects, in general, are relevant interactional resources (Jakonen, 2018b) and access to them can have an impact on the organisation of interaction (e.g., Heller, 2016). In Article I (in press), I argue that lack of access to digital devices can also result in a 'fractured ecology' (Luff et al., 2003), where participants' abilities to interpret the ongoing interaction and task activity are asymmetric due to their varying degrees of access to the information on screens. To resolve this asymmetry, peers need to construct a shared interactional space with a mutual focus on the technological device (see also Oittinen, 2020b) in order to achieve joint attention (Kidwell & Zimmerman, 2007) to the digital task. Recent CA research on learning contexts has been interested especially in how intersubjectivity and joint attention are achieved in online and hybrid settings (e.g., Balaman & Pekarek Doehler, 2022; Jakonen & Jauni, 2021; Oittinen, 2022; Rusk & Pörn, 2019; Uskokovic & Talehgani-Nikazm, 2022) and less in face-to-face interactions around digital devices. In a setting where students walk together while handling a shared digital device used for a pedagogical activity, however, Thorne and colleagues (2015) show that joint attention to the device is maintained through embodied resources, such as gaze and postural alignment with the device and its holder. Article I contributes to this line of research by illustrating how pupils seek joint attention through negotiations of access to digital devices.

To be more specific, Article I explores the multimodal trajectories of resolving asymmetric access to a digital device when mutual attention to it is needed for collaborative purposes. The topic for the study arose from the observation that pupils in the data visibly orient to their lack of visual, aural, or haptic access to digital devices that others are handling and attempt to resolve this asymmetry of access through multimodal resources. The multimodal work by these pupils results in or demonstrably aims at two differing types of scenarios: 1) obtaining the exclusive rights to handle the device they seek access to, or 2) achieving shared access to the device to collaborate on a task or to help a peer. For Article I, I decided to focus on the latter, analysing the resulting collection of 51 cases, where pupils strive for mutual visual and/or aural access to a digital device. The cases come from all four participating schools. The aim of the study is to illustrate how shared visual and/or aural access to mobile digital devices is negotiated through multimodal resources and what preferences pupils display during these negotiations for access. In addition, Article I highlights resolutions of asymmetric access as indicative of peers' local, situated roles and authority.

At the time of writing Article I, only two studies had specifically addressed negotiations of access to digital technology in face-to-face classrooms. In one of these, Jakonen and Niemi (2020) investigate how pupils block their peers' access to a tablet computer they are handling. Råman (2022), on the other hand, shows how a teacher negotiates visual and/or haptic access to elderly students' devices through verbal directives and gestures or more directly through taking hold of the device. These negotiations for access also reflect the distribution of deontic rights and obligations (see e.g., Stevanovic & Peräkylä, 2012) between participants, and teachers' institutional authority is reflected in their rights to access students' devices (Råman, 2022) and to allocate turns on the devices to pupils (Theobald et al., 2016). In peer interaction, participants do not have the same kind of institutional authority, however, and it has been suggested instead that merely holding a device may bring along particular rights to the device-holder (Thorne et al., 2015). While this is also the case in the data for Article I, I also show that there are several types of local roles available that can influence negotiations of access to digital devices in classroom peer interaction.

The findings show that asymmetry of access to a digital device is oriented to and resolved primarily through embodied resources, such as body shifts, head movements, and moving in the classroom, as well as through arranging material objects, including furniture and digital devices. The multimodal trajectories of access negotiations indicate a preference for the pupil that lacks access to the device held by a peer to perform trouble resolutions and for avoiding touching the device unless a participant's rights to access it are constantly violated. In addition, the findings illustrate the kinds of negotiations that occur during collaborations around digital technology and the situated, local roles that are displayed in these processes.

The analysis is divided into two subsections that illustrate the two general contexts in which the access negotiations in the data set occur: 1) during individual tasks on individual devices, typically after recruitments for help, and

2) during collaborative tasks. In both contexts, the negotiations stem from the need to collaborate on a device and the resources used to gain visual and/or aural access to it are similar, but they also reflect different kinds of rights and obligations. In the first subsection, it is shown how pupils orient to their situated 'ownership' (see Day & Rasmussen, 2019) of the devices they are borrowing from the school to perform individual tasks. When one of the participants encounters trouble with a task and recruits assistance from a peer, the participants shift their attention from individual trajectories to a joint orientation to solving the trouble. In addition to transforming the interactional space, the recruitment involves a renegotiation of the pupils' roles as the recruited participant is oriented to as having the epistemic access to knowledge and ability to help. The recruited participant therefore also gains a right to access the trouble source. While the recruiters tend to start arranging for a shared interactional space to grant the recruited peer access to the device, this access is sometimes displayed as inadequate.

The findings of the first subsection show how pupils in these cases orient to and solve the asymmetric access to the device through multimodal resources. These include head and body shifts, moving closer to the device, and organising the material space by relocating objects and furniture. Throughout these negotiations, participants carefully coordinate their actions in such a way that the device-holders maintain their control of the devices, thus displaying an orientation to their exclusive deontic rights over them. The findings also illustrate how visual and/or aural access to the digital devices used for learning is crucial for assisting peers in their tasks and thus for collaboration.

The second subsection of the analysis illustrates trajectories of negotiating visual access to a shared device used for a collaborative task. In this context, peer groups work on a single digital device to perform joint tasks and orient to their equal rights and obligations as team members. Since digital devices are generally designed for individual rather than collaborative use, however, they can typically only be handled by one participant at a time, and making the small screen visible to all participants simultaneously can prove difficult. In the data for the study, this tends to be resolved through a distribution of roles: one participant at a time handles the device while others perform other tasks, such as looking for and providing right answers or deciding over team names or turns on the device. Situations emerge, however, where one of the team members lacks visual access (at least momentarily) to the device screen and to the information on it when it is needed. Extract 3 in Article I demonstrates how this can lead to the exclusion of that team member from the task interaction and how they can then attempt to (re)gain participant status through negotiating access to the device in embodied ways. As in negotiations after recruitments, this is done through head and body shifts that visibly display an orientation to the asymmetry of access but still align with the device-holder's rights to handle the shared device. As Extract 4 in the study illustrates, however, these rights can clash with other team members' rights if one of the peers is constantly denied access to the shared device. In these cases, the interactional space and access to the device is renegotiated more boldly

by repositioning the device held by a peer through touch. The analysis shows how this reflects both a rejection of the device-holder's exclusive deontic rights and an allusion to the participants' responsibilities as team members. In other words, team members' rights to access shared devices seems to supersede the situated ownership granted to the device-holder, at least when those rights have been constantly neglected.

The findings show that resolving trouble with access to digital devices in classroom peer interaction does not only reflect static roles related to institutional authority or local ownership of devices. Rather, rights and responsibilities are (re)negotiated in the local, moment-to-moment trajectories of access negotiations. The findings therefore contribute to our understanding of the moral order and of the different types of roles manifested and negotiated in classroom interactions. In addition, Article I demonstrates that asymmetric access to devices used for tasks can be consequential for task-progression as well as group dynamics and that its resolution is therefore crucial for the collaboration of peer groups.

Article I contributes to CA research investigating peer interaction around digital technology and to studies focusing on multimodality in technology-rich pedagogical contexts. While previous studies have demonstrated the use of eye gaze, talk, touch, and gestures in producing social actions and meaning around technology (e.g., Jakonen & Niemi, 2020; Juvonen et al., 2019; Theobald et al., 2016; Tuncer et al., 2022), Article I adds to this line of research by illustrating the role of head and body shifts and of moving in the physical space in displays and resolutions of trouble. Furthermore, the study reveals that collaborating on a digital device requires diverse forms of competences, including the ability to handle digital devices, to gain and maintain access to them, to work in collaboration with others, and to negotiate roles, rights, and responsibilities.

4.1.2 Article II: Resolving asymmetric access to interactions in a hybrid classroom

Vänttinen, Minttu (2023). *Constructing interactional space across distant locations in a hybrid classroom* [Manuscript submitted for publication]. Department of Language and Communication Studies, University of Jyväskylä.

Article II (submitted) addresses the problematics of engaging in classroom activities and interactions in a hybrid classroom, where geographically distributed pupils have limited access to each other's embodied cues and surroundings. The single case analysis focuses on the multimodal construction of a hybrid interactional space between a dyad of pupils, one of whom is present in the physical classroom while the other participates through a videoconferencing platform that is visible only on the teacher's laptop in the classroom. The study highlights the asymmetries of participation in a new-to-the-participants hybrid configuration but also draws attention to pupils' creative use of the affordances of the local context in resolving the problem. In addition, it offers a unique glimpse into the continuously changing circumstances that

teachers and pupils needed to manage in classrooms during the first year of the COVID-19 pandemic.

The data set for Article II consists of three video recorded instances from a single hybrid lesson in School C (see Table 2 in Section 3.1). In their hybrid configuration, the classroom participants and the remote participants, despite the affordances of the videoconferencing platform, do not have visual access to each other. The three interactional sequences presented in the article are the only times during the lesson that a classroom pupil demonstrably orients to interacting with the remote participants, and they illustrate an intriguing trajectory of finding a medium to interact with a remote pupil, confirming their availability and establishing contact with them, and finally building a stable hybrid interactional space for an off-task conversation. Eventually the established space is also utilised by the teacher to engage the remote participant in the current pedagogical activity.

Article II contributes to research on interactional space (Haddington & Oittinen, 2022; Mondada, 2009, 2013a) and openings of conversation (Schegloff, 1968), which are examined from the perspective of participation (e.g., Goffman, 1979; Goodwin & Goodwin, 2004; Jacknick, 2021) in hybrid interactions. The study shows how a hybrid interactional space is constructed through a stepwise coordination of actions (see e.g., Oittinen & Piirainen-Marsh, 2015) in a context where the local and the remote participant cannot see each other and are unfamiliar with the technological configuration. In this study, I conceptualise interactional space as joint attention and mutual orientation built through the multimodal resources that the participants have at their disposal in the local context, instead of definitions that emphasise physical copresence (cf. Mondada, 2009, 2013a) or visual access to coparticipants (cf. e.g., Kohonen-Aho, 2023). Generally, previous research has shown the complexity and challenges of constructing and managing interactional spaces, intersubjectivity, and engagement in video-mediated and hybrid contexts (e.g., Badem-Korkmaz & Balaman, 2022; Melander Bowden & Svahn, 2020; Saatçi et al., 2020; Wigham & Satar, 2021), resulting from a lack of "reciprocity of perspectives" (Heath & Luff, 1992, p. 320) and from the existence of various overlapping interactional spaces that can be both private and public (Büyükgüzel & Balaman, 2023; Oittinen, 2018; Kohonen-Aho, 2023; Wasson, 2006). In addition to these complexities, however, Article II reveals the creative and flexible ways of using the situated embodied and technological resources available to participants for achieving mutual attention (see also Çimenli et al., 2022; Dooly & Davitova, 2018; Gudmundsen, 2023; Haddington & Oittinen, 2022; Oittinen, 2022).

Article II also contributes to our understanding of openings, which have previously been explored, for example in face-to-face (e.g., Schegloff, 1968; Mondada, 2009) and telephone call contexts (e.g., Schegloff, 1979; Whalen & Zimmerman, 1987). The existing studies on video-mediated and hybrid settings (e.g., Oittinen & Piirainen-Marsh, 2015; Siitonen et al., 2022) mostly focus on the official opening phases of joint interactional events, whereas Article II investigates how two participants perform an opening of conversation within a

hybrid configuration after the official opening phase of the lesson has been performed. It thus sheds light on the possibilities and constraints of building hybrid interactions between pupil dyads during different phases of lessons.

The findings show how the classroom participant engages in prolonged pre-beginning (e.g., Mondada, 2009; Schegloff, 1979, p. 34; Whalen & Zimmerman, 1987) work to identify the medium through which contact with one of the remote participants can be established and how this involves testing various technological devices available to the participants. The process is delayed partly due to the microphone that has been placed on the classroom participant's desk for research purposes and which the focal pupil initially tests as a potential communication channel. The microphone does not transmit sound to the remote participants, and the classroom participant eventually changes their trajectory. The initial contact is finally achieved via an instant messaging application on the pupils' mobile phones. Nevertheless, the classroom participant continues to seek contact via an official medium of the lesson, orienting to the teacher's laptop, on which the video call has been made and which has been left unattended by the teacher. Since the video has been turned off for all the participants and the classroom participant does not have visual access to the laptop screen, contact needs to be made relying on audio only. The first successful opening through the video call is performed through a summons–answer sequence (Schegloff, 1968; see also Jenks & Brandt, 2013), as the classroom participant greets the remote pupil, addressing them by name. Although the remote pupil responds with a greeting, the opening does not result in continued interaction but, instead, the classroom participants start joking amongst themselves. The established connection is exploited later in the lesson, however, as the focal classroom pupil again seeks contact with the remote participant. After another summons-answer sequence, the two engage in a brief off-topic conversation via the video call on the teacher's laptop.

The analysis also reveals the potential role that classroom pupils have in engaging remote pupils in classroom activities and interactions during synchronous hybrid teaching. Namely, the hybrid conversation between the classroom and the remote pupil draws the teacher's attention, and the already established hybrid interactional space is utilised by the teacher to enquire of the remote participant's progress with the current pedagogical task. The focal classroom participant has thus acted as a bridging participant between the classroom and the remote locations, eventually promoting the remote participant's (more) active engagement in classroom activities. This is highlighted in the change in the remote pupil's participation status in the lesson: whereas they have previously been positioned as a (potential) overhearer rather than a ratified participant (Goffman, 1979) through third-person references, their status shifts to that of an active participant in the interactions that unfold via the video call.

Article II highlights the asymmetric possibilities of participating in a hybrid classroom, thus conforming to the findings of previous research that has illustrated the complexity of hybrid contexts (e.g., Büyükgüzel & Balaman, 2023;

Jakonen & Jauni, 2021, 2022; Kohonen-Aho, 2023; Oittinen, 2022) and the "primary room dominance" (Karis et al., 2016, p. 31) characteristic of hybrid configurations, where most participants are located in the same physical setting. In addition, however, the study reveals the additional constraints for participation created by the lack of visual access to each other's embodied cues and surroundings when all participants in the video call have turned off their cameras. As also shown by Jenks and Brandt (2013), achieving mutual orientation in this type of a setting can rely on verbal summons-answer sequences through which a coparticipant's availability for interaction is confirmed. Owing to the limited modalities available for interaction, openings of interaction can also be disrupted (see also Oittinen & Piirainen-Marsh, 2015) and delayed. In addition, the complexity of the hybrid configuration, especially if it is new to the participants, can lead to confusions over which technologies serve as communication channels between participants in different locations.

In addition to exploring the potential challenges of hybrid teaching, Article II sheds light on the classroom interactional competences (Walsh, 2011, 2012; also Jacknick, 2021; Sert, 2019) required and displayed by pupils in synchronous hybrid teaching. It illustrates the flexibility that pupils show in resolving interactional trouble in a stepwise, locally relevant manner and by fluently shifting from one possible trajectory to another. Although the study represents a single case analysis of a unique setting that the participants are only beginning to get acquainted with, it serves as a first step in delineating and understanding the multimodal strategies in building hybrid interactional spaces in classroom contexts with limited visual access to and by remote participants. It also shows how CA studies can contribute to the development of technological solutions and pedagogical practices for educational contexts by offering detailed analyses of interactions in the increasingly technologized learning and teaching settings.

4.1.3 Article III: Resolving interactional and task-related trouble through gaze shifts

Vänttinen, Minttu (2022). Eye gaze as a resource in handling trouble around mobile devices in classroom interaction. *AFinLA Yearbook, 2022*, 395–413. https://doi.org/10.30661/afinlavk.114401

Article III (Vänttinen, 2022) investigates the role of eye gaze in orienting to and resolving trouble in peer interaction during tasks performed on or with mobile digital devices. It focuses on two types of trouble: trouble with task accomplishment as well as trouble related to peer interaction during digital tasks. The analysed cases come from different lessons in all four participating schools, and they therefore illustrate the general tendency in the data to indicate something as problematic through gaze shifts during tasks that involve handling digital devices. This article was the first one I wrote, and the preliminary idea arose during the first rounds of observing the video recorded data as I noticed that eye gaze was predominantly directed at the digital devices used for tasks even when simultaneously interacting with coparticipants. I became interested

in instances when gaze was shifted to peers during digital tasks and started exploring the context and functions of these gaze shifts. Prior research has shown that gaze shifts to coparticipants occur more frequently in sequence initiations than in other positions (Rossano, 2013) and while many of the gaze shifts in the data collection conform to this claim, sequences are also often initiated while gazing at the device. Thus, more seems to be needed for the participant to prioritise gazing at a coparticipant over focusing on the device. A closer inspection of the initial collection of cases revealed that gaze shifts tended to occur as indications of and as first attempts at solving trouble. Trouble types varied from problems with technological aspects of the devices to managing peer relations, and while some of these are discussed in Articles I, II and IV, the focus in Article III is on the instances of hiccups in the progression of peer interactions and on task-related problems. The article aims at showing how gaze is used to build joint attention and a shared interactional space for recruitments of help and response pursuits.

Article III draws on the concepts of recruitment of assistance (Drew & Kendrick, 2018; Kendrick & Drew, 2016), response pursuit (e.g., Pomerantz, 1984b), and interactional space (Mondada, 2009, 2013a; also Haddington & Oittinen, 2022), which can all involve gaze shifts as one of the multimodal resources to achieve interactional goals. Recruitments of assistance refer to the various ways in which help is offered and sought in interaction through verbal and/or embodied means (e.g., Kendrick & Drew, 2016), and it has been shown previously that eye gaze to a coparticipant can be used in conjunction with other multimodal resources to recruit help (Drew & Kendrick, 2018; Pfeiffer & Anna, 2021). Gaze can also function as one of the resources to pursue a response when a coparticipant fails to respond to the first-pair part of an adjacency pair (Stivers & Rossano, 2010), for instance when teachers attempt to elicit student responses after an unanswered question (e.g., Duran & Jacknick, 2020). Both recruiting assistance and mobilising a response tend to require (re)negotiations of interactional space as mutual attention needs to be brought to the trouble source and its resolution. While both social actions have been studied in different contexts, including the practices of teachers in classrooms (e.g., Duran & Jacknick, 2020; Okada, 2010), learners' multimodal achievement of these actions remains understudied (see, however, Jakonen, 2014). Article III therefore focuses on how pupils within technology-rich classrooms in Finnish basic education use gaze and other multimodal resources to orient to trouble, to negotiate shared focus on the trouble source, and to resolve it through recruitments of help or response pursuits.

Since participants' eye gaze in the data is predominantly directed at digital devices while performing tasks on them, gaze shifts to coparticipants become particularly noticeable and meaningful for the interaction (see also Auer & Zima, 2021). This is the case for all types of tasks, from individual writing tasks and quizzes to collaborative games, although gaze shifts to coparticipants tend to occur more during multiparty collaborations on a single device. The 37 examples that I focus on in the analysis for this article are cases where gaze shifts are used

to signal inability to proceed with a task due to technological problems or lack of knowledge needed in the task (20 cases) or to orient to trouble in the progression of peer interaction during a task (17 cases), which ultimately can also lead to disruptions in the task activity. Pupils in the data seek to solve problems with the task and/or with the digital device through recruitments of assistance, whereas response pursuits are used in instances of interactional trouble.

Most of the recruitments of assistance in the data for Article III include combinations of gaze shifts to coparticipants and verbal requests or reports of trouble in their formation. While embodied displays of trouble (e.g., visibly looking for something in a book) or vocalisations used as trouble alerts (e.g., *öö*, 'umm') sometimes pave the way for the recruitments in the data, the recruitment proper is initiated with a gaze shift to a peer, either preceding or coinciding with a verbal utterance. In one of the cases, the recruitment is initially performed solely through a gaze shift without verbal resources, but when a response is missing, it is mobilised by producing verbal reports of the trouble in addition to a prolonged gaze at the recipient. The example highlights the role that eye gaze is given in the action formation by the recruiter: withdrawing gaze from the device and directing it at a coparticipant is relied on as a prominent visual cue of trouble. It is not always successful at drawing a coparticipant's attention, however, as it depends on the recruited peer's availability for interaction. Recruitments therefore also involve a (re)negotiation of the interactional space since both the recruiter and the recruited participant need to shift their orientation from their ongoing trajectories to solving the problem and to establish mutual focus on the trouble source.

In response pursuits, gaze shifts to coparticipants are used either as the only resource to indicate trouble and to mobilise a missing response or as part of a multimodal ensemble, together with verbal utterances (e.g., repetitions of a prior turn) or other embodied resources (e.g., nods, body shifts). Usually, a gaze shift to the recipient occurs at a sequence-initial position in the response pursuit and is performed when a response has not been produced. It seems to function both as an indicator of a problem in the interaction and as a way to pursue a relevant response. Other resources tend to be harnessed if the gaze shift and/or a sustained gaze does not yield results. The two examples of response pursuits presented in Article III show how gaze is employed as the first resource 1) to transform the interactional space to achieve joint attention, or 2) to resume a fragmented interactional space, which has resulted when interaction has come to a halt due to the coparticipant's attention having shifted away from joint task to a private off-task activity. Similarly to recruitments, the successfulness of the gaze shifts in response pursuits is contingent on the availability of the recipient, and as Extract 4 in Article III demonstrates, task progression and peer interaction can be interrupted by competing lines of activity.

Article III contributes to research investigating the functions of eye gaze by showing how it systematically operates as a constituent in recruitments and response pursuits around digital devices. While previous studies have also suggested that eye gaze can function as a resource in response mobilisations

(Duran & Jacknick, 2020; Stivers & Rossano, 2010), Article III adds to these findings in two ways. First, it demonstrates that a gaze shift from a digital device to a coparticipant functions as one of the *first* indications of trouble with task-progression or peer interaction. Second, gaze is employed both to check the availability of the recipient and, often together with other multimodal resources, to resolve trouble by initiating a recruitment or a response pursuit. Similar observations about the functions of gaze shifts to coparticipants have since been made by Satti (2023), who illustrates differences in gaze patterns during verification requests across different varieties of Spanish and demonstrates that gaze shifts to coparticipants are used together with other multimodal resources to imply uncertainty over what is being uttered and to mobilise responses.

In addition, Article III contributes to research focusing on object-centred interactions and multiactivity, which has shown that eye gaze tends to be on the object that is handled but can be harnessed for other purposes when needed, such as interacting with coparticipants (e.g., Deppermann, 2014; Nishizaka, 2014; see also Tuncer et al., 2019). As the findings highlight, however, withdrawing gaze from the digital device during a task and shifting it to a peer gains particular significance in this technology-rich context and is oriented to as one of the primary resources to flag trouble and to initiate problem-solving sequences.

The findings show that resolving trouble during tasks on and with digital devices in classroom contexts requires skilful management of interactional spaces. Orientation and resources need to be divided and prioritised between the digital device and peer interaction on a moment-to-moment basis, and collaborative resolutions of trouble can succeed only if the coparticipant's availability for interaction is confirmed and a mutual focus on the trouble is secured. As Article III demonstrates, gaze shifts to coparticipants are treated as essential constituents in performing these actions.

4.1.4 Article IV: Resolving issues of mistakes through multimodal blame attributions

Vänttinen, Minttu & Kääntä, Leila (2024). Multimodal blame attributions in technology-supported peer interaction. *Classroom Discourse*. Advance online publication. https://doi.org/10.1080/19463014.2023.2292361

Article IV (Vänttinen & Kääntä, 2024) focuses on the resolution of a particular type of trouble in peer interaction around digital devices: mistakes made by peers during collaborative digital tasks. These mistakes affect the whole team's task performance and can be oriented to through blamings, whereby the responsibility for a mistake is attributed to a coparticipant. The article investigates the multimodal construction of such blame attributions as a way to deal with the issue of the mistake, considering the role of embodied actions and digital devices in their formation. It also shows how the interactional space is renegotiated in order to bring joint attention to the mistake and to solve the question of culpability.

The data set for Article IV comprises 19 cases from a 4th and a 5th grade classroom in School D (see Table 2 in Section 3.1), where tablet computers were used for collaborative tasks, including quizzes and other game-like tasks. The context enabled us to explore resolutions of trouble that involved moral implications for peer groups and were related to the progression of digital tasks performed as part of the official lesson agenda. For this study, the screen-recordings collected during the four lessons in the school provided invaluable information, as we were able to see what occurred on the screens of the devices during peer interactions and how the actions on the screens were used as resources for performing blame attributions.

Article IV relies on the notion of blame attributions by Pomerantz (1978), who showed that blamings consist of two parts: a report of an "unhappy incident" followed by an attribution of blame for that incident. These two parts do not need to immediately follow one another nor do they need to be produced by the same participant, as the examples in the article by Pomerantz (1978) and in later studies (e.g., Atkinson & Drew, 1979; Niemi & Bateman, 2015) illustrate. While the sequential structures and verbal design of blamings and accusations among children and adolescents have been described in several studies (e.g., Evaldsson, 2007, 2016; M. H. Goodwin, 1990; Niemi & Bateman, 2015), their multimodal construction has been understudied (but see M. H. Goodwin et al., 2002). Article IV therefore aims at bridging this gap and furthering an understanding of blamings as social actions by illustrating how multimodal resources are used to construct blame attributions. We show how digital technology and embodied resources merge into a phygital entity (Due & Toft, 2021) that accomplishes the blame attribution. In this way, the study also contributes to research on multimodality (e.g., Mondada, 2019) in device-centred peer interactions, which has investigated themes such as the organisation of interaction around shared devices (e.g., Jakonen & Niemi, 2020; Theobald et al., 2016; Thorne et al., 2015) and the usage of the affordances of technology, such as spellcheckers (e.g., Musk, 2016) and synthetic voicing (Norén et al., 2022), for corrective purposes in collaborative tasks.

The findings illustrate blame attributions as local, multimodal accomplishments that are intertwined with task-interaction. Pupil dyads and peer groups negotiate and provide responses to the scripted questions on the game and quiz applications, and their answers trigger automatic evaluations that appear on screens. The digital tasks are thus performed as series of automated Initiation – Response – Evaluation sequences (IRE; Mehan, 1979) on the digital devices. When a pupil chooses an incorrect answer, their peers can orient to the problematic situation by attributing blame to the responsible party. The analysis shows that the design of such a blame attribution is contingent on whether or not the mistake is oriented to by a peer before the application marks it as incorrect. If the peer flags the mistake as soon as it is made and before the application reports it, they tend to design the blame attribution in a verbally explicit manner and with fewer embodied resources. These attributions form a sub-collection of cases for Article IV (n=5). In most cases (n=14), however, blame is attributed only after

the digital application has rejected an answer and thus build on these rejections. In these cases, the attributions involve several layers of multimodal resources in their lamination (C. Goodwin, 2013) instead of relying on direct verbal utterances.

In the cases where a pupil notices and flags a mistake before it is signalled by the digital application, they tend to produce verbal utterances that directly report the mistake and attribute the responsibility to the peer that has selected an incorrect answer. Despite the direct nature of the attributions, they are typically rather mild in tone and usually involve few multimodal resources in the action formation. In addition, if the mistake occurs after collaborative negotiation where peers agree on the answer and/or if the mistake is oriented to as accidental, the pupils also display continued joint orientation to the device and to collaborative task progression.

Since written accounts of social interaction are always incomplete (see e.g., Lindwall & Lymer, 2023) and because the differences between the cases in this article are challenging to explain without visual representations because of the relevance of timing and embodied cues for the social action, I present here a piece of an extract from the article. It illustrates in more detail what occurs when blame is attributed before the mistake is flagged by the application. The transcript of Extract 1 is of course itself an approximation of what occurred in the actual interaction, but it shows with some more granularity how an accidental mistake is oriented to by a peer in a direct, yet affiliative manner, and how the participant attributing the blame displays an orientation to sustaining the existing interactional space and their focus on the task. In the example, two 4th grade pupils, Mea and Paula, are answering multiple-choice questions on a game-like application (Kahoot!) using a shared tablet computer. Although the two agree on the correct answer (*feet*), Mea accidentally selects an incorrect answer (*a feet*) and, realising the mistake, produces an embodied extreme-case expression (Skogmyr Marian, 2021) involving a loud cry, hiding her face behind her hands, and abruptly pulling away from the device. Before the device has marked the answer as incorrect, Paula directly reports the mistake and attributes the blame to Mea.

Extract 1 (excerpt from Article IV, Extract 2)

```
1    Mea       =↑A::÷↓A:[:: ]=

2    Paula               [↑ei]=
                           no
     paulaG    >>gaze to tablet->>
     mea            ÷hands cover face, throws herself back->

3    Mea       =[ me÷%+♥ni ]=
                 (it) went
4    Paula     =[mea÷%+♥ sä]=
                  mea    you
     mea             ÷leans forward, hands cover mouth->
     meaF             %open eyes->
     meaG              +to tablet->>
     paulaF            ♥smiles->

5    Mea       =[(x)]
```

```
6    Paula      =[lai]►#toit÷ a fee(h):::(h)t.
                  put a feet
     mea                    ->÷leans toward tablet,
                               hands cover mouth->
     tablet               ►answer marked incorrect
     fig.                   #Fig.3
```

FIGURE 3 Mea reacts to a mistake.

```
7                (0.2)•(0.6)
     paula            •...->

8    Paula       ne•x:          •t,♥
     paula       ->•taps 'next'•,,,->
     paulaF                      ->♥

9                (0.2)•(0.4)÷%(0.3)
     paula          ->•taps 'next' twice->
     mea                  ->÷lowers hands from face->
     meaF                    %smiles->

10   Paula       ne•x:÷t:
     paula       ->•
     mea            ->÷
```

The blame attribution (lines 2, 4, and 6) is started before the application flags the mistake (line 6), and it relies on a direct verbal report of the mistake and an allocation of responsibility. It is also mitigated through a smile (line 4, Figure 3), however, and mimics Mea's response cry (line 1) in tone and pitch. Furthermore, Paula maintains gaze on the device and displays orientation to continuing the game by tapping on the 'next' button on screen and repeating it also verbally (lines 7–10). All these actions together signal an avoidance of confrontation, affiliation with Mea, and an inclination to sustain their mutual attention on the game. In other words, the mistake is not oriented to as serious enough to require a suspension of task progression or a confrontation. It is noteworthy that Mea's self-attribution of blame may also hinder Paula from producing a more aggravated blame attribution, and this also occurs in another case from the sub-collection, where Paula reacts to having made a mistake before Mea starts producing a blame attribution and before the application flags the mistake. In

that case, however, Mea's blame attribution builds on several multimodal resources, although it is brief in duration.

The main data set in Article IV demonstrates that actions on screens are systematically exploited in designing blame attributions during collaborative digital games in the data. In these cases, the rejection of an answer by the digital device is treated as a report of a mistake, and an attribution of responsibility for the mistake follows it. The analysis shows how pupils are able to attribute the blame to a coparticipant indirectly after the application has already signalled a mistake, without needing to report it or to allocate responsibility verbally. Nonetheless, these blame attributions tend to be clear and bold, deriving their force and meaning from how the digital actions are intertwined with a lamination of multiple layers of embodied resources such as gaze shifts, facial expressions, body shifts, prosodic features, or gestures. In addition, they generally involve a renegotiation of the existing interactional space, as one of the participants shifts their attention away from the game and prioritises settling the issue of the mistake and responsibility for it. This occurs especially after mistakes that result from a lack of negotiation or from ignoring a (correct) candidate answer offered by a peer. The blamed participant can in these cases accept the blame, provide a reason for the mistake, or downplay its significance. Extract 2 is an illustrative example where ignoring a peer's candidate answer leads to a multimodally produced, indirect blame attribution that is immediately treated as such by the blamed party. In this 5th grade lesson, Ella and Heidi are performing a Kahoot! task with multiple choice questions that involve translations of Finnish questions into English. In this case, the correct translation is 'Did you eat chocolate yesterday?', and despite Heidi having started to utter the translation in the correct tense, Ella picks an option in the wrong tense. When the application has signalled the mistake, Heidi orients to it through embodied actions.

Extract 2 (excerpt from Article IV, Extract 4)

```
1              (.)÷►
     heidiG    >>to tablet->
     ellaG     >>to tablet->
     ella         ÷,,,->
     tablet        ►answer marked incorrect,
                    correct answer shown

2    Heidi     chocolate÷ yester-÷
     ella             ->÷adjusts posture÷

3              (1.0)÷*(0.2)♥(0.2)*
     ella           ÷adjusts posture->
     heidiG        ->*...........*to ella->
     heidiF                 ♥smiles, eyes half-closed->

4              #(0.5)*♥
     heidiG        ->*to tablet->
     heidiF         ->♥
     fig.      #Fig.4

5    Heidi     n%ii.♥
```

```
                yeah
     ellaF       %smiles->>
     heidiF          ♥presses lips together->

6                (0.3)#(0.3)♥*(0.3)*
     heidiF                ->♥upper lip rolled up on teeth->>
     heidiG                 ->*.....*up->
     fig.              #Fig.5
```

FIGURE 4 Heidi gazes at Ella.

FIGURE 5 Heidi presses lips together.

```
7    Ella        (no ku ÷mä) (xx)=
                 (well cause I)
     ella             ->÷taps 'next´->

8                =(näh÷*ny sieltä)*(.)(ku-)
                  (see there)           (cause)
     ella          ->÷
     heidiG         ->*to tablet--*right->>
```

The extract shows how the application signals the chosen answer as incorrect (line 1). Heidi treats the rejection of the answer by the application as an adequate report of the mistake and builds on it to attribute the blame to Ella through the short, indirect verbal turn *nii* ('yeah'; line 5) and a lamination of embodied resources. Heidi shifts her gaze to Ella and produces a smug or defiant smile with her eyes half-closed (line 3, Figure 4), thus displaying trouble and implying Ella's responsibility for it. Heidi then reorients her gaze toward the device (line 4) and presses her lips together after producing the verbal turn (line 5, Figure 5),

orienting to the fact that Heidi had offered the correct beginning for the translation while Ella chose the incorrect one without consulting her. Finally, the grimace (line 6) explicitly displays Heidi's stance toward the mistake, implying annoyance or disappointment. Ella's subsequent account for the mistake (lines 7–8) reveals her interpretation of Heidi's actions as a blame attribution, and in addition to acknowledging her responsibility, the account serves as a mitigation of the mistake. While the blame attribution has led to a momentary renegotiation of the interactional space, the dyad's attention is soon brought back to the game as Ella proceeds to a new question in the task. The extract illustrates how what occurs on the screens of digital devices can be used to produce and interpret social actions during collaborative digital tasks and how the digital actions thus make explicit verbal attributions of blame redundant.

The findings of the study elaborate on the notion of blame attribution by showing how it can be multimodally produced without verbal reports of trouble. The study highlights the formation of blame attributions in peer interaction as a skilful achievement with moral implications. Blame attributions are shown to be used by the pupils to resolve issues of mistakes and responsibility and to manage the moral order of the classroom (Evaldsson, 2016; Niemi & Bateman, 2015) through allusions to a shared responsibility for a team's success as parts of a 'we' (Etelämäki, 2021). In addition, Article IV contributes to studies on multimodality and, in particular, to the emerging research on phygitality (Due & Toft, 2021) in the moment-to-moment construction of the local context.

4.2 Summary of main findings

Drawing on data from Finnish EFL classrooms with child and teenage participants, the current dissertation has shown that pupils are faced with diverse trouble types during their peer interactions around and mediated by technology. It has focused on two general categories of trouble: 1) trouble related to accessing devices and classroom interactions and activities, and 2) trouble that arises during task performance. In the first case, pupils orient to problems of gaining access to a device that is needed for collaborative tasks or for helping a peer (Article I) or to difficulties in opening interaction with peers via a technological medium (Article II). In other words, pupils display trouble in constructing, maintaining, or transforming shared interactional spaces. These kinds of trouble affect pupils' possibilities to participate in face-to-face and hybrid peer interactions and to claim their roles as members of a group. Trouble in the second category arises during task performance and can involve diverse problems, such as disruptions to tasks and interactions (Article III) or issues related to mistakes and responsibility for them (IV). In these cases, (re)negotiations of interactional space form part of the trouble resolution. For instance, when pupils' task progression is halted because of technical trouble with the device, pupils can perform recruitments of assistance, which involve a shift from individual task trajectories to a shared focus on the trouble resolution.

Generally, whereas the first trouble context involves an orientation to resolving asymmetry of access to devices, activities, and/or interactions, trouble resolutions in the second context aim at restoring progressivity of interaction and task progression.

The dissertation has shown trouble resolutions to be highly multimodal in nature, consisting of varying ensembles of verbal, embodied, material, and digital resources. Resolutions are designed to address trouble in locally relevant ways, coordinating resources afforded by the context with the unfolding interaction and activities.

These findings and their contributions to theory as well their practical implications are considered next in Chapter 5.

5 DISCUSSION AND CONCLUSION

This doctoral dissertation has explored interactional, technological, and task-related trouble and resolutions of these troubles in peer interactions in technology-rich classrooms. In the context of English as a Foreign Language (EFL) lessons within Finnish basic education, it has investigated the multimodal resources that are used by pupils to accomplish trouble resolutions in a locally relevant and collaborative manner. In addition, the study has aimed at finding out how interactional spaces are built, maintained, and transformed during trouble resolutions in peer interactions around and via digital technology. This has been done through a micro-level analysis of interactions by using the methods of multimodal CA, which has enabled me to inspect the use of technology *in situ* from an emic perspective. In this chapter I discuss the findings of the original articles in relation to the overall research questions of the dissertation. First, I consider what the findings indicate about the kinds of trouble that are encountered in technology-rich classrooms and about their multimodal resolutions (Section 5.1). I then address the notion of interactional space and how it can be elaborated on based on the current findings (Section 5.2). In addition, I suggest some implications for theory, pedagogy, and the development of technology (Section 5.3) and discuss the limitations of the study and some potential directions for future research (Section 5.4).

5.1 Multimodal trouble resolutions in technology-rich classrooms

The overarching aim of the dissertation has been to investigate how pupils resolve the types of trouble they encounter in their peer interactions while working on digital devices or interacting via technology. We know from previous research that using digital devices for tasks in classrooms can lead to technical problems that stem from limited technological know-how (Oloff, 2021; Råman, 2022; Råman & Oloff, 2022) or spelling problems (Cekaite, 2009; Musk, 2016) and to negotiations over who has the right to manipulate them (Jakonen & Niemi,

2020). On the other hand, studies have shown remote and hybrid lessons to involve asymmetry of access to one another's embodied cues and materials in the physical environment (e.g., Jakonen & Jauni, 2021; 2022; Oittinen, 2022). This dissertation has demonstrated that pupils orient to various types of trouble related to task interactions around technology in classrooms. The trouble types that stand out in the data can be classified into two broad categories: 1) issues related to asymmetry of access to devices and to classroom tasks and interactions, and 2) trouble that arises during task performance in relation to progression of task or interaction related to the task. While trouble from either category at least momentarily affects pupils' task accomplishment and/or participation and involves (re)negotiations of interactional space, the study has also revealed differences between the categories.

The first category of trouble investigated in the dissertation, trouble with access to devices or to classroom activities and interactions, is explored in Articles I and II. These sub-studies show that this kind of trouble is in its essence trouble with negotiating a shared interactional space, or in other words, trouble with achieving joint attention to relevant information, artefacts (e.g., a digital mobile device), and even to other participants. In face-to-face classrooms, pupils need a shared focus on devices when they are performing collaborative tasks on them or engage in helping sequences, for example (Article I). If one of the peers lacks access to a device when it is needed, it hinders their possibilities to participate in the activity. This has consequences for task performance and progression of interaction and can lead to exclusion from a group activity. In the case of hybrid teaching, remote pupils' limited access to classroom interactions leads to reduced possibilities to interact with their peers and to participate in task activities (Article II).

When problems of access to devices and interactions are resolved, peers can engage in performing their tasks. Task performance is where trouble from the second category may occur. These troubles are investigated in Articles III and IV. During tasks, pupils in the current data encounter and indicate trouble resulting from technical difficulties with digital devices or lacking knowledge regarding the topic of the task, for example, or from a momentarily fragmented interactional space between peers (Article III). Resolution in these types of trouble can be sought through recruitments of assistance (Drew & Kendrick, 2018; Kendrick & Drew, 2016) and response pursuits (e.g., Pomerantz, 1984b), respectively. During collaborative digital tasks, mistakes made by peers can also be oriented to as problematic (Article IV). In these cases, peer mistakes can be dealt with through blame attributions (e.g., Pomerantz, 1978), which momentarily shift participants' attention from the task to a negotiation of responsibility.

The two trouble categories differ from each other in terms of their complexity. Resolutions of the trouble types illustrated in Articles III and IV tend to be quite easily achieved in the peer interactions of the current data. While these troubles can momentarily halt task progression, they tend to be rather minimal hiccups that do not require resolutions that extend over long sequences. In

contrast, trouble related to access to interactions and devices (Articles I and II) potentially has more far-reaching consequences as it can hinder giving assistance or prevent peers from participating in classroom activities. Asymmetry of access also tends to occasion lengthy trouble resolution processes that can spread out across multiple sequences (Article I) or even different phases of the lesson (Article II). At times, however, the boundaries between trouble types become blurred, and the more easily solved trouble types during task progression can involve or lead to other, possibly more complex types of trouble. Recruitments are a good example of this since recruiting a peer to assist with technical or epistemic problems can sometimes lead to additional trouble related to access issues, as shown in Article I. In these cases negotiations occur as the recruited participant is unable to assist due to lacking access to the trouble source.

By addressing the first research question, the dissertation contributes to the line of research investigating multimodal co-construction of peer interactions (see e.g., Heinonen & Tainio, 2023; Jakonen, 2014; Jakonen & Niemi, 2020; Konzett, 2015; Kääntä & Piirainen-Marsh, 2013; Piirainen-Marsh & Kääntä, 2022). The research question is as follows:

1. How and through what kinds of multimodal resources do pupils collaboratively resolve trouble in peer interactions in technology-rich classrooms?

The findings highlight trouble resolutions as multimodal, collaborative achievements, where ensembles or sets of resources are carefully designed according to the local context (also C. Goodwin, 2000; Mondada, 2014b). Different types of trouble resolutions rely on different combinations of resources, but the role of the body is highlighted in all of them: trouble resolutions can rely heavily on embodied resources and can sometimes be achieved entirely through them. For example, response pursuits can be performed without verbal resources through a combination of a gaze shift to a coparticipant and nods (Article III). Embodied resources also often function as first displays of trouble: gaze shifts away from digital devices towards coparticipants, for instance, can display pupils' orientation to technical and task-related problems (Articles I and III), missing responses (Articles II and III), and peer mistakes (Article IV). Furthermore, the embodied nature of trouble resolutions is not only characteristic of face-to-face interactions. For instance, when the classroom participant in Article II does not at first receive a response from the remote participant, they shift their gaze towards the device through which they have tried to establish contact and tend to move closer to the device when producing a summons. This shows that while access to one another's embodied cues in the hybrid setting may be limited, participants still orient to the unfolding interactions in them in highly embodied ways.

In addition to eye gaze, the articles have illustrated the use of various other multimodal resources in trouble resolutions. Verbal resources tend to be relied on more when a shared understanding of the trouble requires explicit accounts

of it. When pupils experience trouble answering a task question due to a lack of knowledge, for instance, they explicate the problem verbally (Articles I and III). Verbal resources are also harnessed in building a hybrid interactional space when visual embodied cues cannot be accessed by the participant in the other location (Article II). Body shifts and movements as well as rearrangements of the material environment, on the other hand, are employed when pupils try to gain access to digital devices in face-to-face classrooms (Article I), whereas facial expressions tend to reveal pupils' stance towards problematic actions by their peers (Article IV). In addition to employing different kinds of multimodal resources, trouble resolutions also differ in the lamination (C. Goodwin, 2013) of resources that are mobilised to achieve a resolution. Generally, there is a tendency for verbally implicit resolutions to use a lamination of various other multimodal resources for meaning making (Articles I, III, and IV). Pupils also tend to add layers of resources when trouble resolutions become more aggravated, as in the case of blame attributions (Article IV). In addition, when trouble resolution processes become prolonged, participants tend to harness more resources to accomplish a resolution (see also Kääntä & Piirainen-Marsh, 2013). For instance, Article I shows that when a pupil does not gain visual access to a shared device, they add resources in a stepwise manner, starting with smaller embodied actions, such as head movements, and gradually producing more noticeable multimodal actions involving shifts of the whole body, verbal resources, and sometimes even touch to reposition the device.

Since technology-rich settings often involve simultaneous or consecutive management of both technology and peer interactions, different resources are distributed between parallel or overlapping activities. For instance, while hands tend to be needed for handling devices, eye gaze and verbal resources can more easily be harnessed for interaction (see also Nishizaka, 2014) and as first resources to address trouble. Many of the digital tasks in the data are quite fast-paced, however, and eye gaze, for example, therefore tends to be shifted away from a device only when another line of action more urgently needs attention. The fast pace also requires peers to closely monitor and coordinate each other's actions so that they can participate in a timely fashion (see also Haddington et al., 2014; Jakonen & Niemi, 2020; Kääntä & Piirainen-Marsh, 2013; Mondada, 2019). All the articles have illustrated how peers carefully place their displays of trouble and initiations of resolutions within the unfolding interaction and how resolution processes are carried out step by step through a (mutual) coordination of actions.

The mobilisation of multimodal resources and their distribution between activities are also shaped by the affordances and the role of technology in the interactions (see also Luff et al., 2003). While technology does not determine the trajectories of trouble resolutions, it may become relevant for the selection of resources that pupils employ to achieve their interactional goals. Article II, for example, demonstrates how the geographically distributed participants need to rely on auditory cues to achieve an opening of interaction in a hybrid context with no visual access between the co-present and remote participants. On the other hand, the classroom participant is able to use eye gaze and touch to inspect

different technological devices as potential media for contact. In face-to-face settings, not only are the visually perceivable bodies and audible voices of peers "available as source[s] of embodied information" (Goffman, 1963, p. 15) but also the digital devices and participants' actions on them can be monitored. In addition to being employed as tools for task activities, then, digital devices can be harnessed for use as interactional resources (Article IV). The current study thus shows how technology can have varied roles in peer interactions: as tools for tasks, media for interaction, or interactional resources. Actions on screens can also be used as parts of phygital social actions that combine verbal, embodied, and digital resources in their formation.

The dissertation has also contributed to our understanding of how pupils orient to varied roles in their trouble resolutions. While pupils in the current data display an orientation to their institutional roles and the institutional goal of learning (e.g., Arminen, 2005; Seedhouse, 2015) in that they tend to prioritise task progression, they also demonstrate their orientations to other kinds of roles, rights, and responsibilities. For instance, pupils treat themselves and each other as having situated, local participation roles (e.g., Goffman, 1979; C. Goodwin, 2000; C. Goodwin & M. H. Goodwin, 2004) that may change as interactions and activities unfold. In face-to-face classrooms, pupils who lack access to devices, for example, can (re)claim their roles as ratified participants in the task interaction by resolving access issues (Article I). During recruitments, on the other hand, the recruiter and the recruited move into a shared participation framework (Articles I and III). In the hybrid teaching context in Article II, the remote pupils are generally oriented to as overhearers rather than fully ratified participants in the classroom activities. One of the classroom participants and a remote participant start interacting with each other, however, thus converting the participation status of the remote pupil into a more active one. Pupils are thus not just performing prescribed roles but actively display, negotiate, and transform their statuses in different participation frameworks.

In trouble resolutions during collaborative tasks in face-to-face classrooms, peers also allude to and construct their roles as a 'we' (Etelämäki, 2021), as a team with shared rights and responsibilities. This is shown in how devices are positioned to include and exclude peers from the activity (Article I; see also Niemi & Katila, 2022) and how pupils orient to their rights to access shared devices (Article I) and to be heard in answer negotiations (Article IV). In addition, when peers neglect their responsibilities as team members who make joint decisions, they are held responsible, especially if that neglect results in mistakes that affect the whole team (Article IV). At other times, pupils can have distributed roles and tasks in activities. Whereas some pupils are displayed as having epistemic access to needed information (e.g., in the recruitments in Articles I and III), others may have roles as the ones who look for answers or decide over a team's name (Article I). Furthermore, the pupil who currently handles a digital device seems to have special deontic rights to decide over what is done with the device and in the task performed on it (see also Cekaite, 2009; Musk, 2016; Thorne et al., 2015). As shown in Article I, however, this deontic authority can be

questioned and problematised if other team members' rights to participate in the task activity are (repeatedly) neglected or denied. Through trouble resolutions, then, pupils dynamically orient to, maintain, and negotiate their roles and the moral order of the classroom (see also Evaldsson, 2016; Niemi & Bateman, 2015; Niemi & Katila, 2022).

5.2 (Re)negotiations of interactional space in technology-rich classrooms

Interactional space "is a precondition to any real-time and copresent interaction" (Haddington & Oittinen, 2022, p. 317), and it is dynamically shaped as interaction unfolds (e.g., Mondada, 2009, 2013a). Thus it necessarily follows that interactional space is also a prerequisite for collaborative trouble resolutions and that it is (re)negotiated or adjusted as part of the resolution process, from the first noticing of trouble to its resolution. How it is done in practice by peer groups in technology-rich classrooms has not previously been addressed in research on classroom interactions. Therefore the second research question of the dissertation is:

2. How are interactional spaces (re)negotiated in the processes of trouble resolution?

Similarly to the first research question, this has been addressed in all the individual articles of the dissertation by investigating the resources that are mobilised by pupils to (re)negotiate interactional spaces in different trouble contexts and how this contributes to the overall trouble resolution process. The findings indicate a reflexive relation between the way that "interactional space is constantly being (re-)established and transformed" (Mondada, 2013a, p. 250) and the process of the trouble resolution. In addition, adjustments of the interactional space are sensitive to the affordances and constraints of the technological and material configurations of the classrooms. The emic perspective adopted in the study has allowed for an elaboration of the concept of interactional space to account for how shifting orientations and mutual focus are managed *in situ* by the participants. In other words, negotiations of interactional space are here understood as a practical concern for participants in interaction.

The two categories of trouble reported in the current study and their resolutions involve differences in the role that (re)negotiations of the interactional space have in the process. More specifically, they differ in terms of whether achieving shared interactional space is problematic or whether interactional space is configured to resolve trouble related to tasks. Articles I and II show how the problems of establishing a shared interactional space may hinder or delay a collaborative activity (Article I) or an opening of interaction (Article II) and may even lead to a pupil's (momentary) exclusion from a peer group and

their activity (Article I). In these cases, it is particularly the technological devices that are monitored through eye gaze as well as by hearing and touch since access to them is needed to secure joint attention and mutual availability for (task) interaction. During collaborative digital tasks in the face-to-face classroom, the *shared digital task space* is also crucial for achieving a mutual understanding of the task activity and for its progressivity. Trouble with establishing a shared, local interactional space in peer interaction is therefore oriented to through multimodal resolutions, where mutual attention to the task is sought especially through movements of the head and the body that are both visible to others as displays of lacking access and function as ways to gain visual access to the device. Adjustments of the material environment can also aid in the establishment of a shared interactional space. For example, digital devices can be (re)positioned so that all participants can access them, and furniture and other artefacts can be moved to enable adjustments of participants' positions and an unrestricted view of the device and each other. While the technological and material environment therefore functions "as a structuring resource" (Mondada, 2013a, p. 270) for the shared interactional space, it is also dynamically shaped to meet the requirements for achieving joint attention and for resolving trouble. In the case of hybrid settings, this shaping of the technological configuration can also involve the mobilisation of other digital devices and applications in addition to the videoconferencing platform to build a connection with a remote participant. The focal dyad of geographically distributed pupils in Article II use their mobile phones to achieve an initial contact with each other (see also Hoffmann & Fele, 2023), thus stretching the limits set by the technological configuration of the lesson.

Articles III and IV demonstrate how interactional spaces are (re)negotiated when pupils orient to resolving trouble during digital tasks. These resolutions of trouble related to tasks, devices, and mistakes by peers involve a move from individual trajectories on digital devices to joint attention to the trouble source (Article III) or a shift of mutual focus from the performance of the task – and from the shared digital task space – to a negotiation of responsibility (Article IV). When pupils encounter disturbances in the progression of their individual tasks and recruit a peer to assist them (Article III), they may check the peer's availability for interaction through a gaze shift to them. Mutual attention to the trouble source can then be sought through a sustained gaze to the peer and a subsequent gaze shift to the device to invite the peer's gaze to it. In addition, vocalisations can be used as trouble alerts (Kendrick & Drew, 2016), trouble can be verbalised, and the device may be handled to draw the recruited participant's attention to the trouble. In the case of mistakes made by peers during collaborative tasks (Article IV), on the other hand, joint attention is already on the device and the task, and the readjustment of the interactional space therefore involves a shift away from the device. As one of the participants begins a blaming sequence, they may shift their gaze to the peer that has made a mistake and modify their body position to adjust the interactional space. In some cases, this may lead to a mutual gaze and a successful, collaborative renegotiation of the interactional space, but

the blamed participant may also resist taking the blame and maintain their attention on the task, whereby the interactional space may become momentarily fragmented.

It is worth noting that the boundary between resolutions of trouble with interactional space and resolutions of other kinds of trouble is not definitive. As discussed in 5.1, resolutions of trouble with tasks or digital devices, for instance, may eventually lead to a problem with renegotiating the interactional space, as in the recruitments illustrated in Article I. On the other hand, the response pursuits in Article III are simultaneously targeted both at restoring a momentarily fragmented interactional space and at getting a response from the peer to be able to continue with the task activity. These cases show that distinguishing between actions that address issues of interactional space and those that aim at resolving other types of trouble is not always straightforward. Rather, trouble resolutions in general can be conceptualised as seeking to restore intersubjectivity and progressivity of the ongoing activity. To achieve this aim, participants dynamically adjust interactional space in accordance with the situated needs of the unfolding trouble resolution process.

The findings of the current dissertation support those of previous studies that have pointed to the layered nature of interactional spaces (e.g., Kohonen-Aho, 2023; Mondada, 2011; Oittinen, 2020a). While this layeredness is emphasised especially in hybrid settings (Kohonen-Aho, 2023; Oittinen, 2020a), the current study shows that establishing and maintaining shared interactional spaces during digital tasks in face-to-face classrooms also involve joint orientation to different layers of interaction. To be more specific, a digital device, when used for performing tasks, is not a static artefact that is there merely to be perceived as a feature of the material environment. It functions instead as a dynamic space for performing actions in, a *shared digital task space* that forms a layer of the shared interactional space (see Figure 1 in Section 1.2). As digital tasks are often fast-paced and require responsive actions from the participants, they need to be carefully and actively monitored. Thus, interactions around digital tasks also easily result in asymmetric access to the information and actions on screen, forestalling intersubjectivity and collaborative action (see also Luff et al., 2003, p. 52). The shared digital task space thus becomes a crucial layer of interactional space in peer interactions around digital devices, and actions on the device need to be carefully coordinated with the ongoing peer interaction and vice versa. In the case of recruitments, for instance, pupils reposition their digital device in attentive coordination with the recruitment sequence and the recruited participant's actions so that they can invite their gaze to the device before manipulating it to show the trouble (e.g., Extract 1 in Article I).

Another feature that adds to the layeredness of space in the peer interactions in the studied classrooms is the public space that is oriented to by the participants in addition to the pair and group interactions. This is visible in Article II and in Extract 5 in Article IV, for example, where participants involved in peer interactions also orient to their overhearers in an almost performative manner. Different layers are flexibly oriented to through different resources by

positioning the body towards the digital device and the peer(s) in the team, for instance, while shifting gaze between the device, the peer group, and others in the classroom (see e.g., Extract 5 in Article IV). This illustrates the complex and dynamic nature of interactional space around technology in classrooms, where pupils need to be able to monitor and manage multiple layers of space and several participation frameworks, often simultaneously (see also Koole, 2007).

In the case of synchronous hybrid teaching, the findings suggest that the layeredness of interactional space materialises more in terms of overlapping rather than embedded spaces (see e.g. Kohonen-Aho, 2023; Oittinen, 2020a). As demonstrated in Article II, the focal classroom participant orients both to the local space of the classroom and to the hybrid space with the remote participant. In this way, the different spaces overlap, and different resources are distributed or alternated between the spaces. For example, gaze and body orientation can be directed at other classroom participants while talking to the remote participant, inviting others to witness the interaction in the hybrid space. While the conversation in the hybrid space occurs between the two focal participants, it becomes publicly hearable for the others in the local classroom space. In addition, however, the focal pupil dyad employs their mobile phones to achieve a connection with each other, thus building a private space (e.g., Wasson, 2006), which can also be conceived of as an *adjoining space* (Oittinen, 2020a) that is relevant for building interaction between the pupil dyad but not for the overall lesson. For the local participant, then, opening hybrid interaction with the remote participant requires simultaneous monitoring of multiple spaces and a careful coordination of actions, not only in relation to the remote participant but also in relation to the activity and interactions unfolding in the local space. This highlights the complexity as well as the situated nature of building, maintaining, and transforming interactional spaces in hybrid settings.

One final aspect of interactional space that the current dissertation sheds light on is its embodied nature. As highlighted in the definition by Mondada (e.g., 2009, 2013a), interactional space involves shared attention that is achieved through the dynamic orientation of participants' *bodies* to each other. This raises the question of what constitutes a 'body' in the accomplishment of interactional space? The definition seems to emphasise the visually perceivable features of the body: the movements and the position of the whole body in relation to other bodies that are co-present in the same physical environment. More recent studies have argued that interactional space is a prerequisite for all kinds of interactions, even those where participants are not co-present, such as VR and hybrid interactions (Haddington & Oittinen, 2022; Kohonen-Aho, 2023; Oittinen, 2020a). Even in these contexts, however, there is an emphasis on visual cues, such as the representation of human bodies in the form of avatars in VR settings (Haddington & Oittinen, 2022) or video-mediation of remote participants in hybrid meetings (Kohonen-Aho, 2023). In hybrid settings with restricted access to embodied cues from the remote space, participants are described as relying on visual notifications of other participants entering the digital meeting space or on visual signs of disturbances in the connection (Haddington & Oittinen, 2022;

Oittinen, 2020a, 2020b). The current study shows, however, how a shared hybrid interactional space can be achieved relying on aural cues in a context where the local participant does not have any visual access to the remote participant or even to the screen of the laptop on which the video call has been made (Article II). Paradoxically, this resembles the settings that Sacks, Schegloff, and Jefferson first studied when laying the foundations for CA: telephone calls. In addition, the study has shown how interactional space can be adjusted haptically through touch and by repositioning material artefacts (Article I). When a pupil repositions a digital mobile device handled by a peer through touch, for instance, this can also be noticed by the peer through the tactile sense in addition to potentially visually perceiving it. The changes in interactional space are therefore not only seen but also noticed through other senses. In sum, then, the study illustrates interactional space as being built on those embodied resources that are available in and afforded by the local setting and calls for an embodied conceptualisation of interactional space beyond the visually perceivable body.

5.3 Implications

This doctoral research has shown the value of investigating the use of technology in classrooms *in situ*, as this approach can provide us with insights into the kinds of trouble that pupils encounter in their everyday classroom interactions around technology and how they address that trouble in practice. It has also illustrated trouble resolutions as multimodal, local accomplishments that in technology-rich contexts are adapted to the affordances of the technological configuration. Furthermore, I have shown how the use of technology and trouble resolutions are intertwined with interactional space as well as broader issues of classroom interactions, such as moral order and negotiations of roles, rights, and responsibilities. Next, I consider the implications that these findings have for research, pedagogy, and technological development.

First, the dissertation has implications for CA research and theory. The study has conceptualised interactional trouble as a broad and complex phenomenon that cannot always be addressed through the traditional notion of repair (e.g., Sacks et al., 1974; Schegloff, 1987a, 1987b; Schegloff et al., 1977). The term *trouble resolution* refers here to the interactional work that pupils engage in when displaying and dealing with varied kinds of trouble in peer interactions in technology-rich contexts. In line with recent studies that have focused on embodied aspects of repair (e.g., Mortensen, 2016; Oittinen, 2020b; Sert, 2015; Stolle & Pfeiffer, 2024; Vatanen, 2023; Wang & Li, 2024), I propose that research on trouble resolutions focuses on their multimodal achievement as well as on the multimodal and complex nature of the trouble itself. In addition, however, the findings have illustrated that trouble resolutions can sometimes involve lengthy, stepwise processes of trial and error that spread out over multiple sequences of interaction and are often performed in collaboration (see also Ilomäki & Stevanovic, 2024). The collaborative, complex nature of resolutions may therefore

blur the line between the self and the other in carrying out the resolution (see also Greiffenhagen & Watson, 2009) and instead highlights the need for joint coordination of actions for their success.

The dissertation has also drawn attention to the need to investigate holistically the various multimodal resources that are employed in human interactions. While there is a growing body of research aiming at an understanding of the role of haptics and, more generally, *sensoriality* (e.g., Cekaite, 2015; Heinonen et al., 2020; Heinonen & Tainio, 2023; Meyer, 2021; Mondada, 2019, 2023), there is still an overwhelming emphasis on visually perceivable embodied actions in studies on multimodality. The current study also investigates the role of visual cues such as gaze shifts and the visually monitored body movements in trouble resolutions, but it additionally shows how aural modality can become an important – and potentially the primary – modality in achieving joint attention and a shared interactional space (Articles I and II) and how digitally produced sounds can be used as resources in social actions (Article IV). Further, the study illustrates how touch can be used to negotiate access to a device and how the moving body is not only there to be visually perceived by others but affords adjustment to the material space and access to varied modalities in interactions and in the use of technology (Article I). At the same time, the dissertation has taken another step towards understanding how embodied and digital actions are intertwined (see also Due & Toft, 2021) by showing how what occurs on a device screen can be built on to achieve social actions.

As to research on interaction around and with technology, the dissertation has contributed to the ongoing discussions on the role of technology in human interaction. Scholars inspired by ideas from new materialism and the actor-network theory, for instance, instead of considering technology as a mere feature of the material environment, have explored how humans and technological tools as participants or 'actants' together perform actions and activities (see e.g., Latour, 2005; Thorne, 2016; Thorne & Hellermann, 2022; Thorne et al., 2021). This dissertation shows that the role of technology and how the human participants themselves orient to technology in their interactions, vary from context to context. While technological affordances shape social interactions, the findings suggest that devices are not treated as participants in the current data. Rather, pupils mainly orient to technological devices as tools for accomplishing pedagogical tasks (Articles I, III, and IV) or as media through which they can interact (Article II). Occasionally, however, the role of digital applications seems to transform into something resembling a participant: as the application provides questions and assesses pupils' responses to them as right or wrong, they seem to be participants in IRE sequences similar to those initiated by teachers (see Article IV). The assessments by the application can also be used by pupils to avoid making direct verbal blamings when mistakes occur. It is noteworthy, however, that these sequences are automated on the part of technology and based on questions and answers inserted in the application by the teacher, and while they enable certain actions and activities, the human participants demonstrably treat them as

resources rather than agentive participants. In this way the interactions explored in the dissertation are different from those that occur between social robots and human participants (see e.g., Pelikan et al., 2022), for instance. The findings thus highlight the need to study different forms of technology in their context of use to understand their local, emergent roles in social interactions.

The study has also offered new insights into two understudied contexts: digital pedagogical tasks and synchronous hybrid teaching in contexts with children and teenagers (but see Jakonen & Niemi, 2020). These contexts have proved to be a fruitful context for studying trouble resolutions and the use of technology, highlighting the dynamic, locally emerging nature of peer interactions and processes of trouble resolutions. The findings reveal the complexity of participating in classroom interactions, where different types of participation frameworks (e.g., C. Goodwin, 2000; C. Goodwin & M. H. Goodwin, 2004) and interactional spaces are available. The use of technology in face-to-face classrooms may involve a type of multiactivity (e.g., Haddington et al., 2014), as pedagogical tasks are performed on individual digital devices while concurrently or alternately interacting with peers. On the other hand, pupils may have to manage their participation in multiple overlapping interactional spaces in hybrid classrooms.

As to pedagogical implications, the dissertation has shown that the use of technology for pedagogical purposes can involve trouble, negotiations, and activities that were not originally part of the teacher's pedagogical aim (cf. Dooly, 2018). Most mobile digital devices are designed to be handled by individual users rather than multiple participants, for example, potentially resulting in difficulties related to performing shared tasks and in conflicts centring around peer roles and rights (Article I). A lack of knowledge of certain features of technology, or encounters with new technological configurations (Articles II and III), can also result in disturbances in task progression or in limited possibilities to interact with peers. On the other hand, technological problems that are encountered during digital tasks or hybrid interactions can offer possibilities for collaborative work and learning as pupils jointly figure out how to resolve the trouble (Articles II and III). In addition, the affordances of the technology can aid in managing peer relations when the reports and actions of the digital application make potentially face-threatening actions, such as verbal attributions of blame, unnecessary (Article IV). Consequently, while the use of technology can create various kinds of trouble related to technology, task performance, and peer interactions, it can also offer space for developing different kinds of competence. Teachers therefore need to carefully consider and weigh different learning goals, the affordances and constraints of distinct technological tools, and the existing skills of pupils, when implementing technological devices in their lessons. Furthermore, one of the tasks of teachers is to support pupils in the kinds of classroom interactional competence (CIC; Walsh, 2011, 2012; also Sert, 2015), or the skills needed to appropriately interact and perform in classrooms, that the use of technology for collaborative purposes requires. In addition to interacting in the target (or the first) language, they involve varied other skills and

competence, such as technological skills, the ability to take and negotiate turns in handling the device, sharing responsibilities, and simultaneously managing the use of technology and peer interaction.

While the current study does not make claims about the effects of the use of technology on learning, it does show that there are difficulties related to its use in classrooms that are usually not addressed in public discussions. As I mention in Chapter 1, public debates tend to centre around the perceived benefits of technological devices for motivation and learning or focus on how pupils' personal mobile devices draw pupils' attention away from teaching. The current study shows how the introduction of technology in classrooms can shape peer interactions. Trouble with access to devices or to classroom interactions can affect pupils' possibilities to participate in task activities and peer interactions, especially in video-mediated and hybrid contexts. This is a point that should be more widely considered when developing pedagogical practices involving digital technology, and I argue that micro-level CA analyses of classroom interactions can inform that development by showing how activities and interactions unfold *in situ* in real time.

Finally, the dissertation can offer insights into the development of technological tools for pedagogical purposes. For example, the study has shown that there is a need for developing devices and applications that can easily be used for collaboration in pedagogical contexts. By investigating how pupils use different devices in real-life situations, we can draw attention to the varied interactional needs that should be met by devices and applications used in teaching and learning. Furthermore, the findings have highlighted the asymmetric nature of hybrid interactions, and while there have been experiments with enhanced systems for video-mediated interactions (e.g., Jakonen & Jauni, 2021, 2022), we have yet to develop platforms that would allow equal participation in classroom interactions by both local and remote participants. The dissertation therefore aims at opening up discussions about the development of technological tools that would meet the needs of all participants in today's classrooms.

5.4 Limitations and directions for future research

While this dissertation has contributed to our understanding of the multimodal and locally accomplished nature of peer interactions in technology-rich classrooms, it also has some limitations. Most of these relate to the nature of the data and some methodological choices, which I discuss next. At the end of this section, I suggest possible directions for future research on interactions in technology-rich classrooms.

One of the methodological limitations relates to the data having been collected during the COVID-19 pandemic, restricting my access to the classrooms I investigated. This influenced my choices regarding the collection of ethnographic data to support the analysis, and for most of the lessons, I do not

have additional materials, such as pictures of pedagogical tasks or observation notes. As an exception, I took photos of the classrooms I could visit prior to data collection to be able to make a record of the spatial layout. Any other information that I have gained on the participants, tasks, and spatial layout of the classrooms has been through the video-recorded data.

Another limitation related to the changing circumstances during the pandemic was that I was not able to set up the recording equipment in Schools A and C (see Table 2 in Section 3.1) or to observe lessons other than those in School D. During the research process, I noticed that having more information on the types of tasks that participants were performing, for instance, could have aided in understanding some of the interactions unfolding around them. In addition, owing to the restricted view of the classrooms in the video recordings, it was occasionally difficult to analyse the meaning of some eye gazes, gestures, or utterances that seemed to be directed at something outside the frame of the video. In future research, then, I would consider combining CA methods with ethnographic data to expand the analysis as well as observing and perhaps participating in the classroom activities to get a more encompassing "member's view" of them (see Hofstetter, 2021). On the other hand, the existing data have offered extraordinary insights into the everyday classroom interactions during the pandemic and, especially in the case of the hybrid data, into the struggles of teaching and learning in the rapidly changing circumstances.

The study could have benefitted from screen recordings of digital devices also from other classrooms besides School D. As shown in Article IV, for example, the actions on the screens of the digital mobile devices often became consequential for peer interactions, and the lack of screen recordings from some of the lessons affected my ability to fully understand the meaning of some pupil turns and actions. In the case of the hybrid teaching data, additional recordings of the remote participants' screens and from their physical locations would have offered better insights into their perspective of the hybrid lessons as well as into their conduct during the hybrid interactions portrayed in Article II. As the focal classroom participant's access to the remote participants' embodied cues was likewise limited, however, the existing data have enabled analysing the interactional sequences from the local participant's perspective.

Finally, although the dissertation sheds light on the kinds of trouble that pupils face in today's technology-rich classroom settings, it does not pretend to offer an exhaustive list of all the possible problems that pupils may encounter in settings that involve the use of technology for pedagogical purposes. Specifically, in the context of hybrid teaching, the study has provided only a single case analysis, so the findings cannot be generalised. Yet the dissertation does draw attention to how technology is used in real-life situations in classrooms and how its incorporation into lessons may not always be unproblematic. On the other hand, the study also shows that pupils are able to resolve most of these problems by using the resources that the context affords and by working around its constraints.

The dissertation has shown that we still need a more encompassing understanding of how peer interactions unfold in technology-rich contexts. One important topic for future studies is to unravel the competences that pupils need to be able to participate in collaborative digital tasks. While the current study has indicated that digitally performed tasks require a distribution of resources and careful monitoring of both the technology and peer interaction, we still lack evidence for whether this involves competences that are significantly different from other competences needed in the classroom. Furthermore, we need a deeper understanding of how participation in classroom activities is shaped by the use of technology as a pedagogical tool. Another topic relates to the roles and relationships that pupils orient to in their peer interactions and whether the roles displayed and negotiated during digital tasks, for instance, differ from those oriented to during other types of pedagogical activities. For instance, does the use of technology invoke questions of epistemics or know-how that shape negotiations of roles, rights, and responsibilities? Or does the use of shared, school-owned devices impact the way roles are negotiated, as compared with contexts where pupils use their own mobile devices? In general, questions of moral order and participation in technology-rich classroom contexts could offer worthwhile topics for future studies on classroom interactions.

As to hybrid teaching, pedagogical contexts with children remain notably understudied. While there is a surge of interest in video-mediated and hybrid interactions within higher education and other learning settings with adult participants (e.g., Badem-Korkmaz & Balaman, 2022; Gudmundsen, 2023; Jakonen & Jauni, 2021, 2022; Malabarba et al., 2022; Oittinen, 2022), the current dissertation is one of the rare contributions to understanding hybrid interactions in the basic education context (but see studies on telecollaboration, e.g., Dooly & Davitova, 2018). The current data come from a situation where the teacher is forced to set up a synchronous hybrid lesson on short notice and the classroom participants are not experienced in interacting in the new setting. We therefore need research on post-COVID hybrid teaching settings to find out how interactions unfold when the participants are already accustomed to the hybrid configuration. Further research on diverse hybrid teaching contexts could also inform the development of video-conferencing platforms and pedagogical practices.

All in all, trouble resolutions in technology-rich classrooms provide a fruitful avenue for elaborating on theories of problem-solving. As suggested by Ilomäki and Stevanovic (2024), this kind of analysis could benefit from an encompassing view that considers both the multimodal, co-operative actions (Goodwin, 2017) of the participants and the technological and material affordances of the context. At the same time, these kinds of explorations of trouble resolutions in technology-rich contexts would shed more light on the diverse roles of technology in human interactions.

5.5 Concluding remarks

> [W]e are always in our bodies, always everywhere embodied beings, acting and doing things in a material world. In that sense, all interaction is embodied, all actions are embodied, and all turns are embodied turns. (Nevile, 2015, p. 141)

This dissertation has contributed to our understanding of how pupils as embodied beings 'do' trouble resolutions in their peer interactions in a classroom setting. As indicated by the four sub-studies, the actions that are produced to resolve these instances of trouble are overwhelmingly embodied. Access to digital devices is sought through head and body shifts and movements, devices are inspected through gaze and touch when assessing whether they can be used to contact remote peers, and gaze is shifted to potential helpers when technical problems arise with tablet computers. Even social actions that could be thought of as requiring intricate verbal explanations, such as negotiations of blame, rights, responsibilities, and 'we-ness' (Etelämäki, 2021; Heinonen & Tainio, 2023), can be performed (primarily) through embodied turns. Importantly, the precondition for co-present interaction - a shared interactional space - is achieved through embodied resources, such as eye gaze, voice, and positioning the body in relation to others.

Embodied beings do not interact in a void but instead their actions are shaped by the material world around them. In the current data, and increasingly in today's classrooms, pupils' material world involves technological devices that are needed for participation in diverse pedagogical activities. These tools generate trouble that pupils need to overcome to accomplish their tasks and to interact with their peers. Technological devices can also be harnessed to solve trouble, however, and, in general, become employed in producing multimodal social actions. In addition, the physical environment, such as furniture, can be arranged in ways that afford certain kinds of actions which become consequential for learning. This study has shown that a multimodal analysis of classroom peer interactions and trouble resolutions around technology needs to account not only for talk and embodied actions, but also for the role of technology and other material artefacts as well as for the spatial aspects of the context. In this way the study has contributed to CA as an approach to investigating classroom interactions and technology-rich contexts and offered insights into the development of technology and pedagogical practice.

SUMMARY IN FINNISH

Ongelmanratkaisu vertaisvuorovaikutuksessa digitaalisen teknologian äärellä: Vuorovaikutustilan multimodaalinen neuvottelu kasvokkaisissa ja hybrideissä luokkahuoneissa

Tässä väitöskirjassa tarkastelen luokkahuoneen vertaisvuorovaikutusta teknologian äärellä. Tutkimukseni keskittyy siihen, kuinka oppilasparit ja -ryhmät ratkaisevat erilaisia ongelmia (engl. *trouble*), joita he kohtaavat työskennellessään digitaalisilla laitteilla tai niiden välityksellä kasvokkaisilla ja hybrideillä englannin tunneilla suomalaisessa peruskoulussa. Ongelmat voivat liittyä teknologian käyttöön, sen avulla suoritettaviin tehtäviin tai oppilaiden väliseen vuorovaikutukseen. Tutkin multimodaalisen keskustelunanalyysin keinoin, millaisia verbaalisia, kehollisia, digitaalisia ja materiaalisia resursseja oppilaat hyödyntävät ratkaistessaan näitä ongelmia. Analysoin myös sitä, kuinka vuorovaikutustilasta neuvotellaan ongelmanratkaisun (engl. *trouble resolution*) aikana. Vuorovaikutustilalla (engl. *interactional space*) tarkoitan sellaista tilaa, joka muodostuu vuorovaikutukseen osallistujien välille, kun he suuntautuvat kehollisesti toisiinsa ja ympäristöönsä kiinnittääkseen yhteisen huomionsa toisiinsa ja/tai esimerkiksi johonkin ympäristönsä objektiin (esim. Haddington & Oittinen, 2022; Mondada, 2013a). Tutkimustulokset osoittavat, että oppilaiden ongelmanratkaisu on kompleksista, tilanteista ja luovaa. Toisaalta tutkimus näyttää, että oppilaat joutuvat samanaikaisesti jakamaan huomionsa teknologian ja vertaisvuorovaikutuksen välillä. Tulosten perusteella esitän myös laajennus- ja tarkennusehdotuksen vuorovaikutustilan määritelmälle ja esittelen kehittämäni *jaettu digitaalinen tehtävätila* -käsitteen (engl. *shared digital task space*), joka korostaa vuorovaikutustilan dynaamisuutta ja kerroksisuutta teknologian kanssa työskenneltäessä.

Aiempaa tutkimusta oppilaiden kohtaamista ongelmista ja niiden ratkaisuun tähtäävästä vuorovaikutuksesta teknologiarikasteisissa luokkahuoneissa ei juurikaan ole. Aiempi luokkahuonevuorovaikutukseen keskittynyt tutkimus on perehtynyt esimerkiksi siihen, kuinka oppilaat koordinoivat puhetta ja kehollista toimintaansa käyttäessään teknologiaa eli lähinnä tietokoneita (esim. Gardner & Levy, 2010; Levy & Gardner, 2012) tai kuinka he neuvottelevat vuoroistaan digitaalisilla laitteilla (Jakonen & Niemi, 2020; Theobald ym., 2016). Ongelmanratkaisuun liittyvissä tutkimuksissa on analysoitu muun muassa sitä, miten laitteiden ominaisuuksia, kuten oikolukuohjelmaa tai synteettistä ääntä, käytetään kirjoitusvirheiden huomaamiseen ja korjaamiseen (Cekaite, 2009; Musk, 2016; Norén ym., 2022) tai kuinka aikuisopiskelijat pyytävät tai tarjoavat apua, kun heidän puutteelliset teknologiset taitonsa aiheuttavat vaikeuksia laitteiden käytössä (Råman & Oloff, 2022; Oloff, 2021). Tähän mennessä ei ole kuitenkaan tehty kattavaa tutkimusta erilaisista ongelmatyypeistä, joita digitaalisten laitteiden äärellä kohdataan nimenomaan peruskoulun luokkahuoneissa, saati siitä, kuinka näitä ongelmia vertaisvuorovaikutuksessa ratkaistaan.

Myös viime aikoina räjähdysmäisesti kasvanut teknologiavälitteisen ja hybridin vuorovaikutuksen tutkimus on pedagogisissa konteksteissa keskittynyt

lähinnä aikuisten ja korkeakouluopiskelijoiden vuorovaikutukseen (esim. Çimenli ym., 2022; Dooly & Tudini, 2022; Jakonen & Jauni, 2021, 2022; Oittinen, 2022; Park & Park, 2022; Veronesi ym., 2021). Näissä tutkimuksissa on todettu, että videovälitteisissä opetuskonteksteissa yhteisen vuorovaikutustilan ja intersubjektiivisuuden luominen on haastavaa. Tämä johtuu muun muassa kontekstin monitahoisuudesta sekä osallistujien rajoitetusta pääsystä toistensa kehollisiin vihjeisiin tai oppimateriaaleihin. Siksi esimerkiksi etäopiskelijat jäävät hybridiopetuksessa helposti ulkopuolisiksi. Toisaalta sekä opettajat että opiskelijat käyttävät teknologioiden tarjoumia hyväkseen ja ratkaisevat ja ennaltaehkäisevät vuorovaikutuksen ongelmia esimerkiksi sellaisin kehollisin resurssein, jotka ovat käytettävissä videovälitteisessä kontekstissa (kuten ilmeet tai verbaaliset kehotteet; esim. Badem-Korkmaz & Balaman, 2022; Malabarba ym., 2022; Veronesi ym., 2021), sekä hyödyntämällä muun muassa videokokouksen viestitoimintoja, jaettua näyttöä ja internetlinkkejä (Badem-Korkmaz & Balaman, 2022; Çimenli ym., 2022; Dooly & Tudini, 2022; Park & Park, 2022).

Näiden tutkimusten valossa pyrin tässä väitöskirjassa laajentamaan ymmärrystämme peruskouluikäisten lasten ja nuorten vuorovaikutuksesta ja ongelmanratkaisusta teknologiarikasteisissa luokkahuonekonteksteissa. Väitöskirjan yleisenä tavoitteena on vastata siihen, millaisia ongelmia oppilaat kohtaavat vertaisvuorovaikutuksessaan digitaalisten laitteiden äärellä ja miten näitä ongelmia ratkotaan. Tarkempia tutkimuskysymyksiä ovat: (1) Miten ja millaisin multimodaalisin resurssein oppilaat ratkovat ongelmatilanteita vertaisvuorovaikutuksessa digitaalisten laitteiden äärellä? (2) Miten vuorovaikutustiloista neuvotellaan ja miten niitä muokataan osana ongelmanratkaisuprosessia?

Väitöskirja koostuu neljästä vertaisarvioidusta artikkelista sekä yhteenvetoosiosta. Yhteenveto-osio puolestaan koostuu viidestä luvusta ja niiden alaluvuista. Ensimmäisessä luvussa esittelen lyhyesti tutkimuksen tärkeimmät teoreettiset käsitteet. Näitä ovat multimodaalisuus ja multimodaalinen keskustelunanalyysi, teknologiarikasteiset luokkahuoneet, vertaisvuorovaikutus, vuorovaikutustila sekä ongelmanratkaisu multimodaalisena ja kompleksisena ilmiönä. Lisäksi esittelen tutkimuksen tavoitteet, väitöskirjan tutkimusongelman sekä yksittäisten artikkeleiden tutkimuskysymykset.

Luvussa 2 käsittelen tarkemmin tutkimuksen teoreettis-menetelmällistä viitekehystä, jonka muodostavat multimodaalinen keskustelunanalyysi, luokkahuonevuorovaikutuksen tutkimus sekä teknologiarikasteisen ja -välitteisen vuorovaikutuksen tutkimus. Esittelen aluksi tiivistetysti keskustelunanalyysin historiaa ja sen 1960- ja 1970-lukujen sosiologiaan ulottuvia juuria (ks. esim. Clayman & Maynard, 1995; Eilittä ym., 2024; Hutchby & Wooffit, 2008; Maynard, 2013), siinä tutkittavia vuorovaikutuksen perusjäsennyksiä sekä alalla viime vuosikymmeninä vallinneita suuntauksia, kuten multimodaalisuuden ja teknologiavälitteisen vuorovaikutuksen tutkimusta. Alaluvussa 2.2 esittelen keskustelunanalyyttistä luokkahuonevuorovaikutuksen tutkimusta, jonka tutkimuskenttä on viime vuosikymmeninä laajentunut opettajan (verbaalisen) toiminnan tarkastelusta kattavampaan ja monipuolisempaan näkemykseen luokkahuoneesta dynaamisesti muovautuvana ympäristönä, jossa esiintyy monenlaisia ja vaihtuvia

vuorovaikutustilanteita ja osallistumiskehikoita (C. Goodwin, 1981; C. Goodwin & M. H. Goodwin, 2004). Luvun lopussa kokoan yhteen keskustelunanalyyttistä tutkimusta teknologian roolista kasvokkaisissa, videovälitteisissä ja hybrideissä (luokkahuone)konteksteissa.

Luvussa 3 esittelen tutkimusprosessin kulun sekä perustelen menetelmällisiä ratkaisujani. Tutkimus on laadullinen ja sen aineisto koostuu aidoissa luokkahuonetilanteissa kerätyistä videonauhoituksista. Tutkimukseen osallistui seitsemän 4.–9. luokan oppilasryhmää opettajineen neljästä suomalaisesta peruskoulusta. Videonauhoitukset tehtiin ryhmien sellaisilla oppitunneilla, joilla ryhmät opiskelivat englantia vieraana kielenä. Lisäksi osalta tunneista kerättiin näyttötallenteet opiskeluun käytetyiltä tablettitietokoneilta. Aineiston oppitunneilla oppilaat käyttivät sekä omia mobiililaitteitaan että koulujen tablettitietokoneita ja hybridilaitteita. Laitteita hyödynnettiin monipuolisesti erilaisissa yksilö- ja ryhmätehtävissä. Lisäksi aineistossa on kolme nauhoitettua hybridioppituntia, joille pieni osa oppilaista osallistui videokokoussovelluksen kautta. Vaikka videoyhteyden käyttö on sovelluksessa mahdollista, kaikki osallistujat opettaja mukaan lukien pitivät videon pois päältä oppituntien ajan. Etäoppilaat näkivät vain opettajan jakamat materiaalit ja osallistuivat opetukseen ääniyhteyden välityksellä. Näiltä tunneilta olen kerännyt sekä videonauhoituksen luokkahuoneesta että näyttötallenteet videokokouksesta.

Olen koko tutkimusprosessin ajan huomioinut tutkimusetiikan aineiston keräämisessä, käsittelyssä, säilyttämisessä ja esittämisessä. Tutkimus noudattaa Jyväskylän yliopiston tutkimuseettisiä ohjeita sekä kansallisia ja eurooppalaisia tutkimusetiikan säädöksiä ja ohjeistuksia. Osallistuminen on ollut osallistujille vapaaehtoista, ja he ovat saaneet tutkimuksesta tietoa mahdollisimman läpinäkyvästi. Osallistujien yksityisyyttä olen suojellut muun muassa käyttämällä heistä pseudonyymejä, esittämällä aineistosta otettuja pysäytyskuvia piirroksina sekä antamalla osallistuvista kouluista vain kontekstin ymmärtämisen kannalta tarvittavan määrän tietoa.

Tutkimuksen teoreettis-menetelmällisenä viitekehyksenä on multimodaalinen keskustelunanalyysi (Hazel ym., 2014; Lilja, 2022; Mondada, 2019), jonka avulla olen analysoinut oppilaiden vuorovaikutusta mikrotasolla. Keskustelunanalyysin perusperiaatteisiin kuuluu se, että aineistoa kerätessä lopullinen kysymyksenasettelu ei ole vielä tarkentunut, vaan olen löytänyt tutkittavat ilmiöt useiden analyysikierrosten aikana. Artikkeleita I, III ja IV varten keräsin aineistokokoelmat, joista tein tarkat multimodaaliset litteraatit (ks. esim. Mondada, 2022) ja jotka analysoin mikrotasolla. Artikkelissa II analysoin kokoelman sijaan aineistosta löytynyttä yksittäistä tapausta yksityiskohtaisesti.

Luvussa 4 tiivistän väitöskirjan yksittäisten artikkeleiden tulokset sekä kuvaan sitä, miten ne vastaavat väitöskirjan yleisiin tutkimuskysymyksiin. Olen ryhmitellyt artikkeleiden tiivistelmät teemoittain niiden ajallisen kirjoitusjärjestyksen sijaan. Artikkeleissa I ja II tarkastelen ongelmia, jotka liittyvät oppilaiden epäsymmetriseen pääsyyn (engl. *access*) toisaalta laitteille ja niiltä saatavaan tietoon ja toisaalta vertaisvuorovaikutukseen. Artikkeleissa pureudun siis tilanteisiin, joissa tehtävän aloittaminen tai yksittäisen oppilaan tai oppilaiden

osallistuminen tehtävään tai vuorovaikutukseen estyy tai hankaloituu, koska he esimerkiksi näkevät tai kuulevat tehtävään tarkoitettua laitetta tai ryhmän vuorovaikutusta hyvin rajallisesti tai eivät ollenkaan. Artikkeleissa III ja IV taas keskityn ongelmatilanteisiin sellaisina hetkinä, kun tehtävä on jo voitu aloittaa, mutta sen eteneminen pysähtyy hetkellisesti esimerkiksi laiteongelmien, virheiden tai vuorovaikutuksen ongelmien takia.

Artikkelissa I (Vänttinen, 2024) analysoin sitä, kuinka oppilaat neuvottelevat visuaalisesta tai auraalisesta pääsystä toisen oppilaan pitelemälle tai käsittelemälle digitaaliselle laitteelle silloin, kun epäsymmetrinen pääsy laitteelle estää tai hankaloittaa yhteistyötä. Digitaalisille laitteille pääsystä neuvottelua ei ole juuri aiemmin tutkittu oppilaiden vertaisvuorovaikutuksessa (ks. kuitenkin Jakonen & Niemi, 2020, jotka käsittelevät oppilaan pääsyn estämistä digitaaliselle laitteelle). Artikkelissani osoitan, että epäsymmetrinen pääsy laitteelle johtaa siihen, että oppilailla on erilaiset mahdollisuudet tulkita meneillään olevaa tehtävää ja vuorovaikutusta sen ympärillä. Osallistuessaan ryhmätehtäviin digitaalisella laitteella tai auttaessaan vertaista digitaalisen tehtävän tekemisessä oppilaiden on siis neuvoteltava yhteisestä vuorovaikutustilasta, jossa jaettu huomio on laitteella. Toisin sanoen oppilaiden vuorovaikutustilaan muodostuu jaettu digitaalinen tehtävätila.

Tutkimuksen aineistossa oppilaat suuntautuvat epäsymmetrisen pääsyn ongelmaan ja ratkovat sitä pääosin omilla kehollisilla resursseillaan. He esimerkiksi nojaavat lähemmäs laitetta, kääntelevät päätään, liikkuvat laitetta kohti tai sen ympärillä tai järjestelevät materiaalista ympäristöään siirtämällä tuoliaan tai heidän tiellään olevia esineitä. On huomion arvoista, että oppilaat hakevat harvoin pääsyä laitteelle verbaalisesti pyytämällä. He myös välttelevät toisen oppilaan käsittelemän laitteen koskettamista, elleivät ryhmän muut oppilaat toistuvasti estä heidän pääsyään laitteelle ja siten laiminlyö heidän oikeuksiaan ryhmän jäseninä. Laitetta käsittelevälle oppilaalle siis ikään kuin myönnetään sen tilanteinen omistajuus. Näin pääsyn neuvottelut digitaalisen teknologian äärellä tuovat esille myös vertaisten erilaiset roolit, oikeudet ja vastuut niin tehtävässä, laitteen käytössä kuin vertaisryhmässä. Artikkelissa kuitenkin osoitan, etteivät erilaiset vertaisryhmien roolit ole institutionaalisesti pysyviä, vaan niitä neuvotellaan tilanteisesti. Tutkimus antaa siis uutta tietoa sekä lasten ja nuorten vertaisvuorovaikutuksesta että multimodaalisesta ongelmanratkaisusta digitaalisen teknologian äärellä. Tutkimus myös osoittaa, että yhteistyö digitaalisella laitteella vaatii oppilailta teknologiataitojen lisäksi esimerkiksi yhteistyö- ja neuvottelukykyä.

Artikkelissa II (Vänttinen, käsikirjoitus) esittelen tapaustutkimuksen hybridiopetuskontekstista. Myös tässä artikkelissa keskityn pääsyn ongelmiin, mutta tällä kertaa haasteena on etä- ja lähioppilaiden rajattu pääsy toistensa kehollisiin vihjeisiin ja fyysiseen ympäristöön. Tarkastelen artikkelissa oppilasparia, joista toinen on paikalla fyysisessä luokkahuoneessa ja toinen osallistuu tunnille videoyhteyden välityksellä. Opettaja ja etäoppilaat pitävät kuitenkin videokameransa kiinni koko oppitunnin ajan, joten etäoppilaat kuulevat vain osan luokkahuonevuorovaikutuksesta ja näkevät vain opettajan jakamat materiaalit

videokokoussovelluksessa. Luokkahuoneen osallistujat eivät myöskään näe etäoppilaita. Analyysissa keskityn siihen, kuinka oppilaspari rakentaa yhteistä hybridiä vuorovaikutustilaa käyttämällä rajallisia resursseja heille uudessa oppimisympäristössä.

Aiempi vuorovaikutuksen tutkimus on osoittanut, että vuorovaikutukseen osallistuminen sekä intersubjektiivisuuden ja yhteisen vuorovaikutustilan rakentaminen on haastavaa hybridikonteksteissa (esim. Badem-Korkmaz & Balaman, 2022; Melander Bowden & Svahn, 2020; Saatçi ym., 2020; Wigham & Satar, 2021). Artikkelissa II kuvaan, kuinka luokassa oleva oppilas pyrkii avaamaan keskustelun etäosallistujan kanssa ja kuinka avaussekvenssiä edeltävä esijakso (engl. *pre-beginning*; ks. Mondada, 2009; Schegloff, 1979, s. 34; Whalen & Zimmerman, 1987) pitkittyy oppilaan etsiessä keinoa saada etäoppilaaseen yhteys. Oppilas kokeilee erilaisia luokassa olevia teknologisia laitteita, kunnes pari lopulta saa rakennettua hybridin vuorovaikutustilan opettajan tietokoneen avulla. Myös opettaja käyttää myöhemmin tätä valmiiksi neuvoteltua hybridiä tilaa etäoppilaan osallistamiseen, eli luokkahuoneen avainoppilas on näin toiminut linkkinä luokan ja etäoppilaan välillä. Artikkelini tuloksilla on yhteys aiempiin tutkimuksiin, jotka ovat osoittaneet osallistumisen olevan kompleksista ja epäsymmetristä hybridikonteksteissa (esim. Büyükgüzel & Balaman, 2023; Jakonen & Jauni, 2021, 2022; Kohonen-Aho, 2023; Oittinen, 2022). Toisaalta artikkeli osoittaa, että oppilaat ratkaisevat hybridin osallistumisen ongelmia luovasti erilaisia teknologioita hyödyntäen ja että puuttuvasta visuaalisesta pääsystä huolimatta hybridi vuorovaikutustila voidaan rakentaa esimerkiksi äänen varaan. Artikkeli II korostaakin niitä erilaisia ongelmanratkaisu- ja vuorovaikutustaitoja, joita oppilaat tarvitsevat tämän päivän teknologiarikkaissa luokkahuoneissa.

Artikkelissa III (Vänttinen, 2022) tarkastelen ongelmanratkaisua tilanteissa, joissa tehtävä tai tehtävävuorovaikutus keskeytyy, koska oppilailla on laitteeseen, tehtävään tai vertaisvuorovaikutukseen liittyviä ongelmia. Erityisesti analysoin katseen roolia avunpyynnöissä (engl. *recruitments of assistance*; Drew & Kendrick, 2018; Kendrick & Drew, 2016) ja tilanteissa, joissa oppilas hakee vastausta omaan vuoroonsa (engl., *response pursuits*; esim. Pomerantz, 1984b; Stivers & Rossano, 2010). Aiemmat tutkimukset ovat osoittaneet, että katse voi liittyä kumpaankin sosiaaliseen toimintoon (Drew & Kendrick, 2018; Duran & Jacknick, 2020; Pfeiffer & Anna, 2021), mutta artikkelini valottaa näitä ilmiöitä nimenomaan lasten ja nuorten vertaisvuorovaikutuksessa teknologian avulla suoritettavien tehtävien aikana.

Tulokset osoittavat, että katseen siirtäminen digitaalisesta laitteesta vertaiseen toimii usein yhtenä ensimmäisistä resursseista, joiden avulla oppilaat osoittavat ja ratkovat ongelmatilanteita. Katse toimii yhdessä muiden kehollisten ja verbaalisten resurssien kanssa niin avunpyynnöissä kuin vastauksen hauissa, ja sen avulla pyritään luomaan yhteistä, ongelmanratkaisun mahdollistavaa vuorovaikutustilaa. Toisinaan katseen siirtäminen vertaiseen toimii aluksi oppilaan ainoana keinona osoittaa avun tarvetta tai suuntautua puuttuvaan vastaukseen, mutta oppilaat myös lisäävät tarvittaessa muita resursseja asteittaisesti. Katseen avulla oppilas myös tarkistaa toisen oppilaan saatavuutta vuorovaikutukseen.

Artikkeli osoittaa, että ongelmanratkaisu luokkahuoneessa vaatii taitoa neuvotella vuorovaikutustiloista sekä teknologian ja vuorovaikutuksen samanaikaista hallinnoimista. Osatutkimuksen avulla voimme ymmärtää paremmin katseen vuorovaikutuksellisia tehtäviä, vertaisryhmien vuorovaikutusta ja teknologiarikkaita oppimisympäristöjä.

Artikkelissa IV (Vänttinen & Kääntä, 2024) käsittelemme tilanteita, joissa vertainen tekee virheen oppilasparin tai -ryhmän yhteisessä digitaalisessa tehtävässä. Tarkastelemme oppilaiden syytösten tuottamista (engl. *blame attributions*; Pomerantz, 1978) näissä tilanteissa ja näytämme, miten niissä voidaan hyödyntää kehollisia resursseja ja digitaalista laitetta. Pomerantz (1978) on aiemmin osoittanut, että syytökset (engl. *blamings*) rakentuvat kahdesta osasta: ikävän sattumuksen kertomisesta ja syyllisen osoittamisesta. Aiempi syytösten tutkimus on keskittynyt lähinnä verbaalisiin resursseihin (ks. kuitenkin M. H. Goodwin ym., 2002), joten tässä artikkelissa keskityimme toiminnon multimodaaliseen ja tilanteiseen rakentumiseen lasten vuorovaikutuksessa teknologiakontekstissa.

Artikkelissa IV osoitamme, että oppilaat voivat tuottaa syytöksiä hyvinkin suorasukaisesti useiden multimodaalisten resurssien laminoinnin (engl. *lamination*; C. Goodwin, 2013) eli kerrostamisen avulla, mutta usein jopa ilman eksplisiittistä ilmoitusta virheen tapahtumisesta tai siitä, kuka on syyllinen. Oppilaat voivat myös välttää verbaalista syytöstä nojautumalla toiminnon tuottamisessa digitaalisella laitteella tapahtuviin, kaikille osapuolille näkyviin ilmoituksiin virheistä. Näin syytöksissä yhdistyvät digitaaliset ja keholliset resurssit, jotka sulautuvat yhdeksi sosiaaliseksi toiminnoksi (vrt. engl. *phygital actions*; Due & Toft, 2021). Artikkeli IV tarkentaa ja täydentää aiempaa syytösten käsitettä keskustelunanalyysissä ja korostaa syytösten multimodaalista rakentumista. Lisäksi sen avulla voimme ymmärtää syvemmin teknologiarikasteisten luokkahuoneiden vertaisvuorovaikutusta ja siihen liittyviä moraalisia implikaatioita.

Luvussa 5 käsittelen artikkeleiden tuloksia suhteessa koko väitöskirjan tutkimuskysymyksiin sekä sitä, kuinka tulosten perusteella voidaan laajentaa ongelmanratkaisun ja vuorovaikutustilan käsitteitä. Lisäksi esittelen tutkimuksen teoreettista ja käytännön tason sovellettavuutta sekä sen rajoituksia. Esittelen myös mahdollisia kysymyksiä jatkotutkimukselle.

Tutkimukseni tuo esille erityisesti kahdenlaiset ongelmatilanteet, joihin oppilaat törmäävät työskennellessään digitaalisen teknologian äärellä. Ensinnäkin tutkimus osoittaa, että ongelmat, jotka liittyvät pääsyyn laitteelle tai vuorovaikutukseen, ovat pohjimmiltaan ongelmia vuorovaikutustilan neuvottelussa. Kun oppilaat eivät saa neuvoteltua yhteistä fokusta esimerkiksi laitteella suoritettavaan tehtävään, voi tehtävän aloittaminen estyä tai yksittäinen oppilas voi joutua poissuljetuksi tehtävästä tai vertaisvuorovaikutuksesta. Toiseksi tutkimus havainnollistaa, kuinka oppilaat hyödyntävät vuorovaikutustilasta neuvottelua tehtävien aikana ilmenevien laitteeseen, tehtävään tai vuorovaikutukseen liittyvien ongelmien ratkaisussa. Kummassakin ongelmatyypissä ongelmanratkaisu on multimodaalinen ja vaiheittainen prosessi, jossa oppilaat pyrkivät tekemään yhteistyötä. Erityisesti pääsyn haasteissa ongelmanratkaisu on usein kompleksisesti rakentunutta. Huomattavaa on, että oppilaat nojaavat erityisesti kehollisiin

resursseihin, kun taas verbaalisten resurssien käyttö liittyy monesti tilanteisiin, joissa ongelma pitkittyy tai sen ymmärtämiseksi tarvitaan eksplisiittisempiä selityksiä. Lisäksi oppilaiden erilaiset roolit ryhmässä, tehtävissä ja vuorovaikutuksessa vaikuttavat siihen, millaisia resursseja ongelmien ratkomiseen käytetään.

Vaikka tutkimukseni vahvistaakin aiempien tutkimusten käsitystä vuorovaikutustilan dynaamisuudesta ja kompleksisuudesta (Kohonen-Aho, 2023; Mondada, 2011; Oittinen, 2020a), se tarjoaa myös uutta tietoa vuorovaikutustilan kerroksisuudesta erityisesti digitaalisia tehtäviä tehdessä. Esittelemäni jaetun digitaalisen tehtävätilan käsitteen avulla voidaan analysoida sitä, kuinka digitaalinen tehtävä ja oppilaiden toiminta laitteella ovat dynaaminen osa jaettua huomiota ja vuorovaikutustilaa. Oppilaiden täytyy siis monitoroida laitetta aktiivisesti ja koordinoida sillä suoritettuja toimintoja samanaikaisesti laitteen ympärillä tapahtuvan vuorovaikutuksen kanssa. Lisäksi löydökset osoittavat, että hybridikontekstissa eri vuorovaikutustilat limittyvät, kun oppilas voi samanaikaisesti orientoitua sekä fyysiseen että hybridiin tilaan ja jakaa eri resursseja näiden tilojen välillä joustavasti. Toisaalta osoitan, että hybridin vuorovaikutustilan rakentaminen on mahdollista myös auraalisten vihjeiden perusteella – siitäkin huolimatta, että viimeaikainen hybridikontekstien tutkimus on painottanut erityisesti visuaalisten resurssien merkitystä (esim. Kohonen-Aho, 2023). Korostankin tilanteisen kontekstin ja saatavilla olevien resurssien huomioimisen tärkeyttä vuorovaikutustilan ja kehollisuuden tutkimuksessa.

Väitöskirjani tuo uutta näkökulmaa vuorovaikutuksen ongelmiin keskittyvään keskustelunanalyyttiseen tutkimukseen valottamalla ongelmanratkaisun yhteistoiminnallista, kompleksista ja prosessimaista luonnetta, jonka kuvaamiseen perinteinen korjauksen (engl. *repair*) käsite ei sellaisenaan riitä. Tutkimus myös jatkaa multimodaalista keskustelunanalyysin perinnettä tarjoamalla lisää tietoa oppilasvuorovaikutuksen multimodaalisesta rakentumisesta sekä kehollisten ja digitaalisten resurssien limittymisestä ongelmanratkaisussa. Lisäksi tutkimus ottaa osaa keskusteluun teknologian roolista ihmisten välisessä vuorovaikutuksessa ja korostaa sen tilanteista luonnetta. Tutkimuksen löydöksiä voidaan myös soveltaa pedagogisten käytänteiden ja teknologisten sovellusten kehittämisessä. Kaiken kaikkiaan tutkimus auttaa ymmärtämään oppilaiden vertaisvuorovaikutusta teknologian äärellä multimodaalisena ilmiönä, jonka tarkastelussa täytyy kokonaisvaltaisesti huomioida verbaalisten ja kehollisten resurssien lisäksi sen teknologinen, materiaalinen ja tilallinen konteksti.

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ORIGINAL PAPERS

I

RESOLVING ASYMMETRY OF ACCESS IN PEER INTERACTION DURING DIGITAL TASKS IN EFL CLASSROOMS

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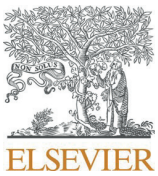

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Resolving asymmetry of access in peer interactions during digital tasks in EFL classrooms

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ABSTRACT

In face-to-face classrooms, when mutual visual and/or aural access to a digital device is needed but lacking during digital tasks, participants display an orientation to asymmetric access and resolve the issue through multimodal resources. This study examines the trajectory of negotiating access to digital devices held or handled by a coparticipant in peer classroom interactions. The data are audio-video recordings from English as a Foreign Language (EFL) classrooms, where individual and collaborative learning tasks are performed on or with digital devices. The findings show that pupils seek access to devices mainly through embodiment, such as body shifts, and rearranging material resources, and display a preference for not touching a device held by another pupil. Overall, the negotiation process reflects different types of situated roles and authority. The study contributes to an understanding of peer interaction around digital devices and offers important pedagogical implications for the implementation of technology in classrooms.

1. Introduction

As digital devices and applications have become everyday tools in today's face-to-face classrooms, a growing body of research has described classroom interaction around such digital technology (e.g., Jakonen & Niemi, 2020; Juvonen et al., 2019; Rusk, 2019; Råman, 2022; Råman & Oloff, 2022; Sahlström et al., 2019; Theobald et al., 2016; Vänttinen & Kääntä, 2024; see also Jakonen et al., 2022). It has been shown, for instance, that pupils may "engage with technology in unexpected, and at times, highly innovative ways that often diverge from the task-as-workplan" (Dooly, 2018, p. 184) and that they simultaneously need to manage both the task on the digital device and the interaction around it, while solving interactional or task-related trouble (Vänttinen, 2022). Similarly to any pedagogical methods and tools, tasks performed on digital devices can engender various types of trouble, which often derive from the fact that many digital tools have originally been designed for individual rather than for collaborative or, as Jakonen et al. (2022, p. 112) point out, any kind of educational use. During tasks, this design feature can lead to situations where participants have asymmetric visual or aural access to a digital device even when mutual access to it is needed for collaboration, which in turn can result in unequal opportunities to access important information and to participate in activities.

The present study investigates how pupils in English as a Foreign Language (EFL) lessons within Finnish basic education negotiate visual and/or aural access to a digital device when mutual access to it is needed to perform groupwork or to assist a peer, for example. Specifically, I analyse instances where a pupil lacks access to a device handled by a peer and seeks to resolve this asymmetry of access through varied combinations of multimodal resources. With multimodality, I refer to all the resources that participants employ in interaction, including talk, embodied resources, such as eye gaze, gestures, and movements of the head and the body, as well as material resources, such as different objects that are relevant for the ongoing interaction (see e.g., Lilja, 2022; Mondada, 2019). Through these resources, participants in interaction can achieve joint attention by (re)orienting to each other, interactionally relevant objects, and the space surrounding them in embodied ways. In other words, they can build and renegotiate interactional spaces (Mondada, 2013). In the context of the current study, a pupil with access trouble can renegotiate the existing interactional space to achieve mutual access to a device and to secure a joint focus on a task.

The study draws on multimodal conversation analysis (CA), which examines how social interaction is temporally and sequentially structured, not only through talk but also other multimodal resources (e.g., Lilja, 2022; Mondada, 2019). Through its microanalytic lens and its focus on multimodality, CA can tease out the various methods that pupils in the data use to negotiate access to a device and which would not be visible through a narrower analytical focus only on talk or through an

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investigation of macro-level phenomena. Since CA also emphasises the role of sequential context and the ongoing activity in how actions are formed and understood (Deppermann & Haugh, 2022), it is well suited for analysing the local, situated roles that are reflected in the trajectories of access negotiation during task activities. The aim of the study, then, is to find out (1) how mutual visual and/or aural access is negotiated to a digital device held or handled by a peer, (2) what preferences for multimodal resources are displayed in the negotiation, and (3) what kinds of local roles and authority are reflected in this process.

Previously, asymmetry of access to digital devices has received little attention within classroom and CA research (see, however, Jakonen & Niemi, 2020; Råman, 2022). The current study contributes to the field by showing how children and teenagers negotiate mutual access to a device within classroom peer interaction and thus by illustrating the kind of multimodal work that pupils engage in while building collaboration in educational settings. In addition, it furthers our understanding of the roles that pupils orient to and display in classroom peer interaction. Finally, the study has important pedagogical implications since (the lack of) access to devices used for pedagogical tasks may ultimately affect pupils' opportunities for collaboration and learning.

2. Background

In pedagogical contexts, technological objects can be seen as situated resources (Nevile et al., 2014) for learning activities performed on or with them, and access to them thus affects participation and learning opportunities (see e.g., Eilola & Lilja, 2021; Greer, 2016). In this sense, they are comparable to any other semiotic objects in the classroom, such as books, whiteboards, or maps, that are engaged with for pedagogical purposes (e.g., Jakonen, 2018), and pupils' (lack of) access to them may also become relevant for the organisation of interaction (see e.g., Heller, 2016). Asymmetric access to devices may also lead to situations similar to the "fractured ecologies" in video-mediated contexts (Luff et al., 2003), when access to the information mediated through devices or to actions performed on them is not shared by all participants.

During digital learning tasks, achieving joint attention (Kidwell & Zimmerman, 2007) becomes a practical problem of building mutual access to the device and generates a need for constant (re)negotiation of interactional space (Mondada, 2013; Haddington & Oittinen, 2022). Organising the interactional space around a digital device is a multimodal task, which involves arranging participants' bodies, embodied resources, and the material surroundings in a way that grants mutual attention to coparticipants and interactionally relevant objects (Mondada, 2013), including technology (Oittinen, 2020). Outside the classroom context, Due and Toft (2021), for instance, illustrate how joint attention is secured to computer screens by pointing and using the cursor to highlight text (see also Olbertz-Siitonen & Piirainen-Marsh, 2021). Within an educational setting, Thorne et al. (2015) show how a group of university-level students walk on campus and simultaneously maintain joint attention to a shared digital device by remaining in the proximity of the device holder, displaying orientation to the device through gaze and postural alignment, and at times requesting to manipulate the device. Intersubjectivity around digital devices is thus sustained through multimodality, combining verbal resources with embodiment (see also Thorne et al., 2021) and with the use of digital technology.

While questions of access and intersubjectivity have recently received particular interest within CA research on remote and hybrid educational contexts (e.g., Balaman, 2018; Balaman & Pekarek Doehler, 2022; Jakonen & Jauni, 2021; Oittinen, 2022; Rusk & Pörn, 2019; Sert & Balaman, 2018; Uskokovic & Talehgani-Nikazm, 2022), surprisingly little attention has been paid to negotiations of access to digital devices in face-to-face classrooms. Jakonen and Niemi (2020), however, show how a pupil can use touch to block a peer's attempt to gain haptic access to a digital device during collaborative tasks. Closely related to the present paper, Råman's (2022) study explores teachers' multimodal work to negotiate visual and haptic access to their students' devices. In a context of problem-solving on digital skills courses for senior citizens, Råman illustrates how the type of problem may affect what kinds of resources teachers prefer when attempting to gain access to devices; when the objective is for the students themselves to learn how to solve a problem with the device, teachers tend to use resources, such as verbal directives and pointing gestures, that allow the student to maintain control over the device. By contrast, when problems are treated as 'solvables', teachers more directly take control over students' devices to locate and solve the trouble (Råman, 2022). Råman (2022) and Jakonen and Niemi (2020) thus highlight negotiation for access to digital devices as a multimodal phenomenon, a viewpoint which the current study also adopts.

By examining the role of embodiment and material resources in access negotiations, the current study contributes to the line of classroom interaction research that investigates multimodality in technology-rich pedagogical contexts. Earlier studies have shown, for instance, that talk needs to be carefully coordinated with and can be disrupted during actions performed on a computer (Gardner & Levy, 2010; Levy & Gardner, 2012). Various studies have also confirmed that action formation can rely on embodied and digital resources, sometimes even without talk. Theobald et al. (2016), for instance, describe how a teacher mobilises pre-schoolers' actions on a digital device in embodied ways. In studies on peer interaction around technology, embodied resources, such as eye gaze, facial expressions, and gestures, as well as actions on digital devices have been shown to be used for various social actions, such as pursuing a response and recruiting assistance from peers (Vänttinen, 2022), asking for and giving instructions (Tuncer et al., 2022), attributing blame to a peer after mistakes in digital tasks (Vänttinen & Kääntä, 2024), and signalling 'being stuck' during collaborative writing (Juvonen et al., 2019). To my knowledge, however, body shifts and movements of the head have not received similar interest in research on digitally rich classrooms.

Negotiating access to objects, such as digital devices, also brings forth questions of participants' roles and authority (Heller, 2016, p. 270). Who gets access to a device and has the power to regulate others' access to it reflects the distribution of deontic rights and obligations (see e.g., Stevanovic & Peräkylä, 2012) in the local context. Råman (2022) suggests that teachers' institutional role and epistemic authority may grant them the right to access students' devices, even the ones owned by the students. Theobald et al. (2016) also illustrate the institutional role of the teacher in allocating turns on a mobile device to pupils but in a way that enables the pupils to maintain the ownership of the device. In the context of peer interaction, however, pupils have a more equal standing, at least from a purely institutional perspective, and their distinct methods of negotiating access to devices may therefore not be explained solely in terms of institutional authority. Indeed, Thorne et al. (2015) argue that the device holder "may sometimes have special privileges (and responsibilities) by the fact that [they are] holding the device" (p. 282), which suggests that the digital device itself brings with it deontic authority for its holder. In a similar vein, Cekaite (2009) and Musk (2016) found that students having access to the mouse and keyboard seemed to have the authority to make final decisions about spelling corrections during collaborative tasks on a computer. This study shows, however, that there may be combinations of different types of local and situated roles at play when access to digital devices is negotiated in classroom peer interaction.

The current study contributes to CA research investigating multimodality and classroom interaction research by illustrating how pupils negotiate not only visual but also aural access to digital devices during peer interaction. It shows how pupils design their conduct so that it both displays orientation to the asymmetry of access and works to gain access to the device. In particular, the study highlights the role of movements of the head, body shifts, and moving the body in the physical classroom space as well as adjusting the material resources, such as digital devices and chairs, in access negotiations. In addition, the peer context allows us

to look past the institutionally unequal status between teachers and pupils and, instead, to examine how a preference for certain, self-initiated actions reflects different types of roles and authority among institutional equals.

3. Data and methods

The videorecorded data for the study come from a larger data set consisting of 19 English as a Foreign Language (EFL) lessons in four Finnish comprehensive schools. Digital devices, such as pupils' smartphones or the school's tablet computers, were used in all these lessons, but the time spent on devices varied. While some lessons ($n = 10$) were mostly structured around digitally supported tasks, others only included short digital tasks or games. The task types in the whole data set varied from vocabulary games and grammar tasks to preparing short presentations in English and involved both individual and teamwork. The lessons (from 45 to 60 min each) were recorded with two to three fixed video cameras and three external microphones, and in four lessons, additional screen recordings were made of the school-owned mobile devices that were used for tasks. Altogether this resulted in circa 51.5 h of video data.

Seven groups of pupils aged 10 to 15 years (from grades 4 to 9), four teachers, and two assistant teachers participated in the study. All pupils spoke Finnish as one of their languages and studied English as a foreign language. Permission to collect data was obtained from the schools, and the adult participants and the underaged participants' guardians gave informed written consent to participate and to have the data used for research publications. Participants were informed at the beginning of the lessons that they could withdraw from the study without prior notification – a freedom that a few pupils exercised.

From the data set, I made an initial collection of all instances of peer interactions that occurred around digital devices. These data were analysed using multimodal conversation analysis (CA), which involves a micro-level inspection of the temporal and sequential structures of social interaction (e.g., Sidnell & Stivers, 2013) and how these structures are collaboratively built out of talk, embodiment, such as gaze, body shifts, and gestures, as well as material resources (e.g., C. Goodwin, 2000; Mondada, 2019). During preliminary analysis, my attention was drawn to instances where pupils visibly oriented to an asymmetry of visual and/or aural access to mobile devices handled by their peers, when joint attention to them was needed for teamwork, negotiating answers, or assisting a peer. A collection of 51 cases was thus built for the purposes of the present study and analysed in detail to identify trajectories of resolving asymmetric access to a device. The focus was on discerning potential preferences for certain multimodal resources and understanding how participants' conduct reflected aspects related to local, situated roles and authority. The preferences varied according to whether tasks were performed on individual or shared devices, and accordingly, the final collection used in the study can be divided into three subcollections: (1) 23 cases where pupils perform individual tasks on individual devices, (2) 4 cases of teamwork performed on individual devices, and (3) 24 cases of teamwork on shared devices. The first two subcollections ($n = 27$) involve individual devices and an orientation to each pupil's 'ownership' of their device, whereas negotiations in the third subcollection reflect an orientation to a shared device and joint responsibility for the task.

The data have been transcribed using CA conventions (Jefferson, 2004) and an adaptation of the multimodal transcribing system developed by Mondada (2018, 2022). The original talk is given in bold font, with translations from Finnish to English below it in italics and embodied as well as on-screen actions in grey font (for details, see the Appendix). The participant names are pseudonyms, and drawings have been used instead of video stills for pseudonymisation purposes.

4. Analysis

In the following sections, four representative extracts are analysed to illustrate how multimodal resources feature in the trajectories of negotiating mutual access to digital devices when joint attention to them is needed for collaboration, such as assisting peers or performing teamwork. The negotiations in the data collection involve a variety of multimodal resources used to display and resolve asymmetric access to devices. In all cases, participants perform some forms of body shifts, usually leaning towards the device or adjusting their (sitting) position. Most cases ($n = 29$) also involve head movements, and sometimes pupils move in the classroom space ($n = 11$), arrange the material environment ($n = 7$), such as furniture, and/or reach out their hands to gesture or point towards the device ($n = 12$). Verbal requests, sometimes indirect, are performed in only 6 cases. Touch is used to re-position a device handled by a peer in 7 cases, as a type of last resort, when a team member's access to a device is repeatedly denied or otherwise neglected.

The extracts exemplify the kinds of multimodal negotiations pupils engage in as they perform pedagogical tasks on devices. In addition, they show that the participants primarily display a preference for self-initiated multimodal work in gaining access to a device. Furthermore, the extracts illustrate different types of local roles and authority that are displayed in the negotiation process. The analysis is divided into two sections. Section 4.1 discusses the multimodal process of negotiating access to a device 'owned' by a coparticipant (subcollections 1 and 2), and Section 4.2 shows how problems of access to a shared device are resolved during teamwork (subcollection 3).

4.1. Negotiating access to coparticipant's device

Negotiations of access to a coparticipant's device occur after recruitments ($n = 24$) or occasionally ($n = 3$) amidst showings of devices. Recruitment refers to different ways that participants request or offer assistance in interaction (Kendrick & Drew, 2016), and, similarly to showings, require joint attention from coparticipants. In most cases in this subcollection (in 14 out of 24 recruitments), the recruiter starts arranging a shared interactional space with mutual access to the device during the recruitment, but the recruited participant displays that the access remains insufficient (see Extract 1). In 10 cases, however, the recruiter does not initially provide access to the device, and the recruited participant takes on the responsibility of negotiating shared access to the trouble source (Extract 2). Due to the high occurrence of recruitments in the data, Extracts 1 and 2 both illustrate multimodal trajectories of resolving asymmetric access to a device after recruitments. In both examples, the asymmetry is visibly oriented to by the recruited participant, and the trouble is resolved stepwise through a multimodal interactive process that is representative of the whole subcollection. Throughout the problem-solving sequence, the participants show a preference for maintaining the device-holder's situated ownership (see Day & Rasmussen, 2019) of the device. In Extract 1, the problem is related to asymmetric aural access, whereas Extract 2 showcases a trajectory of negotiating mutual visual access.

In Extract 1, fifth-grade pupils handle school-owned tablet computers to execute tasks on a digital platform offered by the publisher of the book series they use. The pupils are familiar with the platform and have completed similar tasks before. Sara and Anna, sitting next to each other (Fig. 1), perform individual tasks on their devices, sometimes helping each other and engaging in brief off-task conversations. Sara's current task, which Anna has already completed, involves listening to recorded words and spelling them correctly. Sara has trouble identifying the word *waterfall* and repeats an approximate pronunciation of it a few times, glancing at her book. She eventually requests help from Anna (line 1).

Extract 1.

```
1   SARA      #.hhh      +ann+a
    annaG     >>to tablet->
    annaF     >>smiles->
    saraF     >>smiles->
    saraG     >>to tablet+...+to anna's tablet->
    fig.      #Fig.1

2             (.)

3   SARA      kuun+tele±ppa +↑m±ikä tää* on;*÷+
              have a listen   what is this
    saraG       ->+to anna--+to tablet--------+ahead->
    sara                    ->±turns tablet toward anna->
    annaG                           ->*....*to sara->
    saraF                                 ->÷

4             (0.3)+♥#
    saraG       ->+to tablet->
    annaF        ->♥
    fig.            #Fig.2
```

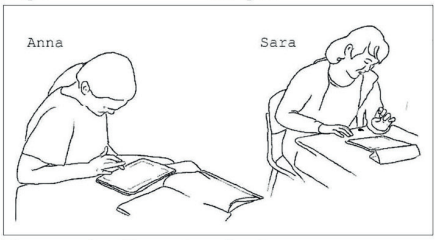

Figure 1. Gaze to devices.

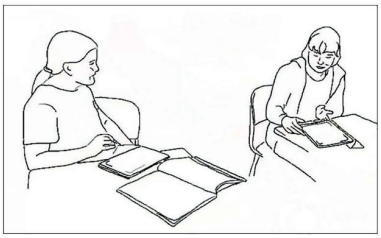

Figure 2. Sara turns device.

```
5   ANNA      krh* rhm• ((clears throat))
    annaG      ->*to sara's tablet->
    anna              •leans forward toward sara's tablet->

6             (0.2)±
    sara        ->±...->

7   SARA      kuuntele:.•
              listen
    anna              ->•immobile, leaning position->

8             (0.2)±
    sara        ->±adjusts tablet->

9             (0.6)±(0.6)•±
    sara        ->±......±presses 'play' button->
    anna             ->•stretched neck,
                        ear toward tablet->

10            (0.2)*±+(0.5)÷±+(0.2)#► (0.2)►
    annaG       ->*away->
    sara         ->±,,,,,,,±
    saraG         ->+.......+to anna->
    saraF               ->÷mouth open->
    tablet                        ►bleeps►
    fig.                        #Fig.3
```

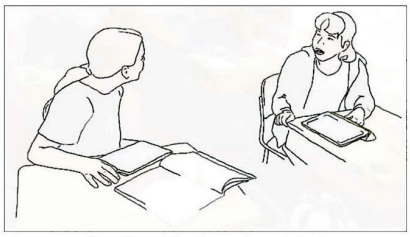

Figure 3. Participants listen.

```
11              (0.2)

12   TABLET     waterf[all

13   ?                [(XX•*♥X)
     anna               ->•leans back->
     annaG               ->*to sara->
     annaF                  ♥smiles->

14              (0.4)•(0.2)*±(0.3)+
     anna          ->•stands up->
     annaG               ->*to sara's tablet->
     sara                   ±turns tablet toward herself->
     saraG                      ->+...->

15   ANNA       @>kuu(nte)le+ppa< #uuellee@?•
                  listen again
     saraG               ->+to tablet->
     anna                                  ->•steps toward
                                              sara's desk->
     fig.                          #Fig.4
```

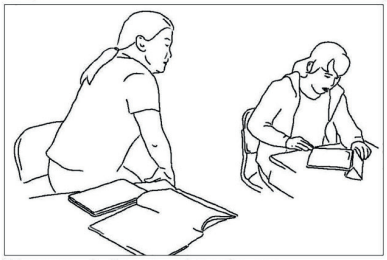

Figure 4.Anna stands up.

```
16              (0.4)±(0.5)•*            ±
     sara          ->±leans toward tablet±presses 'play'->
     anna               ->•crouches over sara's tablet,
                           brings ear close it->
     annaG               ->*left->

17              (0.3)+±(0.5)#
     saraG         ->+to desk->
     sara           ->±brings ear close to tablet->
     fig.                 #Fig.5
```

. (*continued*).

Figure 5. Participants lean towards tablet.

```
18   TABLET     =water•*fall*±÷
     anna            ->•
     annaG             *....*to sara->
     sara                  ->±sits up->
     saraF                    ÷smiles mouth open, frowns->

19               (0.3)•(0.6)±(0.2)+*(.)+(.)
     anna             •straightens up->
     sara                ->±gestures with open hands,
                            palms up->
     saraG                     ->+....+to anna->
     annaG                      ->*gaze direction
                                   not visible->>

20   ANNA       ↑/va•terfo:l/.
     anna         ->•steps left->

21               (0.4)+(0.2)+(.)•±÷
     saraG          ->+.....+to tablet->>
     anna                     ->•turns, returns to her desk->>
     sara                      ->±
     saraF                      ->÷mouth closed, smiles->>

22   SARA       ahaa:,
                oh okay
```

. (*continued*).

In Extract 1, Anna visibly orients to asymmetric aural access to the tablet. Here, mutual access is needed for Anna to assist Sara in recognising the target word *waterfall*. Sara's request for Anna to listen (line 3) is formed as an imperative *kuunteleppa* but mitigated by a somewhat dialectal pronunciation and the clitic *-pa*, which can be used to make directives more polite (Institute for the Languages of Finland, 2015; note however, that it may also assume authority over the listener, see (VISK, 2004)). Sara starts arranging a shared interactional space by shifting her gaze to Anna and turning the device on the desk toward Anna (Fig. 2). During Sara's turn, Anna puts her own task on hold and displays her availability for interaction (Kidwell & Zimmerman, 2006) through a gaze shift to Sara. After following Sara's gaze to the device (lines 4 and 5, respectively), Anna leans forward, either as a reaction to lacking access to the device or as a further display of orientation to Sara's line of action. Having secured Anna's attention, Sara further turns the device toward Anna (line 8). Coordinating her bodily actions with Sara's and displaying focus on the device, Anna stretches her neck and turns her right ear toward the tablet (Fig. 3), just as Sara presses 'play' (line 9). Sara then turns to look at Anna with her mouth open (line 10), and a bleep, followed by the word *waterfall*, can be heard from the device (lines 11 and 12). Overlapping the word, however, another pupil in the classroom exclaims loudly, which may hinder hearing the word.

Indeed, Anna orients to the lacking aural access by shifting and moving her body in the physical space of the classroom, despite Sara's earlier attempts at adjusting the interactional space. Anna leans back in the chair, glances at Sara (line 13), and then stands up, returning her gaze to the device (line 14; Fig. 4), which, interestingly, Sara brings to its original position facing herself – perhaps, in anticipation of a response. Anna requests Sara to 'listen' to the word again (line 15), mimicking Sara's request in line 3 but mitigating it through an animated voice. It is noteworthy that this request is not strictly for access to the device but rather alludes to the aural nature of the problem.

Although the request positions Sara as responsible for listening, the careful bodily coordination that follows reveals that they both orient to solving the problem as a joint task. Anna seeks aural access by stepping toward Sara's desk, crouching over the device, and turning one ear toward it (Fig. 5), while simultaneously orienting to Sara's ownership of the device by letting her remain in control of it. Sara aligns with these actions and aids Anna in gaining access to the problem source: she leans toward the tablet, leaving enough space for Anna above it, and replays the word (line 16). Even while the application produces the word, Anna starts shifting her gaze to Sara. As Sara frowns and smiles (line 18), Anna resumes a standing position (line 19), dissolving the configuration. As an embodied next turn to the listening activity, Sara produces an open, palms-up gesture with her hands, indicating that she does not know or recognise the word (Müller, 2004, p. 238), and invites Anna's response through gazing at her. Accordingly, Anna utters the word *waterfall*, emphasising its written form by pronouncing the beginning of the word as it would be read in Finnish (line 20). The sequence ends as Anna returns to her desk (line 21) and Sara resumes home-position (Sacks & Schegloff, 2002), claiming understanding through the change-of-state token *ahaa* ('oh okay'; line 22) before starting to type (data not shown).

In sum, Anna multimodally displays her orientation to the asymmetric aural access to the device and shows a preference for solving this through her own embodied work. Sara aligns with Anna's attempts, however, and the careful coordination of their embodied actions displays a joint orientation to gaining mutual access. Yet, the resources adopted display a preference for the 'owner' to maintain haptic control over the device: Anna negotiates aural access to the device without touching it, while Sara manipulates and repositions the device as

needed. Thus, Sara maintains deontic rights regarding the tablet, while simultaneously positioning Anna as potentially having epistemic access (Stivers et al., 2011) to the information needed to solve the trouble.

Extract 2 is taken from a 9th grade lesson, where pupils perform individual assignments distributed by the teacher in Google Classroom, using hybrid laptops, that is hybrid computers that can be used either as laptops or tablets, borrowed from the school. More detailed information on the current task is not available due to the nature of the data, but the goal is to practise translating sentences from Finnish to English in the passive voice. Nora and Martta are seated in a diagonal formation, with the back of Martta's device towards Nora (Fig. 6). The two have been negotiating some previous translations together, and Nora has repeatedly shifted her body toward Martta's screen to access relevant information on the screen. As the extract begins, both focus on their devices, and Nora is typing (line 1).

Extract 2.

```
01  MARTTA     #e•i:::
                 no:::
    marttaG    >>to her device->
    noraG      >>to her device->
    nora       >>typing->
    martta       •straightens back, leans against chair->
    fig.       #Fig. 6

02              (1.1)•
    martta        ->•hands to lap one by one->

03              (0.5)•(1.2)±(0.3)*(0.8)
    martta        ->•
    nora                ->±
    marttaG                   ->*ahead->

04  NORA        nyt +t•[ohon: (.)       tul+±•is tä#ä,]
                now this would come there

05  MARTTA            •[tää* ois       help+±•po muu#t]en=
                       this would be easy otherwise
    noraG           ->+.....................+to martta's device->
    martta            •gestures toward screen•leans toward screen->>
    marttaG             ->*to her device->
    nora                                    ±leans toward
                                             martta's device->
    fig.                                           #Fig.7
```

Figure 6. Martta and Nora.

Figure 7. Nora's gaze to Martta's device.

```
06  MARTTA     =mutku (.) >pi↑tää olla varmaa sit se<±=
                 but        it then probably has to have the
    nora                                          ->±

07              = >(riisi) o- pitää laittaa< eka.
                  (rice) is- has to be put first

08              (0.4)

09  MARTTA      (xx) että,
                (xx) that

10              (0.4)+±(0.2)+
    noraG         ->+....->+to own device->
    nora             ±returns to home position->
```

11	**NORA**	**mäki oon siin± kasis*sa;+ ±**
		I'm also doing that number eight
	nora	->±pushes chair back±turns right->
	marttaG	->*...->
	noraG	>+shifts between objects and floor->
12		**(0.2)***
	marttaG	->*to nora's screen->
13	**MARTTA**	**(jotai ±siinä)* jotaki siitä#=**
		(something there) something about the fact
	nora	->±picks up bag from floor from her right->
	marttaG	->*to her screen->>
	fig.	#Fig.8

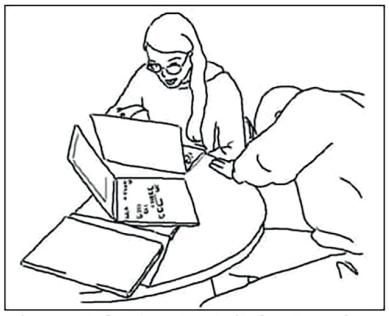

Figure 8. Nora picks up bag.

14		**= et se::::::,±**
		that it
	nora	->±puts bag on floor to her left->
15		**(1.1)+(0.3)±**
	noraG	->+to her device->
	nora	->±rolls chair toward martta ->
16	**NORA**	**öö:±::[:::,]**
		um::::::
17	**MARTTA**	**[>koska (ei±hä]# se-)<**
		because it's not
	nora	->±.....±turns device->
	fig.	#Fig. 9
18		**(.)**
19	**MARTTA**	**ei-# ±(.) ↑voiksen laittaa↑=**
		no- can you put it
	nora	->±adjusts device->
	fig.	#Fig.10

. (*continued*).

Figure 9. Nora turns device.

Figure 10. Device faces both.

20		**=sil±↓lee et niinkun:±;**
		so that like
	nora	->±moves device closer±adjusts device->
21		**(.)**
22	**MARTTA**	**(the)- niinku± hä!**
		(the) like what
	nora	->±...->
23		**(0.3)±(0.3)+(0.1)**
	nora	->±rests elbow on desk,
		supports chin on hand,
		moves chair closer to martta->
	noraG	->+...->
24	**MARTTA**	**pi+tääk-**
		must (we/I)
	noraG	->+to martta's screen->>
25		**(.)**
26	**MARTTA**	**>ku ei sitä±# voi>**
		cause you can't like
	nora	->±stays still,
		chin supported on hand,
		elbow resting on desk->>
	fig.	#Fig.11

Figure 11. Nora gazes at Martta's device.

27		**(.)**
28	**MARTTA**	**sitä >ei varmaa voi< alottaa (sillai)<(.) now:;**
		it can't probably be started with (like) now

. (*continued*).

In Extract 2, Martta indirectly recruits Nora to assist with the translation of a sentence through a multimodal trouble alert. Specifically, Martta utters an elongated *ei* ('no'; line 1) and withdraws from the device by sitting up and leaning against the back of the chair, retracting her hands to her lap (line 2), and shifting her gaze away from the screen (line 3). In addition, Martta attempts to elaborate on the trouble verbally (lines 5–7, 9, 13–14), producing several false starts and restarts, and invites Nora's gaze by gesturing toward the screen (line 5). Finally, Martta formulates a direct question about whether they can start the sentence with the word 'now', again with false starts, self-repair, and pauses (lines 19–28).

Nora responds to the recruitment gradually. After Martta's initial trouble alert, Nora keeps typing (lines 1–3) before taking a turn (line 4), which is designed as a type of self-talk about what should be written next – although it could additionally be used to account for her pending response. During the turn, overlapped by Martta's turn regarding the trouble, Nora shifts her gaze and leans toward Martta's device (Fig. 7) to gain visual access to the trouble source. After Martta has explained what the first word in the sentence perhaps should be ('rice', lines 6–7), Nora shifts her gaze to her own device, returning to home position (line 10), and announces that she is working on the same translation. Nora then starts preparing for mutual access to both devices. While Martta attempts to explain the issue, Nora arranges the material environment by moving a bag out of the way (lines 13 and 14; Fig. 8) and bringing her chair closer to Martta (lines 11 and 15). In addition, Nora turns and adjusts her device, making the screen visible to Martta (lines 17–20; Figs. 9 and 10), and finally moves even closer to Martta, places one elbow on the desk, supports her chin on her hand, and shifts gaze to Martta's screen (lines 22–26; Fig. 11). As mutual access to the devices and the task has been secured, a negotiation of the translation follows (data not shown).

In Extract 2, the rights and responsibilities related to the participants' local, situated roles are reflected in the negotiation for access to Martta's device and the organisation of an interactional space with a shared focus on the task. On the one hand, both orient to their situated ownership of the devices borrowed from the school and their deontic authority over deciding what is done with them. Throughout the sequence, both maintain control over their devices, and Nora seeks access to Martta's screen through self-initiated embodied work, only readjusting her own device. Each participant is also responsible for typing their own translations. On the other hand, Martta's indirect recruitment work through the trouble alert and report of trouble (Kendrick & Drew, 2016) creates an opportunity for collaboration, while also positioning Nora as having access to the knowledge needed to resolve the trouble with the translation. To assist, however, Nora needs to know the trouble source, yet is not granted visual access to Martta's screen (cf. Extract 1, where Sara facilitates Anna's access to the device by repositioning it). In most recruitments in the data, the recruiter attempts to share access to the screen with the recruited participant, but here it is incumbent on Nora to do most of the multimodal work for creating a shared interactional space, and she orients to the lack of access to the device through her embodied actions. While this may imply deontic authority on the part of Martta, it also gives Nora a chance to reposition herself and to reorganise the material surroundings to enable mutual access to the devices.

Besides illustrating how multimodal resources, such as body shifts, head movements, moving in the physical space, and arranging the material space can be used to negotiate aural or visual access to a digital device, Extracts 1 and 2 demonstrate how mutual access to a device can become crucial at certain moments of task-accomplishment: for example, lacking access to a digital device (and to the information it provides) may hinder achieving joint understanding of the trouble and resolving it. In addition, the trajectory towards shared access to a device reveals important aspects of authority and roles at play in peer interaction. Although recruitments position the recruited participants as potentially having access to knowledge that the recruiters lack in terms of the current task, the examples have shown that the exclusive right of the 'owner' to handle the device is still maintained during access negotiations. In the case of shared devices during teamwork, however, the question of ownership is less straightforward, as we will see in Section 4.2.

4.2. *Negotiating access to a shared device*

This section discusses how different local, situated roles may be reflected in and impact the ways in which mutual access to digital devices is negotiated during teamwork. The preference for using resources that do not interfere with the device-holder's rights is observable also in this subcollection, but participants also more clearly orient to access trouble through gestures or verbal requests, for example, which also make the exclusion of a team member visible to others (Extract 3). When a team member's rights to access the device are repeatedly violated, however, the device may be repositioned through touch (Extract 4). In these cases, different peer roles and rights cooperate, or clash, in access negotiations.

In Extract 3, one of the fifth-grade pupils in a team of three works to negotiate visual access to a shared tablet, as they are logging into a Kahoot! challenge that has varied recap questions from the whole course, involving grammar and vocabulary. The participants are familiar with the application and could be expected to know how the task proceeds. Joanna and Mila are seated side by side at Joanna's desk, while Markus is sitting farther away, opposite them (Fig. 12). As the start page is loading, Joanna adjusts the interactional space by turning the device slightly toward Mila on the desk (line 1). This grants the two visual access to the device while enabling Joanna to remain in control of it. Markus, however, has no visual access to the screen.

Extract 3.

```
1                (1.5)±   (0.7)   *   Δ
     milaG       >>scans classroom*to tablet->
     joannaG     >>to tablet->
     markusG     >>shifts between classroom and hands->
     markus      >>plays with blu-tackΔtakes eraser->
     tablet      >>page loading
     joanna           ±turns tablet toward mila->

2                (0.2)±#(0.2)+
     joanna         ->±
     joannaG              ->+eyes closed->
     fig.             #Fig. 12

3                (0.5)♦Δ(0.5)+(1.9)#
     markusG        ->♦toward tablet->
     markus          ->Δleans right, peeking toward tablet->
     joannaG              ->+to tablet->
     fig.                      #Fig. 13
```

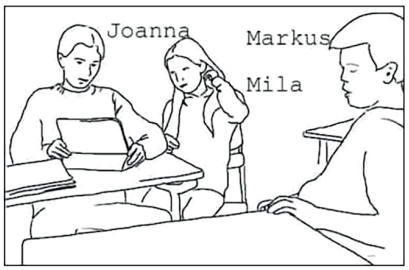

Figure 12. Joanna, Mila, and Markus.

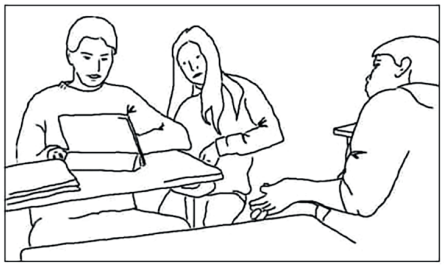

Figure 13. Markus leans right.

```
4    MILA        ollaaks meΔ taasΔ joku;+
                 are we somebody again
     markus               ->Δ.....Δrests head on chair next to him->
     joannaG                        ->+...->

5                (0.2)+
     joannaG        ->+to mila->

6    MARKUS      >montako[ha<     kysymystä       siin]ä o;
                  I wonder how many questions it has

7    JOANNA               [voiaan me+ olla joku+ muuki.]♥+
                          we can also be something else
     joannaG                      ->+.........+to tablet+down->
     milaF                                        ♥smiles->

8                (0.3)

9    MILA        @ei:@* ↑ku me ollaa joku,*
                 no we are somebody
     milaG          ->*to joanna----------*,,,->

10               #(0.2)*+
     milaG           ->*to tablet->
     joannaG          ->+to tablet->>
     fig.        #Fig. 14
```

11 **JOANNA** **oke;÷±Δ**
okay
joannaF ÷smiles->
joanna ±turns tablet toward herself->
markus ->Δraises head, leans toward tablet->

12 **(0.6)♥**
milaF ->♥

13 **MARKUS** **mon#taΔ kysymyst÷±▶ tos on.Δ**
how many questions does that have
markus ->Δadjusts posture-----Δleans right, peeking->
joannaF ->÷
joanna ->±
tablet ->▶Kahoot page appears,
with "waiting symbol"
fig. #Fig. 15

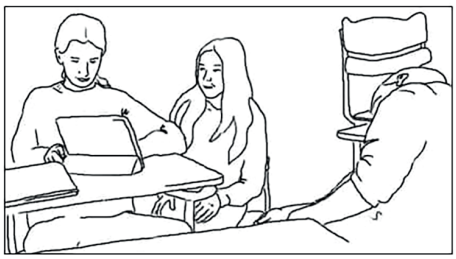
Figure 14. Markus rests head on chair.

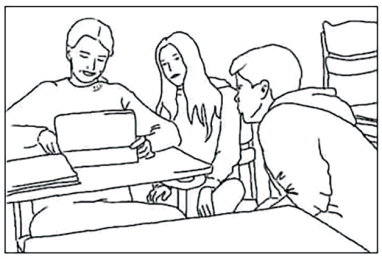
Figure 15. All gaze at device.

14 **(0.6)Δ(0.2)**
markus ->Δ,,,->

15 **JOANNA** **kaksΔ↑toi♦sta kai. ♦**
twelve I guess
markus ->Δleans toward tablet->
markusG ->♦to joanna♦to tablet->

16 **(0.7)**

17 **JOANNA** **emmä tiiä.**
I dunno

18 **(0.2)÷(0.8) ÷(0.2)***
joannaF ->÷smiles÷
milaG ->*down->

19 **(0.5)*(0.6)♦Δ**
milaG ->*to ipad->
markusG ->♦to hands->
markus ->Δplays with blu-tack,
leaning forward->

20 **(1.3)*(0.6)▶**
milaG ->*to markus' hands->
tablet ▶waiting symbol disappears

21 **(0.2)♦* (0.3)*•**
markusG ->♦to tablet->>
milaG ->*to tablet*down->
mila •leans toward tablet->

. (*continued*).

```
22              (0.3)*Δ(0.6)
     milaG        ->*to tablet->
     markus        ->Δleans closer to tablet, stretched neck->

23   JOANNA     (tule.)
                (come)

24              (0.2)►Δ(0.9)
     tablet         ►login page of Kahoot! challenge appears
     markus        ->Δstretches neck further->

25   MARKUS     monta.
                (how many)

26              (0.5)Δ(1.3)±
     markus       ->Δleans right->
     joanna              ±taps 'join the game' field->

27              (0.5)±(1.1)±
     joanna       ->±     ±types 'Joku' ((=Somebody))->

28              (1.0)Δ(0.5)±#(0.6)*
     markus       ->Δleans farther right->
     joanna            ->±
     milaG                  ->*to pupils behind them->
     fig.                #Fig. 16

29              (0.7)±           (0.4)±
     joanna         ±presses "Ok, go!"±

30              (0.9)±(0.3)Δ(0.3)*(0.5)              ±
     joanna         ±turns tablet toward mila & markus±#
     markus           ->Δrelaxes posture,
                        supports arms on thighs->>
     milaG                 ->*to tablet->>
     fig.                                        #Fig.17
```

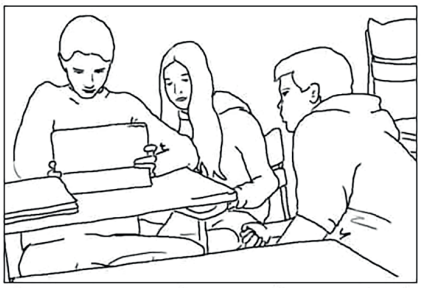

Figure 16. Markus peeks at device.

Figure 17. Markus relaxes posture.

. (*continued*).

While the participants wait for the page to load, Markus seems disengaged from the interaction as his gaze scans the classroom and he plays with a piece of Blu-tack and an eraser (line 1). After Joanna repositions the device on the desk (lines 1–2), however, Markus shifts his gaze towards it and leans right, peeking at the screen (line 3; Fig. 13). It is uncertain, however, how much visual access this grants Markus as he soon readjusts his position, resting his head on the chair placed on the desk next to him (lines 4–11; Fig. 14). Markus' body shift coincides with Mila's inquiry (line 4) about whether their team's nickname will again be *Joku* ('Somebody') like in the previous task. Markus then self-selects, but instead of replying to Mila, he indirectly asks or wonders aloud about the number of questions in the upcoming quiz (line 6). This implies a lack of visual access to the device since Markus seems to be unaware of the fact that this information is not yet visible on screen. Moreover, the positioning of Joanna and Mila's bodies, their turns and gaze patterns, and the position of the device exclude Markus from the interaction and display an embodied social and epistemic alliance between the two (Niemi & Katila, 2022, p. 19; see also M. H. Goodwin, 2008). Ignoring Markus' question, Joanna and Mila glance at each other (although there is no mutual gaze; lines 5 and 9, respectively) and, in overlap with Markus' turn, Joanna suggests to Mila that they could choose another name. Mila then decides on the name (line 9), and Joanna accepts and turns the device to face herself, thus preparing for typing in their nickname (line 11).

Markus proceeds to upgrade his request through a combination of resources. He raises his head, leans toward the device (line 11; Fig. 15), and pursues response by repeating his question (line 13). Markus' gaze remains on the device instead of the addressee(s) (cf. Rossano et al., 2009), which together with the body shift (line 13) indicates that Markus is not only requesting information but also seeking access to the device. After a gap of 0.8 s, Joanna replies to Markus ('twelve I guess'; line 15), orienting to Markus' verbal question rather than the attempts at gaining access to the screen. Markus briefly glances at Joanna but quickly returns his gaze to the device and leans even closer to it. Joanna then expands her turn, saying that she does not know (line 17) – indeed, the information on the number of questions is still unavailable. Markus then glances at the objects in his hands (lines 19–21) but still orients to the device by maintaining the leaning posture. After 2.1 s, Markus again engages in actively seeking visual access to the screen as he fixes his gaze on the device (line 21), leans closer to it, and stretches his neck (lines 22 and 24). The login page finally appears (line 24), and Markus asks, this time in a shortened form, *monta* ('how many'; line 25), displaying the inadequacy of Joanna's response. Markus then leans right, first in line 26 and even more visibly in line 28 (Fig. 16) when Joanna is typing. Finally, when Joanna has finished typing and joined the game (line 29), she turns the device so that all three participants have visual access to it (line 30). Markus immediately relaxes his posture, maintaining his gaze on the screen (Fig. 17).

Extract 3 illustrates how body shifts and head movements can be used together with verbal resources to work towards visual access to the device and to seek participant status in the task. Markus also displays a preference for gaining access to the tablet through his own embodied conduct, but when these attempts fail, he asks about the number of questions in the task. To the coparticipants, the request and the embodiments become "accessible as meaningful actions" (Smith, 2021) that display orientation to the team member's asymmetric access to the information and the device as well as to resolving the issue. Ironically, the verbal request is misaligned due to the very problem it is designed to resolve: the lack of access to on-screen actions leads Markus to attempt resolving the issue through a question that currently cannot be answered. Nonetheless, Markus refrains from touching the device, thus orienting to Joanna's rights as the current device-holder. A practical reason for Joanna not offering Markus access to the screen may be that this position of the device more readily allows her to type in the name. When the login process is finished, Joanna repositions the device to enable mutual access to it and, thus, modifies the existing interactional space into one with shared focus on answering the upcoming questions. By remaining in control of the device and deciding who gets access to it, however, Joanna still orients to her deontic authority as the device-holder.

In the current data, pupils seldomly touch devices held by peers, even during groupwork on shared devices. While shared responsibility for task-progression may entail shared rights to access the (visual) information needed to collaborate, pupils seem to orient to holding the device as a type of ownership with exclusive deontic rights, similar to cases where pupils work on individual devices. Extract 4, however, illustrates a case where a pupil tries to reposition a device held by a coparticipant when her rights to access it have been repeatedly denied. In a 4th grade lesson, Iris, Paula, Mea, and Amanda are performing a Kahoot! quiz on the English names of European countries on a shared tablet. On the desk, Iris' English book is opened to the page that shows these names. The participants are seated around Iris' desk (Fig. 18; Mea is hidden behind Iris in the figure), and thus far, Iris has been manipulating the device, holding it so that the screen faces her, while Amanda and Mea have partial visual access to it. Paula, seated opposite Iris, has displayed trouble accessing the device and has performed several body shifts and adjustments to her position to see the questions. A new question has just appeared on the screen, and they are to spell the English word for *Tanska* ('Denmark').

Extract 4.

```
01              #•              (1.5)♥•
     amandaG    >>to tablet->
     irisG      >>to tablet->
     iris       >>holds tablet facing herself->
     meaG       >>to tablet->
     paulaG     >>to tablet->
     paulaF     >>smiles-----------♥
     paula       •leans toward tablet•hand to tablet->
     fig.       #Fig.18
```

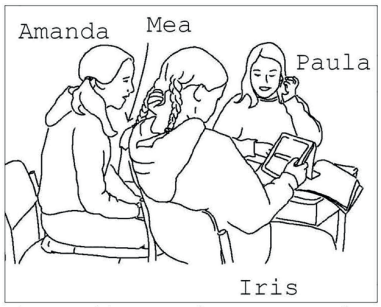

Figure 18. Amanda, Mea, Paula, and Iris.

```
02   IRIS       [.h ↑tanska]• maa.
                     denmark country

03   PAULA      [i#-ris    ]•
     paula                ->•grabs tablet's cover,
                             pulls it->
     fig.         #Fig.19

04              (0.2)♠
     amandaG      ->♠to book->

05   IRIS       no ni.∅
                alright
     meaG          ->∅to book->

06              (0.2)

07   IRIS       tän# mät o[sa•*an,]
                this I know
     iris          ->±lifts & tilts tablet toward herself->
     paula               ->•retracts hand->
     paulaG               ->*to book->
     fig.       #Fig.20

08   MEA?                [ (x)   ]
```

Figure 19. Paula reaches towards tablet.

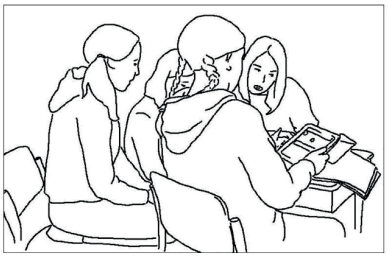

Figure 20. Paula tilts device.

```
09   IRIS      tän•±# mää o[saan (.) uh!]±
               this I know ugh

10   PAULA                  [     ↑I↓RIS ]±↑näytä:↓ä!
                                  iris show
     paula      ->•
     iris        ->±holds tablet high----±lowers tablet->
     fig.           #Fig.21

11             (0.4)#
     fig.           #Fig.22
```

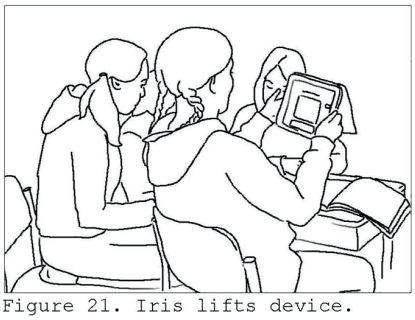

Figure 21. Iris lifts device.

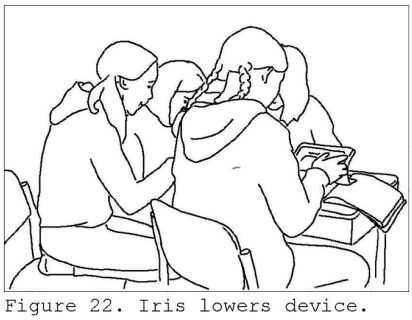

Figure 22. Iris lowers device.

```
12   MEA       de♠±nma:ark(h);∅
     amandaG   ->♠to tablet->
     iris       ->±lifts tablet, tucks in cover->
     meaG                  ->∅...->

13             (0.3)∅(0.3)*± (0.3)*(0.3)+         ±
     meaG         ->∅to tablet->
     paulaG             ->*to iris*to tablet->
     iris                 ->±places tablet on desk±
     irisG                              ->+to book->

14   IRIS      no ni ↑sa+nokaa⊗ ↓ki±rjaimet.
               okay say the letters
     irisG              ->+to tablet->
     mea                       ⊗leans toward tablet->
     iris                           ±leans toward screen,
                                    hands to screen->
```

. (*continued*).

```
15                  (0.4)⊗ ♠
      mea             ->⊗
      amandaG           ->♠to book->

16    AMANDA        dee,♠=
      amandaG         ->♠to tablet->

17    MEA           =de♠±n:::-[  ma:±::r(k) ]♠+=

18    PAULA                     [sähä ±sanosit]♠+=
                                but you said
      amandaG       ->♠to tablet------------♠to book->
      iris           ->±types 'd'--±
      irisG                                  ->+...->

19    PAULA         =et sä+∅ o*[saa#tki kir]*jo♠ttaa sen.+
                     that you know how to write it

20    AMANDA                    *[ e:#::,     ]*-
      irisG             ->+to paula-----------------------+to book->>
      meaG               ->∅to book->>
      paulaG               ->*to iris------*to tablet->>
      amandaG                                ->♠to tablet->>
      fig.                          #Fig.23
```

Figure 23. Mutual gaze.

. (*continued*).

At the beginning of Extract 4, all four pupils gaze toward the screen. Iris, Amanda, and Mea then orient to the next relevant action, producing the correct answer. Iris announces the country they are to name, *Tanska* ('Denmark'; line 2), and the other two shift their gazes to the book on the desk (lines 4 and 5, respectively), orienting to finding the English name there. Paula, however, makes her orientation to the lack of visual access to the device visible by leaning and moving her hand toward it (line 1). Before the extract, Paula has been shifting her body back and forth to secure at least some visual access to the tablet for circa 10 min. She is thus orienting to this continuous lack of access to the game when she finally addresses Iris by name in a reproaching tone and takes hold of the tablet cover. She pulls it, tilting the device slightly and thereby making the screen more visible to herself (line 3; Figs. 19 and 20).

However, Iris blocks Paula's attempts by lifting the device so that it slips away from Paula's hand (lines 7-10; Fig. 21). Simultaneously, she prioritises the task question and claims to know the answer (lines 7 and 9). Although Paula retracts her hand (line 7), she reproaches Iris by loudly addressing her by name and continues her attempts at gaining access by telling Iris to show the screen (line 10). In overlap, Iris lowers the device (Fig. 22), then lifts it again to tuck the cover under it (line 12), and finally places it on the desk (line 13), but still in a manner that restricts Paula's visual access to it.

Meanwhile, Mea offers a candidate answer (*Denmark*; line 12), followed by Iris' request to spell out the word letter by letter (line 14). Amanda complies by starting to announce the letters one by one (lines 16 and 20) while Mea slowly repeats the name (line 17). Paula, however, points out the contrast between Iris' request and her earlier claim of knowledge in an accusing tone (lines 18–19), thus challenging Iris' deontic authority as well as her claimed access to knowledge. The conflict also relates to the problem that a potentially knowing participant, Paula, is not able to access the question, and the task progression can potentially be jeopardised. Iris types the first letter, *d,* in the answer box, before reacting to Paula's turn by shifting her gaze to Paula. A brief mutual gaze follows before Iris gazes at the book (line 20; Fig. 23) and then proceeds to type with help from the others (data not shown). Paula also reorients to the device, but after the task question has been answered, she suggests that they take turns typing in the responses, which leads to a negotiation of how turns should be ordered.

At least three aspects related to authority and roles seem to be reflected in this group's interactions. First, Iris as the device-holder has thus far been granted authority over the device, which gives her the exclusive right to manipulate it and prevents the others from touching it. In other words, Iris seems to hold the deontic authority, not only over the device but also over deciding how the task progresses – until, that is, this authority is questioned by Paula. Second, the participants seem to have distributed roles on the level of performing the task. So far, Iris has positioned the others as having epistemic access by asking them to tell her the answers – although Amanda and Mea here seem to reject this position by seeking the answers in the book. Selecting or typing in correct answers, on the other hand, is Iris' task. Third, issues of moral order become visible in how Paula rejects the distribution of tasks. Paula orients to their roles as team members who share the responsibility for task progression (Vänttinen & Kääntä, 2024) and the rights to access the information needed. By continuously blocking Paula's visual access to the device, Iris is thus violating Paula's rights as an equal member and potentially risking task performance, which eventually leads to Paula defying Iris' deontic authority (see lines 18–19).

Extracts 3 and 4 have illustrated how the resources to gain access to a

digital device during teamwork reflect peers' situated roles. The current data seem to support the argument by Thorne et al. (2015) that the device-holder has some exclusive rights over the device, which is indicated in the way that touching the device held by a peer is avoided and others' access to it is regulated by the device-holder. This also seems to be related more generally to the local distribution of responsibilities in performing the tasks. Whereas one participant may be responsible for handling the device, others may take on – often implicitly negotiated – responsibilities, such as providing the correct answer (Extracts 1 and 2), finding it in a book (Extract 4), or deciding on a team's name (Extract 3). Participants' rights and responsibilities as team members also seem to supersede the deontic authority of the device-holder. As Extract 4 illustrates, pupils can readjust the position of a device held by a peer when their rights to access the information needed to perform the task have been repeatedly neglected and/or when the lack of access potentially puts the group's task performance at risk. Through the repositioning, they can also reclaim their status as team members. In summary, then, the way that access is sought is not *only* dependent on predetermined institutional roles nor on the rights of a device-holder but reflect the situated, local combinations of rights and responsibilities.

5. Discussion and conclusions

This study has investigated the multimodal trajectories of resolving asymmetric access to digital devices in peer interaction during digital learning tasks. Drawing on multimodal conversation analysis (CA), it has illustrated how pupils negotiate mutual access to a device when it is needed, for instance, to proceed with a shared task or to assist a peer. The analysis has drawn attention to how pupils use embodied resources, such as head and body shifts or moving in the physical space of the classroom, or arrange the material surroundings in a way that not only grants them access to the device but also allows the device-holder to maintain haptic control of it. This preference is particularly evident in access negotiations after recruitments (Extracts 1 and 2), where the recruited participant orients to lacking access through multimodal work designed to avoid interfering with the device-holder's situated ownership of the device. In teamwork, on the other hand, there is an expectation of shared access to the device, which is oriented to in the more frequent use of verbal requests and persistent embodied work to gain access to the device. If a team member's access is repeatedly denied or otherwise neglected during groupwork, touch can be used as an attempt to resolve the issue (Extract 4).

The findings echo those of Råman (2022), who illustrated the ways in which teachers instructed students to resolve trouble with their devices without intervening with their haptic control of the device. In teacher-student interaction, however, the institutional authority of the teacher can in some cases give them the right to control students' devices (Råman, 2022). Such asymmetries of institutional status do not apply to the peer interactions in the current data, where pupils orient to different kinds of situated roles and rights. The device-holder seems to be given authority over the device (see also Thorne et al., 2015; Cekaite, 2009; Musk, 2016), even when it is owned by the school, and the rights to manipulate it may also be governed by the different roles adopted in performing the task. While some pupils are oriented to as having epistemic access to needed knowledge and thus as providers of answers, others display deontic authority over the actions on the digital device. As we saw in Extract 4, however, these roles may be questioned by a participant who attempts to reposition a device through touch to gain access to it. In such cases, it is the peers' roles as team members that are oriented to: team members should share access to the device and can take measures when this right is continuously violated. Moreover, the team shares the responsibility for successfully completing tasks, and hindering one member's access to relevant information can potentially impact task performance negatively. These findings give interesting insights into the local, situated roles that pupils orient to and dynamically negotiate in their peer interactions.

The detailed multimodal analysis has contributed to CA research on technology-rich classroom interactions and to our understanding of how meanings are multimodally created in interactions around digital devices. It has shown how asymmetric access to a device may be consequential for task-progression and group dynamics and is therefore addressed and resolved by the participants through locally tailored multimodal resources. Through its focus on peer interactions within Finnish basic education classrooms, the study has also shed light on the multimodal conduct of children and teenagers around digital devices.

In addition, the study has important pedagogical implications. First, since digital devices are often designed for individual rather than collaborative use, their implementation in the classroom requires careful planning. Teachers need to consider the kinds of devices that can be used, the types of tasks that can be performed on them, and how the physical and material space of the classroom can be arranged in a way that promotes working on the devices in relevant ways. Second, learning goals should impact decisions on whether to assign pupils individual devices or ask them to collaborate on shared devices. Sharing a device may result in one pupil getting more practice with handling the device and the digital platform while other participants mostly focus on the content. On the other hand, collaboration can lead to delicate negotiations of authority, rights, and obligations among peers, which leads us to our final pedagogical implication. Namely, these negotiations require the ability to appropriately participate in classroom interactions and activities, a topic which has not been sufficiently addressed in previous literature on interactions in technology-rich classrooms. The teacher's role is to support pupils in developing their competencies, including the ability to use digital devices in collaboration with peers and to share and negotiate rights and responsibilities fairly. Analysing how these abilities are (not) displayed in everyday classroom interactions can offer us important insights regarding how to best support their development.

As digital technology has become an indispensable tool both in institutional and everyday contexts, learning its use is an essential educational goal. Digital devices and platforms thus need to be developed to better support collaboration and pedagogical tasks in and outside of classrooms. Multimodal CA research can inform such development by presenting detailed analyses of how technology is used in and affects classroom interaction. By offering insights into the asymmetries and troubles related to their use as well as into the practices of resolving these issues, CA can help in creating efficient and inclusive digital and pedagogical practices that aid pupils to learn both digital and collaborative competences needed in the 21st century.

CRediT authorship contribution statement

Minttu Vänttinen: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The author declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Participants' talk has been transcribed using the Jeffersonian notations. Conventions from multimodal CA (see e.g., Mondada, 2022) have been adapted for other multimodal actions.

.	final falling intonation
,	continuing intonation
;	slightly falling intonation
?	interrogative intonation
!	animated speech tone
↑	rising intonation
↓	falling intonation
hhh	outbreath
.hhh	inbreath
wh<u>a</u>t	word emphasis
>what<	speech that is quicker than the surrounding talk
<what>	speech that is slower than the surrounding talk
WHAT	speech that is louder than the surrounding talk
wha::t	prolonged vowel or consonant
wha-	cut-off word
(what)	uncertain hearing or talk omitted for anonymisation
[what]	overlapping talk
=	no break between units of talk
((incorrect))	transcriber's comments
(1.5)	silence in seconds
(.)	micro pause
*•♥+±÷	Each participant's gaze, facial expressions, and other embodied actions are assigned a symbol, respectively. The occurrence of the symbol in a line of talk indicates the beginning/end of an embodied action. The action is explained below the lines for speech and translation in grey font.
saraG	Gaze of the participant is explained in grey font in this line.
saraF	Facial expressions of the participant are explained in grey font in this line.
sara	Other embodied actions of the participant are explained in grey font in this line.
-> ->	Action continues across following lines until the same symbol is reached.
>>	Action begins before the beginning of the extract.
->>	Action continues after the extract ends.
…	Action's preparation.
, , ,	Action's retraction.
#	Shows the temporal placement of a figure in a line of talk.

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II

CONSTRUCTING INTERACTIONAL SPACE ACROSS DISTANT LOCATIONS IN A HYBRID CLASSROOM

by

Minttu Vänttinen, 2023

Manuscript submitted for publication

Request a copy from the author.

III

EYE GAZE AS A RESOURCE IN HANDLING TROUBLE AROUND MOBILE DEVICES IN CLASSROOM INTERACTION

by

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Eye gaze as a resource in handling trouble around mobile devices in classroom interaction

This paper offers an insight into how interaction is multimodally built during task-accomplishment around mobile devices in classroom interaction. More specifically, it investigates eye gaze as a resource in recruiting help and pursuing response from peers during interactional or task-related trouble sequences. The data come from video-recorded lessons at Finnish comprehensive schools where mobile devices are used for learning tasks. Drawing on multimodal conversation analysis, the article demonstrates that gaze is employed by pupils as one of the first resources to display and address trouble. Although tasks often require gaze to be directed at devices, it can be flexibly reoriented to peers when needed. The findings increase our understanding of functions of eye gaze and peer interaction in today's technology-rich educational contexts.

Keywords: eye gaze, classroom interaction, multimodal conversation analysis, mobile device
Asiasanat: katse, luokkahuonevuorovaikutus, multimodaalinen keskustelunanalyysi, mobiililaite

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1 Introduction

Technology has become a pervasive resource in educational settings. It has modified pedagogical practices and the ways in which teachers and pupils interact, and therefore has implications for classroom research, which must account for not only what is done with technology but also what happens *around* it. To contribute to an understanding of today's classroom interaction, this paper investigates the multimodal practices used by pupils to deal with trouble in peer interaction while performing learning tasks on mobile devices. Specifically, it aims at describing how eye gaze is used by participants to seek mutual focus while recruiting assistance or pursuing a missing response. Recruitment encompasses different ways in which help is sought and offered (Kendrick & Drew 2016), and the notion of response pursuit refers to the action of soliciting a response from a coparticipant when one is missing (e.g., Pomerantz 1984). To successfully recruit help and pursue responses, participants need to achieve joint attention, or a shared interactional space (Mondada 2009, 2013), through the ways in which they arrange their bodies, embodied resources, such as gaze and gestures, as well as the material resources of the physical context.

The study draws on methodology from multimodal conversation analysis (CA), which investigates the sequential and temporal organization of interaction and how it is orchestrated through an ensemble of different multimodal resources, such as talk, gaze, body posture, gestures, and facial expressions (Lilja 2022; Mondada 2013, 2016). Using video-recordings from classrooms, this paper describes how gaze operates as a constituent of these ensembles in a context that has been largely neglected in previous research: children and teenagers using mobile devices for learning tasks within basic education. The multimodal, emic perspective will offer insights into how gaze is treated by the participants as one of the first resources to display and address trouble.

2 Gaze in interaction

CA research has mainly been interested in the role of gaze in participation, regulation of social interaction, and action formation (Rossano 2013; Ruusuvuori 2016). As to participation, gaze can, among other things, signal participants' attention to a speaker (Goodwin 1980; Goodwin 1981; Holler & Kendrick 2015; Kendon 1967). Rossano and his colleagues (Rossano 2013; Rossano et al. 2009), however, have demonstrated that gaze in showing participation is culturally variable and dependent on the social activity involved. Moreover, studies focusing on the allocation of multimodal resources while handling objects or during multiactivity suggest that gaze is typically on the objects manipulated but can also be used flexibly to show

orientation to multiple activities, including talking to a coparticipant (Deppermann 2014; Nishizaka 2014; Tuncer et al. 2019).

The regulating functions of gaze also seem to vary according to the context (e.g., Lerner 2003) and social activity. Speakers gaze away from recipients more during longer utterances (Kendon 1967) but tend to gaze at them when asking questions (Rossano et al. 2009). Gaze is also effective in choosing the next speaker in multiparty settings (Auer 2021; Tiitinen & Ruusuvuori 2012). In addition, while it has been shown that gaze is used to pursue a response from a recipient (Duran & Jacknick 2020; Stivers & Rossano 2010), it seems to be more powerful in soliciting response in side-by-side formations (i.e., participants sitting or standing next to each other) than in other settings (Auer & Zima 2021). Moreover, it has been suggested that gaze is more frequent in initiating and closing interactional sequences than in other sequential positions (Rossano 2013).

Research on classroom interaction has explored gaze as one of the many embodied resources systematically deployed for interaction. The focus has often been on the embodied conduct of teachers, who have been shown to allocate turns to students using gaze and other embodied resources (Kääntä 2012), to select next speakers based on whether students are gazing at them (Fasel Lauzon & Berger 2015), and to display a listener role during student discussions through gaze, gestures, and laughter, for instance (Willemsen et al. 2019). Duran and Jacknick (2020) also show how a teacher uses multimodal resources, including gaze, to pursue response, and thus, to secure the progressivity of whole-class interaction. In the context of peer interaction, Jakonen (2014) analyses how secondary-school students address lack of knowledge and recruit possible knowers through gaze and verbal addressing, and Juvonen et al. (2019) describe how students use gaze to display being stuck with a task. Tuncer et al. (2022) take a more experimental approach to study how children use gaze to ask for or give instructions and share emotions in robot-mediated interaction. Adding to this line of research, the present study aims to offer insights into the functions of gaze, alongside other resources, in peer recruitments and response pursuits around mobile devices in classroom settings.

3 Recruitments and response pursuits

Recruitment refers to a continuum of different ways in which participants in interaction seek or offer assistance to resolve trouble in performing an action. The methods range from explicit verbal approaches (i.e., requests, reports of trouble) to more indirect, embodied displays of trouble (Kendrick & Drew 2016). The more implicit embodied displays, such as searching for something with gaze, may precede explicit verbalizations of trouble, or they may be effective in recruiting help by themselves (Drew & Kendrick 2018; Kendrick & Drew 2016). As to children, it has been shown

that, even before the age of three, they start using gaze in conjunction with verbal reports of trouble, such as *oh!* to recruit assistance (Pfeiffer & Anna 2021).

Whereas recruitments involve mobilizing help to perform an action, response pursuits occur when the trouble lies in the progression of interaction. When a speaker produces a first pair-part of an adjacency pair, such as a question, the second pair-part (e.g., an answer) by the interlocutor(s) is made relevant (Schegloff 2007: 14). If an interlocutor fails to respond, the producer of the sequence-initiating action may try to pursue a response through different resources. They may, for instance, verbally clarify or modify their initial turns (Pomerantz 1984), initiate self-repair (Bolden et al. 2012), or use embodied resources, such as gaze and nods (Duran & Jacknick 2020). While teachers' response pursuits have received some attention in research on classroom interaction (see e.g., Duran & Jacknick 2020; Okada 2010), pupils' attempts at mobilizing response seem to have been largely neglected (see, however, Jakonen 2014). To bridge this gap in research, the present study illustrates how gaze functions in both recruitments and response pursuits in peer interaction during technology-mediated tasks.

4 Method and data

The data (ca 51,5 hours) come from 19 English as a Foreign Language (EFL) lessons video-recorded at four Finnish comprehensive schools as a part of a larger study on classroom interaction around technology. To capture the actions performed on mobile devices, additional screen recordings were made of the iPads used on four of the lessons. Seven groups from 4th to 9th grade of basic education participated in the research, with group sizes of 12 to 22 pupils. At the time of data collection, the pupils were from 10 to 15 years old. The teachers and most pupils spoke Finnish as their first language. Participants were recruited by contacting schools, and depending on local practices, a permission to collect data was granted either by the participating school or the municipality. All participating teachers and the guardians of all participating pupils gave an informed, written consent for participation in the study. At the beginning of each recorded lesson, participants were reminded that participation was voluntary and that they could withdraw from the study at any time. Safety measures to protect participants' health were taken during data gathering amidst the Covid-19 pandemic.

When analysing the data, the focus was on tasks for which technological devices such as mobile phones, tablet computers, or laptops were used. Participating teachers were instructed to plan their lessons as usual to ensure interactions would unfold as naturally as possible, and data collection was scheduled for lessons on which they had planned to use technology. There was great variation in the amount of time used on devices per lesson, from short games to whole lessons. The technol-

ogy-mediated tasks varied from games to information searches and writing tasks and included both individual and group work.

During preliminary analysis, it became evident that gaze to coparticipants while working on devices is quite infrequent throughout the data. Thus, it becomes particularly significant when it does occur (cf. Auer & Zima 2021). In the present data, it is often associated with trouble, either with task accomplishment or the sequential progression of interaction. Gaze shifts or a sustained gaze to a coparticipant frequently occur when a participant cannot proceed with a task due to insufficient knowledge or technological problems, or when the negotiation of an interactional space does not proceed smoothly (e.g., there is a missing response from a peer). Both trouble types create the need to renegotiate the interactional space or to restore a momentarily fragmented one, resulting from competing lines of activity (i.e., multiactivity; see e.g., Haddington et al. 2014). The phenomena in focus here, recruitments (20 cases) and response pursuits (17 cases), illustrate two techniques that were observed to be deployed systematically when addressing trouble. In both, gaze was found to be a central resource used to seek mutual focus as well as to occur in sequentially similar positions.

The cases have been analysed using multimodal CA, investigating how sequences of (inter)action are collaboratively built from and negotiated through the dynamic use of different embodied resources (Mondada 2013). Participants' talk has been transcribed using conversation analytic conventions (Jefferson 2004), with translations of Finnish talk into English beneath the line for the original talk. Gaze and other embodied actions have been transcribed adapting multimodal conventions (Harjunpää et al. 2020) to show their temporal and sequential relation to talk and other embodied actions. Pseudonyms are used for all participants. In the following sections, I will present a detailed analysis of four representative examples to illustrate how gaze is a recurring resource in the data to recruit help from a peer (Section 5) and to pursue a missing response (Section 6).

5 Gaze in recruitments

In the present collection, 20 recruitments involving a gaze shift to a peer have been identified. Almost all recruitments also include verbal utterances, either requests (n = 14) or reports of trouble (n = 5). In one of the cases (Extract 2), however, the recruiting participant initially seems to treat her gaze shift as a sufficient resource for recruiting but, in the face of a missing response, adds a verbal report of trouble to mobilize a response. Six of the recruitment sequences are preceded by an embodied display of trouble (e.g., searching for a word in a book) and two, by trouble alerts (Extract 1). The gaze shifts occur in sequence initial positions, either preceding the

verbal formulations or co-occurring with talk. In addition, the gaze shifts often result in a transformation of the interactional space.

In Extract 1, recruitment is achieved through a combination of gaze and verbal resources. Pupils on a 9th grade EFL lesson are doing tasks on an e-learning platform, using the school's tablet/laptop hybrids. Each pupil must hand in their own tasks but is allowed to ask others for help. Martta and Nora, seated around the same desk, have started working on the tasks individually but have recruited each other several times and have gradually moved closer to each other. They are translating sentences from Finnish to English and have just finished one together with help from the teacher. As they begin working on a new sentence, Nora sighs heavily, burying her head in her hands, and Martta starts a recruitment sequence. The gaze shifts focused on in the analysis are marked with an arrow (l. 3 and 4). The original verbal turns are given in bold, with English translations below them in italics and other embodied conduct in grey font (see Appendix for the transciption conventions).

(1) A tiny zebra
* = Martta's embodied conduct
+ = Nora's embodied conduct

01	**MARTTA**	**öö::::,**
		um::::
	martta	gaze to laptop
	nora	gaze to Martta's laptop, scratches forehead with right hand, moves left hand to forehead
02	**NORA**	**hhhhh+[hh]#**
	nora	+gaze down, head in hands
	fig.	#Fig.1
03	**MARTTA**	**[ä*ä] #voiks >täsä< nii ku:;=**
		um can one here like
→	martta	*gaze to Nora
	fig	#Fig.2

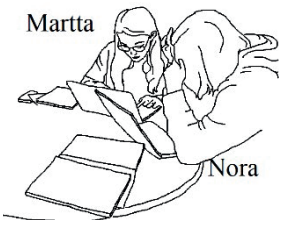

FIGURE 1.

FIGURE 2.

04 MARTTA = *mikä mikä (o) seep#ra. (.) nh.*öh*#h=
what what (is) zebra nh uh
martta *gaze to phone, grabs it
→ *gaze to Nora
*drops phone
fig. #Fig.3 #Fig.4

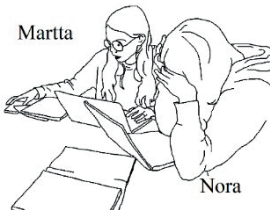

FIGURE 3.


FIGURE 4.

05 NORA =zeb*ra;
martta *gaze to phone

In Extract 1, Martta uses vocalizations (l. 1 and 3) as trouble alerts (Kendrick & Drew 2016) as well as a gaze shift to Nora (l. 3), indicating that there is trouble but not specifying it. The verbal component of the recruitment consists of a cut-off question (l. 3) and the subsequent self-repair, a request for the English translation of *seepra* ('a zebra', l. 4). Martta's embodied conduct shows double orientation to both Nora and her phone as possible sources of information: after directing the question to Nora, she shifts her gaze between Nora and her phone and picks up the device (l. 4 and 5). Even though a mutual gaze is not achieved, Martta's gaze shifts and verbal question (l. 3–4) are effective in recruiting Nora, who responds in line 5. Thus, the recruitment also occasions a slight modification of the interactional space: the two have been negotiating the previous translation together and the collaboration continues quite seamlessly in this extract but, with the recruitment, Martta shifts the focus to a word search requiring Nora's assistance. After the extract, however, Martta's embodied conduct is oriented more towards the trajectory of finding the answer on her phone. She shifts her gaze to the phone, starts handling it, and verbally expresses her need to know the spelling of the word. She thus relies on her phone after Nora's response proves insufficient for her purposes (cf. Musk 2022). Consequently, Martta breaks the momentary space of a mutual orientation on the word search and adopts a more independent line of action on the phone. Gaze, in conjunction with other embodied resources, is therefore flexibly used to display a changing orientation to different possible trajectories.

Extract 2 is an example of gaze used as the primary resource in a recruitment by the recruiting participant. It is taken from a 5th grade EFL lesson during recap activities on iPads. The teacher has instructed the pupils to work independently on vocabulary tasks on an electronic learning platform, but they sometimes negotiate answers together. Anna and Sara are seated next to each other in a side-by-side formation at their individual desks, with Oliver and Daniel behind them. Anna is trying to type the word *valley* and quietly utters it twice, mispronouncing it as [wʌlley] (l. 1). It should be noted that she uses this type of self-talk throughout the task when typing answers, and it does not seem to be directed at other participants. All participants are gazing at their iPads before Anna initiates the recruitment sequence (l. 2).

(2) Doesn't work

* = Anna's embodied conduct

\+ = Sara's embodied conduct

♠ = Daniel's embodied conduct

◊ = Oliver's embodied conduct

01	**ANNA**	**#°wal-ley°? (0.7) °°wali°°;**
		wuhl-le[y] *wuhley*
	anna	gaze to her iPad, typing
	sara	gaze to her iPad
	daniel	gaze to his iPad
	oliver	gaze to his iPad
	fig.	#Fig.5
02		***(1.0)+(0.2) *(1.1)#**
→	anna	*hits 'y' 3 times*stops typing, gaze to Sara
	sara	+gaze ahead
	fig.	#Fig.6

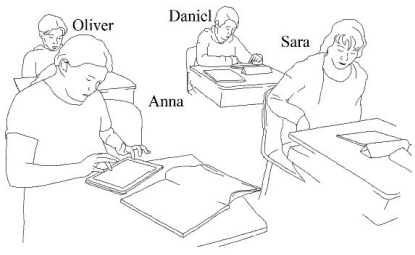

FIGURE 5.

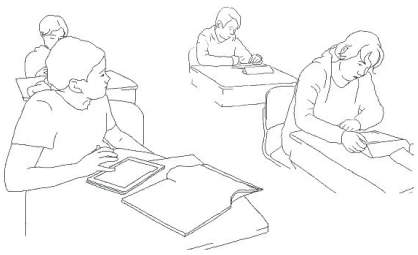

FIGURE 6.

03 OLIVER **MITÄ?+**
what
sara +gaze to her iPad

04 **(0.3)*(0.3)♠(0.6)**
anna *gaze to Oliver
daniel ♠gaze to Oliver

05 ANNA **[ei (tää)-]**
(this) doesn't

06 OLIVER **[mikä♠ val:◊ta] ♠meri oli;**
what was ocean
daniel ♠gaze to Anna♠gaze to Oliver
oliver ◊gaze to Daniel

07 **(0.4)**

08 ANNA **ei *toimi ♠näp+*päi(n).**
doesn't work the key ((=the key doesn't work))
→ anna *gz to Daniel *gaze to Sara
daniel ♠glances at Anna, then glances around
sara +gaze to Oliver, then to Anna

09 DANIEL **ä::+*::n o-se-an♠**
a::::n oh-seh-un ((=an ocean))
sara +gaze to Anna's iPad
anna *gaze to her iPad, taps screen 4 times
daniel ♠gaze to Oliver

10 ANNA **e◊i toi*mi (yy);**
doesn't work (y)
oliver ◊gaze to his iPad
→ anna *gaze to Sara

11 SARA **no >(oota ku ♠sä< oot)=**
well (wait cause you've)
daniel ♠gaze to Anna's book

12	**SARA**	**=räm*pyttäny sitä nii pitkään;**
		kept hitting it for so long
	anna	*gaze to iPad, starts typing

In Extract 2, the gaze shift functions as a display of trouble and a way to deal with it. As Anna notices that the key for "Y" on the keyboard does not seem to produce the letter on the screen (this can be seen from her screen on camera), she stops typing (l. 2). To recruit Sara, Anna needs to renegotiate the existing interactional space, from individual lines of action to a shared focus on Anna's trouble. She attempts this by turning her head and shifting her gaze to Sara (l. 2). The markedly long sustained gaze indicates trouble and solicits attention from Sara. Nonetheless, it does not induce a mutual gaze: Sara's gaze and body posture display orientation to her iPad and the task that she is required to finish. Anna then reacts to Oliver's turn (l. 3) by turning towards him (l. 4) and starts a report of trouble. Since Oliver starts recruiting Daniel to solve his own vocabulary problem (l. 6), Anna refocuses on Sara. Through two reports of trouble and gaze shifts to Sara (l. 8 and 10), she finally secures Sara's attention to her (l. 8) and her iPad (l. 9), mobilizing her response (l. 11–12; see Section 6 for response pursuits).

Extracts 1 and 2 demonstrate that gaze is relied on as a resource for displaying trouble and recruiting assistance in instances of trouble related to the task or the device. Whether or not it is successful, however, depends on the availability of the participant being recruited. For the recruiting participant to renegotiate the interactional space and to secure a mutual focus on the trouble, they need not only to suspend their *own* ongoing activity, such as typing an answer on an iPad (Extract 2), but also to get the recruited participant to momentarily prioritize the solving of the trouble over *their* simultaneously ongoing activity. A gaze shift to a coparticipant allows them both to check the availability of others and to attempt to recruit them, usually together with other multimodal resources, such as trouble alerts and verbal formulations.

6 Gaze in response pursuits

In the present data, gaze is systematically used as a resource in response pursuits (cf. Stivers & Rossano 2010). Out of the 17 cases in the data, seven involve gaze to a coparticipant as the only resource used to mobilize an answer, and in one case, the gaze shift is accompanied with nods (Extract 3). In four cases, gaze is paired with a verbal repetition, and, in five, with a modification of the initial verbal turn (Extract 4). Other embodied resources, such as touching, leaning towards a recipient, and showing a device, are sometimes used. Gaze shifts tend to occur right after a response to a sequence-initial action is perceived to be missing, thus initiating a new

sequence of response pursuit. If the gaze alone does not induce a relevant response (Extract 4), other resources are harnessed to secure one.

In extract 3, we find an embodied response pursuit effectuated by Hugo, a pupil on an 8th grade EFL lesson seated next to a peer, Joel. The class are playing a Kahoot about infinite and -ing forms, using their own mobile phones. Each pupil plays individually but they commonly assist each other during the game. A sentence with a missing verb (*Let me _____ you!*) has just appeared on the whiteboard. The pupils are required to fill in the blank in the sentence by clicking on one of the three options visible on their phone screens: *help*, *to help*, and *helping*. Both Hugo and Joel, focusing on their own phones, tap their screens to choose an answer, and wait for others to answer (data not shown). Hugo then utters the correct answer (l. 1).

(3) Help you
* = Hugo's embodied conduct
\+ = Joel's embodied conduct

01 HUGO **#help you;**
fig. #Fig.7

02 **(0.4)*(0.6)#+**
→ hugo *gaze to Joel
joel +turns slightly towards Hugo
fig. #Fig.8

FIGURE 7. FIGURE 8.

03 **(0.2)*(1.4)+**
hugo *starts nodding
joel +starts nodding

04 **(0.5)***
hugo *turns towards whiteboard

In Extract 3, both the response pursuit and the ensuing response are achieved without a verbal input. In line 1, Hugo seems to utter one of the options presented on screen as a candidate answer for the question (this is done regularly by these participants during the game), making a second-pair part by Joel relevant. After a gap of 0.4 seconds, a pending response is indeed made accountable through a gaze shift to Joel. Joel's response is delayed, however, as attending to Hugo's pursuit makes a suspension of his focus on the game relevant. After a sustained gaze by Hugo, Joel turns his head slightly towards him (l. 2 - it is unclear from the camera angle if there is mutual gaze), and Hugo further invites a response by starting to nod (l. 3). Eventually, Joel also starts nodding (l. 3), and Hugo seems to treat this as a sufficient response. Withdrawing his gaze and focusing on the whiteboard (l. 4), he indicates a sequence closure (Rossano 2013). The extract thus shows how participants seem to treat gaze as a central resource for pursuing a response.

Response pursuits are not always effective, however. Extract 4 comes from another lesson of the same 5th grade group as Extract 2. Sara and Anna are preparing a short presentation on gymnastics as a team. They are looking for information online on their iPads, and Sara is taking notes in her notebook. They are trying to decide what to state as the reason for choosing the sport for the assignment, and Sara recruits Anna in spelling the word *because*. Anna then orients to her iPad before Sara finishes writing (data not shown). Sara soon initiates a new sequence, suggesting a reason they could write down for choosing gymnastics (l. 1).

(4) It's fun

* = Anna's embodied conduct

\+ = Sara's embodied conduct

01	**SARA**	**.mthhhhhh #it's fun:?**
	sara	gaze to notebook
	anna	gaze to iPad
	fig.	#Fig.9
02		**(0.3)*(0.2)+#(0.9) *(0.4)**
	anna	*gaze to her right *gaze to iPad
→	sara	+gaze to Anna
	fig.	#Fig.10

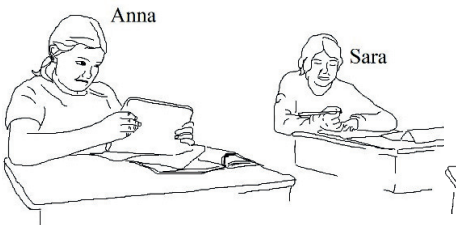

FIGURE 9.

FIGURE 10.

03 SARA **may*be,**
anna *lifts iPad

04 **(0.4)+(0.2)**
sara +gaze to Anna's iPad

05 SARA **is it *fu+n:;#**
anna *gaze to Sara, smiles
→ sara +gaze to Anna
fig. #Fig.11

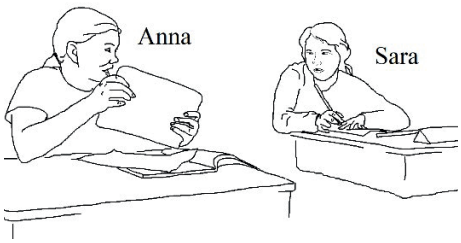

FIGURE 11.

06 **(0.5)*(0.3)+(0.4) *(0.9) ***
anna *gaze to iPad*gaze to Sara*gaze to iPad
sara +gaze to Anna's ipad

07 ANNA **°kato ketä mä nään tääl(tä)°**
look at who I see (from) here

The trouble in Extract 4 lies in the progression of the sequence that Sara has initiated with her turn in line 1. The turn is "try-marked" with a rising intonation (Sacks & Schegloff 1979: 18) and can thus be heard as a suggestion of how to continue their sentence (*We chose gymnastics because it's fun*). Anna, however, seems to shift her focus between her iPad and the opposite side of the classroom, and fails to react to

the suggestion (l.2). Sara seems to hold Anna accountable for the missing response and, through a gaze shift to Anna, initiates what could be called a sequential repair (Schegloff, 1997: 510), a boundary case of repair initiated when an action does not receive a sequentially relevant response. In addition, Sara uses verbal resources in pursuing a response. With the increment *maybe* (l. 3), she converts the gap between her turn and the pending response into a pause inside her own turn and thus mitigates the problem of the missing response (see also Bolden et al. 2012). In the continued absence of mutual gaze and a response, she then reissues a new version of her initial action (Bolden et al. 2012: 138), reformulating her suggestion as a question, and shifts her gaze back to Anna after a brief gaze to Anna's device (l. 5).

Through the gaze shift and the verbal formulations, Sara is engaged in resuming a momentarily fragmented interactional space. Their joint focus before the extract has been on the shared writing task, and Sara is now striving to restore this mutual line of action. Interestingly, Sara fails to mobilize a response and eventually abandons the pursuit. The problem seems to lie in Anna's simultaneous orientation to an off-task activity and her apparent ignorance of Sara's suggestion. Even the brief mutual gaze (l. 5) does not result in a successful mobilization but, rather, invites Sara to follow Anna's line of action, looking at what she can see on her iPad screen (l. 7).

Extracts 3 and 4 demonstrate that, even though gaze is typically directed at devices during technology-mediated tasks, it is often the first resource available to and employed by participants to address trouble in interaction. It is used to (re)negotiate a mutual focus on the trouble to enable the mobilization of a missing response. As we saw in Extract 4, however, the successfulness of the pursuit depends on the availability of the recipient, and competing lines of action may stall the progressivity of the task interaction.

7 Concluding discussion

Offering a new context for research on eye gaze, this article has investigated gaze functions in recruitments and response pursuits in classroom interaction during tasks on mobile devices. The analysis has revealed that gaze to coparticipants is systematically used as a resource in displaying and solving trouble. The findings are in line with previous research on the role of gaze in sequence initiations (Rossano 2013) and response mobilization (Auer & Zima 2021; Duran & Jacknick 2020; Stivers & Rossano 2010). In addition, however, the article has shown that, in the context of the study, gaze seems to be one of the first resources that participants use to display trouble, check the availability of others, and negotiate a shared focus on the trouble source.

The article has focused on how participants themselves orient to the context and its affordances, or the possibilities for action that the context offers (see e.g.,

Hutchby 2001). Thus, it has attempted to avoid the pitfall that research on technology is at risk of facing: any patterns of behaviour are determined to be straightforward results of technology. In fact, the analysis has shown that the gaze patterns around mobile devices in the data are quite consistent with contexts where any other types of objects are handled. Gaze is often needed for the manipulation of objects, for instance, but can quite fluently be harnessed for other purposes, such as recruiting help, whenever it is needed (cf. Deppermann 2014; Nishizaka 2014; Tuncer et al. 2019). Occasional hick-ups in the division of resources between the device and peer interaction are solved step-by-step, using multimodal resources afforded by the context. Technology can therefore only be assumed to have relevance for the interaction if the participants themselves perceivably orient to it as relevant.

Moreover, the analysis has shown that, to accomplish learning tasks on mobile devices, pupils need to manage interactional spaces around the devices, splitting their orientation between the device and interaction with peers. This has pedagogical implications for teachers, who are required to balance the learning aims and the affordances of devices as well as the interactional needs of pupils when planning technology-mediated tasks. Using multimodal resources, pupils actively participate in classroom interaction and manage multiple modalities simultaneously, and the possibility to do this should be taken into consideration when integrating technology into learning.

The article has hopefully offered a glimpse of the competencies needed in today's educational contexts. It has shown how interaction is multimodally accomplished around mobile devices and how trouble is actively addressed through resources such as eye gaze. The challenge for future research on classroom interaction is to unravel more of these competencies and to investigate how embodied resources and technology itself are used to build mutual attention and joint action in educational contexts.

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Appendix:

Transcription conventions

The participants' talk has been transcribed according to the Jeffersonian transcription notations used in CA methodology. Other embodied behaviours have been transcribed adapting conventions from multimodal CA (see e.g., Harjunpää et al. 2020).

.	final falling intonation
,	continuing intonation
;	slightly falling intonation
?	interrogative intonation
↑	rising intonation
↓	falling intonation
hhh	outbreath
.hhh	inbreath
what	word emphasis
°what°	speech that is quieter than the surrounding talk
°°what°°	whisper
>what<	speech that is quicker than the surrounding talk
<what>	speech that is slower than the surrounding talk
WHAT	speech that is louder than the surrounding talk
wha::t	prolonged vowel or consonant
wha-	cut-off word
(what)	uncertain hearing
[what]	overlapping talk
=	no break between utterances or units of talk
((ocean))	transcriber's comments
(1.5)	silence in seconds
(.)	micro pause
→	a line that is focused on in the analysis
*, +, ♠, ◊	Each participant in an extract is assigned one of these symbols. The occurrence of the symbol in a line of talk indicates the beginning of a focal embodied action that is explained underneath the spoken representation and its translation in grey font.
#	Indicates the temporal placement of a figure in a line of talk.

IV

MULTIMODAL BLAME ATTRIBUTIONS IN TECHNOLOGY-SUPPORTED PEER INTERACTION

by

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Multimodal blame attributions in technology-supported peer interaction

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ABSTRACT

This study investigates the multimodal construction of blame attributions in peer interaction during digital tasks in English as a Foreign Language classrooms. Drawing on multimodal conversation analysis (CA), we examine how the force of blamings is manifested in and through the variety of resources used, and the role of digital devices in the emergence and resolution of blaming sequences. The analysis shows that children's blame attributions can be bold and involve a lamination of several multimodal resources, often without an explicit verbal formulation. Additionally, participants may build on the actions of the digital application to allocate blame, using the affordances of the technology to avoid direct verbal attributions. The study thus elaborates on the sequential structure of blamings and highlights their context-bound and multimodal nature. It contributes to research on multimodality in technology-supported classroom interactions, shedding light on the merging of the embodied and the digital in action formation.

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1. Introduction

During collaborative learning tasks, pupils need to manage their roles as team members, as parts of a 'we' (Etelämäki 2021), who are accountable to each other for their actions in ensuring task progression and success. Team members need to collaboratively negotiate answers, as non-existent negotiation or individual decision-making may lead to mistakes that affect the performance and assessment of the whole team. In the event of such a mistake, one possible line of action for the team is to negotiate who is to blame for it and therefore for having violated their role as a team member. Through this kind of a blame attribution (Pomerantz 1978), pupils can resolve the matter of the mistake and reorient to task progression.

In conversation analytic research, blame attributions have previously been studied as primarily verbal accomplishments in different mundane (Evaldsson 2007; M. H. Goodwin, C. Goodwin, and Yaeger-Dror 2002; Pomerantz 1978) and institutional contexts (Atkinson and Drew 1979; Evaldsson 2016; Niemi and Bateman 2015). These studies have shed light on the sequential structure of blamings (see Section 1.1) and the verbal resources used in their formation. Within educational contexts and in interaction among children, blamings and

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accusations have also been shown to be intricately related to the moral order of a peer group and to participants' identity work as group members (Evaldsson 2007, 2016; Niemi and Bateman 2015). What is still lacking, however, is a multimodal analysis of how embodied, material, and technological resources may intertwine in the action formation of blame attributions as well as an inspection of how the ecology of modern, technology-infused classrooms may be reflected in the structure of blaming sequences.

Our aim is to further an understanding of how blame attributions are accomplished in social interaction, particularly in task-based peer interaction around technology. Using multimodal conversation analysis, we investigate data from English as a Foreign Language (EFL) classrooms where mobile devices are used for performing learning tasks in small teams. In these settings, mistakes by peers are often oriented to through blame attributions, which are used to allude to participants' roles as team members. We show the multimodal nature of blame attributions, by which we refer to the fact that they can be built from both verbal and embodied resources as well as rely on varied socio-material and digital affordances. In particular, we show that the actions on screens of digital applications can be used by pupils as resources in designing social actions (see Greiffenhagen and Watson 2009; Norén, Melander Bowden, and Evaldsson 2022), specifically blamings. Our research questions are: (1) How are multimodal resources used to construct blame attributions, and how is the force of the attributions manifested in and through these resources? (2) What is the role of technology in the emergence and resolution of the blaming sequence? The findings show that blame attributions are built in locally contingent ways, drawing on embodied resources and the rejections of answers by the digital application, and that the technology offers students a way to avoid making verbal announcements of peers' mistakes. In addition, we address the issues related to negotiations of roles and responsibilities that emerge during collaborative digital tasks. Our study thus builds on and contributes to research on blaming and disagreement sequences and multimodality in technology-supported classroom interaction, offering novel insights into how multimodal and technological resources blend into a single 'phygital' entity (Due and Toft 2021).

1.1. Blaming sequences in institutional and everyday contexts

With the seminal 1978 paper, Pomerantz described the mechanisms of blame attributions in everyday conversations and suggested that blame can be attributed either to self or the other so that apologies, admissions, and confessions are attributed to the self, while blamings, accusations, and complaints target the other. More importantly, Pomerantz showed that blame attributions occur as subsequent parts, or second segments, in sequences of talk-in-interaction, where the first segments are reports of 'unhappy incidents'. Extract 1, taken from Pomerantz's paper, shows how A reports the destruction of a car, that is, an unhappy incident.

Extract 1. It blew up (Pomerantz 1978, 118).

```
1   A     It blew up.
          .
          .
2   R     Whadju do to it?
```

In the second segment, R explicitly attributes the blame to A by asking what they have done to it, thus assuming that A is responsible. Notice that the second segment need not

immediately follow the report, and it may be uttered by either the producer of the report or another participant, as research on accusations in different settings has also shown (e.g. Atkinson and Drew 1979; Niemi and Bateman 2015).

Later studies have illustrated how blamings and accusations are built sequentially and formulated verbally. In the context of courtrooms, Atkinson and Drew (1979) have shown how counsels design question-answer sequences in such a way that leads to inferences about a person's blameworthiness and ultimately forms an accusation. The attribution of responsibility is in such cases built through several turns. In a classroom context, Niemi and Bateman (2015) offer insights into how pupils collaboratively accomplish accusations by invoking classroom rules and membership categories. Such category work can also be found in the accusations in Evaldsson's studies on preadolescents' talk about friendship (2007) and on children's and teachers' accounts for misconduct (2016). Similarly, M. H. Goodwin (1990) describes children engaging in 'he-said-she-said' disputes, where a peer is accused of having talked about another behind their back and, thus, of having violated the group's moral order. Together, these studies on children show how blamings, accusations, and disagreements in peer interaction are often expressed in an unmitigated manner (also M. H. Goodwin 1983). Whereas adults' disagreeing turns may generally be shaped as dispreferred (e.g. Sacks 1987), those of children seem to bear characteristics of preferred turns, in that they are direct, short, and produced with no delay (Church 2009). The present study will show that, while young pupils often attribute blame in a bold manner and with few mitigating resources, they can also avoid being verbally direct through the affordances of the context, such as technology.

While Pomerantz (1978) offers a useful basis for investigating verbal blaming structures, the nature of the audio-recorded data inhibits an inspection of embodied and material resources in constructing blame attributions. To our knowledge, the only study to specifically address the multimodal design of blamings is that by Goodwin, Goodwin, and Yaeger-Dror (2002), who explored disagreement turns during children's games, focusing especially on prosody. The blame attributions, however, were only discussed as part of larger activities, not detailing their multimodal construction and sequential organisation. Moreover, previous studies on blamings have generally focused on sequences where blame is attributed for incidents that have occurred prior to and separately from the ongoing interaction (see, however, M. H. Goodwin 2006; Goodwin, Goodwin, and Yaeger-Dror 2002, on disputes during games). To bridge these gaps, we aim at delineating the role of embodiment and technology in the emergence and resolution of blame attributions during second language (L2) task interaction, a hitherto unexplored context in research on blaming. Specifically, we describe how blame is attributed for a mistake made by a peer on a mobile device as soon as it has occurred, and how the blaming action is 'built out of the details of the particular social [setting]' (Sidnell 2017, 321). Some of these details are the actions occurring on the screens of digital devices, which, we argue, participants draw on in constructing blame attributions.

1.2. Multimodality in device-centred interactions

Research on social interaction has for decades been interested in objects in human interaction (e.g. C. Goodwin 1994; Hindmarsh and Christian 2003; Tuncer, Licoppe, and Haddington 2019). The rapidly expanding interest in technology and the rise of the concept of multimodality within conversation analysis (e.g. Mondada 2019) have

generated a burgeoning body of studies concerned with how verbal and embodied resources are organised while using technological devices (e.g. Brown, McGregor, and Laurier 2013; Due and Toft 2021; Haddington and Rauniomaa 2011; Thorne et al. 2015). These studies illustrate how interaction can be organised around technology and how technology and embodiment may merge in action formation.

Studies focusing on interaction around technology illustrate how different resources are used to manage tasks performed on or with the help of technology. In these contexts, the embeddedness of the use of technology in social interaction requires a constant (re) negotiation of interactional space, that is, of the space of mutual orientation formed through the arrangement of participants' bodies (Mondada 2013) or through their orientation to and usage of technological devices (Oittinen 2020). In mobile-supported educational contexts, participants have been shown to use resources such as gaze, body movements, talk, and touch to maintain group cohesiveness (Thorne et al. 2015), organise turn-taking around mobile devices (Theobald et al. 2016), modify interactional spaces to solve trouble during digital tasks (Vänttinen 2022), and resist a change in the participation framework by blocking a peer from accessing a device (Jakonen and Niemi 2020). Studies on collaborative digital tasks have also shown that pupils use the affordances of technology, such as spellcheckers and synthetic voicing, as resources in correcting spelling (e.g. Musk 2016; Norén, Melander Bowden, and Evaldsson 2022). However, blame attributions have not been discussed in this research.

Within the line of research investigating the merging of technology and embodiment in the production of (inter)action, Due and Toft (2021) show how the embodied action of highlighting text on a computer screen (through pointing, talk, moving the mouse) is intertwined with the digital actions of the cursor on the screen (see also Olbertz-Siitonen and Piirainen-Marsh 2021). They suggest abandoning the dichotomy between embodiment and digital technology and instead argue that these modalities together form a single, 'phygital' entity. In a somewhat similar vein, we consider how an action, such as a notification of an error, performed by a digital application can be treated by participants as a resource in designing blame attributions during game-based tasks. By relying on the actions on the mobile device, pupils can allocate responsibility to their peers even without verbally announcing the mistake. Thus, the blaming sequences are constructed through the interplay between the embodied and the digital and are understood as such due to the local, sequential contingencies of the ongoing task activity. Thus, our study offers novel insights into how participants utilise technology as a resource in action formation and ascription during digital tasks.

2. Data and methods

The data come from a collection of audio- and video-recordings as well as screen recordings from 19 EFL lessons in four comprehensive schools in Finland in 2020 and 2021. The recordings were made in seven classrooms, with pupils aged 10 to 15 years (grades 4 to 9). All teachers and the guardians of the participating pupils gave their informed written consent, and the participants had the freedom to withdraw from the study at any time. No ethics approval for the study was required by the University of Jyväskylä.

From the beginning, our analytic attention was on peer interactions around mobile devices used in collaborative language learning tasks. Screen recordings proved particularly

useful for analysing these interactions, as they afforded us a window to the tasks and enabled us to investigate how the actions on screens were used by participants to produce social actions. We noticed that when pupils made mistakes in tasks by choosing incorrect answers, their team members tended to design blame attributions by building on the rejections of answers by the digital application. We zoomed in on such blaming sequences to analyse their multimodal construction. The final collection comprises 19 sequences from two classrooms, 4th and 5th grade, where pupils worked in pairs or groups and used such game applications as Kahoot!, Blooket, and Socrative. Tasks on these applications can entail competition since points are awarded for correct answers. While competition was not part of the teachers' task goals, the pupils demonstrably oriented to the tasks as such by verbally commenting on their points and position in the games, for instance.

Drawing on multimodal conversation analysis (CA), we illustrate how interaction is collaboratively built through the dynamic use of multimodal resources, which are adapted to the local sequential and temporal circumstances (Mondada 2013). The emic approach accounts for what is relevant for the pupils themselves in interaction and reveals the situated design of blame attributions. It also shows that, while technology can be given a participation status in dynamic and situated ways in interaction (Krummheuer 2015), the pupils in our data orient to it as an interactional resource not only for the scripted learning activity but also for designing blame attributions. The data have been transcribed using the Jeffersonian conventions of CA for participants' talk and the multimodal conventions developed by Mondada (2022) to illustrate embodied actions. The transcripts have been pseudonymised, and drawings have been used instead of images to protect the participants' identity.

3. Analysis

The analysis will illustrate the local, multimodal tailoring of pupils' blame attributions. The blaming sequences are intertwined with the scripted initiation-response-evaluation (IRE; Mehan 1979) sequences between the pupils and the device (see Figure 1), where the automated multiple-choice questions on the digital application can be conceived of as initiations, triggered by a pupil's manual action of pressing a button on the screen. This is followed by the pupils' response as they choose an answer option. When the answer is incorrect, it becomes relevant for the design of a blame attribution whether the mistake is first flagged by a peer or by the application. In a subcollection of cases (5/19), the blame attributions are produced just before the digital application rejects the chosen answer and designed as verbally explicit. An illustrative example is discussed in Section 3.1.

In most cases, however, the recurring structure of blaming sequences is as follows: First, a pupil makes a mistake, and the incorrect answer is rejected by the application. A peer then builds on this rejection to multimodally attribute the blame to the participant that made the mistake. The 'guilty' party may accept the blame (Extract 3), account for the mistake (Extract 4), or downplay the gravity of the mistake (Extract 5). The blaming sequence is then concluded as the pupils continue with the game, mostly without further discussion on what happened (although see Extract 5). The three extracts in Section 3.2 demonstrate this structure and show different degrees of force from mild to bold blame attributions. We argue that the blame attributions in these cases derive their force from the lamination of multimodal resources rather than relying merely on verbal attributions and that their stance varies depending on the manner different resources are used.

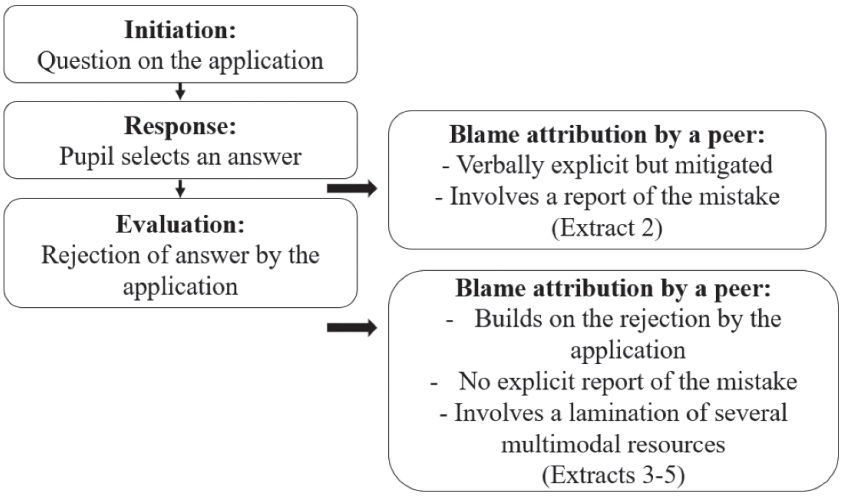

Figure 1. Sequential organisation of the task and the blame attributions.

In addition, we will demonstrate how the pupils' orientation to the mistake influences the interactional space (Mondada 2013) created between the team members and how this is intertwined with the management of participants' roles as parts of a 'we' (Etelämäki 2021) who are accountable for their actions in the game. When pupils negotiate the answer together, and thus potentially share the blame for a mistake, they display joint orientation to the device and solving the issue. In cases where negotiation is non-existent or overridden by an individual, the interactional space is remodified: the blamer disengages from the device and persists in solving the issue, whereas the 'guilty' party mainly orients to the game and tries to avoid further confrontation or resist the blame.

3.1. Attributing blame explicitly

Extract 2 comes from a 4th grade EFL lesson, where pupils practise irregular plural forms of nouns with a Kahoot!. It illustrates the relevance of whether the mistake is flagged by a pupil or the digital application. Namely, one of the pairs (Mea and Paula) in the data often noticed the mistake before the application reported it, after which the blame was attributed to the 'guilty' party explicitly through an address term (or a reference pronoun) and stating what the mistake was. The explicitness of the attribution led to the pupils using fewer embodied resources in action formation, as Extract 2 illustrates.

Mea and Paula are sitting side by side at Mea's desk and use a single tablet computer placed on the desk (Figure 2). The extract begins as the noun *foot* appears on the screen (l. 1). Both pupils react to it by simultaneously reading it aloud (l. 3 & 4) and then offering a candidate answer in overlap (l. 6 & 7). They thus agree on the correct answer without explicitly negotiating it together before the answer options appear on screen.

Extract 2.

```
1    Mea        (okei)#
                (okay)
     paulaG     >>on tablet->
     meaG       >>on tablet->
     tablet     >>the word 'a foot' on screen
     fig.             #Fig.2
```

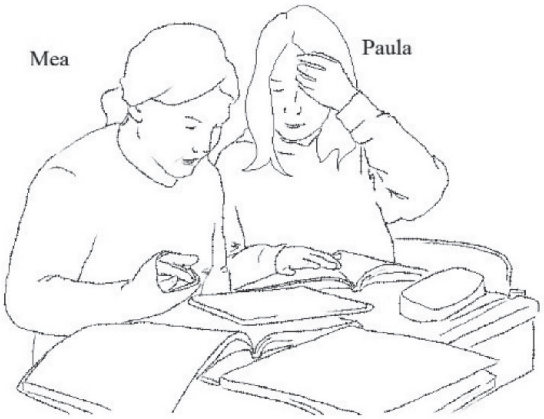

Figure 2. Participants gaze at device.

```
2                (0.6)

3     Mea        [foot].

4     Paula      [ foo]:t,•
      paula               •...->

5                (0.2)*(0.2)*
      paulaG        ->*.....*to book->

6     Paula      [se on•       f*ee•t ].
                 it is feet

7     Mea        [se on•       f*ee•t:]h,
                  it is feet
      paula          ->•grabs book•hand toward tablet->
      paulaG                  ->*to tablet->>

8                (0.5)•÷(0.4)
      paula         ->•hand hovers above device,
                       leans toward tablet->
      mea              ÷leans toward tablet->

9     Paula      se on ▶#÷feet,•÷
                 it is feet
      tablet           ▶answer options appear
      mea              ->÷      ÷hand toward tablet->
      paula                  ->•hand toward tablet->
      fig.              #Fig.3
```

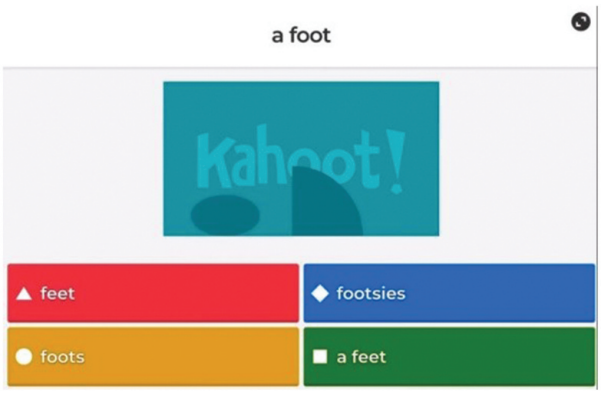

Figure 3. Answer options.

```
10   Mea        feet ÷feet          ÷•feet?+%÷=
     mea           ->÷taps 'a feet'÷,,,,,,,,÷...->
     paula                      ->•retracts hand->
     meaG                             ->+
     meaF                                %closes eyes,
                                          round mouth->

11                =↑A::%÷↓A:[:: ]=

12   Paula                 [↑ei]=
                             no
     meaF            ->%
     mea              ->÷hands cover face, throws herself back->

13   Mea          =[ me÷%+♥ni ]=

14   Paula        =[mea÷%+♥ sä]=
                    mea     you
     mea               ÷leans forward, hands cover mouth->
     meaF               %open eyes->
     meaG                +to tablet->>
     paulaF              ♥smiles->

15   Mea          =[(x)]

16   Paula        =[lai]▶#toit÷ a• fee(h):::(h)t.#
                   put a feet
     mea                    ->÷leans toward tablet,
                               hands cover mouth->
     paula                     ->•
     tablet               ▶answer marked incorrect
     fig.                  #Fig.4                  #Fig.5
```

Figure 4. Mea reacts to mistake.

Figure 5. Application marks answer incorrect.

```
17              (0.2)•(0.6)
     paula           •...->

18   Paula      ne•x:          •t,♥
     paula      ->•taps 'next'•,,,->
     paulaF                     ->♥

19              (0.2)•(0.4)÷%(0.3)
     paula         ->•taps 'next' twice->
     mea                 ->÷lowers hands from face->
     meaF                   %smiles->

20   Paula      ne•▶x:÷t:
     paula      ->•
     tablet        ▶scoreboard appears
     mea            ->÷

21   Mea        me ollaa• iha       •=
                we are just
     paula             •taps 'next'•,,,->

22   Mea        =[h:uippu]▶sur•keita;%
                  truly    lousy

23   Paula      =[nex:t ,]▶
     tablet               ▶new question appears
     paula                  ->•
     meaF                          ->%
```

Before and during the answer options appear, both pupils bring their body and hand closer to the device in preparation to touch the screen (l. 8–9). There thus seems to be competition as to who gets to select the answer. When the answer options appear towards the end of Paula's repetition of the candidate answer (l. 9, Figure 3), Mea is the first to press the option closest to her right hand: *a feet*. Simultaneously, she is repeating the correct answer in quick succession (l. 10). Immediately after having pressed *a feet*, however, Mea covers her face with her hands, throws her body backwards (l. 12; Figure 4), and produces a loud, elongated response cry (l. 11) that serves as a non-lexical affect display (cf. Hofstetter 2020). Her embodied actions together with the cry can be described as an 'embodied extreme-case expression' (Skogmyr Marian 2021), a bold lamination (C. Goodwin 2013) of multiple resources, that visibly manifests her realisation of the mistake. Mea also verbally comments on the mistake (l. 13), but the turn is inaudible due to overlapping talk.

In overlap with Mea's reaction, Paula interjects *no* in Finnish (l. 12) as a response cry and then attributes blame to Mea by addressing her by name and stating the mistake (l. 14 & 16). Paula also underlines the mistake by emphasising the indefinite article *a* that is not part of the plural form. Although Paula's blame attribution is verbally straightforward, it does not involve a lamination of several resources and her smile mitigates it (Figure 4). The smile and the tone and pitch of voice that mimic Mea's cry, can also signal alignment and affiliation with Mea's affect display, marking Mea's mistake as non-serious and as a central part of the game where there is a possibility of losing (Hofstetter 2020). Furthermore, as pupils can signal trouble through a gaze shift to a co-participant during technology-mediated tasks (Vänttinen 2022), the lack of a gaze shift by Paula may here indicate the non-seriousness of the mistake or an avoidance of confrontation.

Amidst the blaming, the application rejects the answer (l. 16; Figure 5). The pupils, however, no longer pay attention to it; instead, they move on in the game. When Paula presses the 'next' button, the overall scoreboard appears on screen (l. 20). Mea's we-deprecation (l. 21–22; cf. Pomerantz' concept of self-deprecation Pomerantz 1984) orients to it as she comments that their team is 'truly lousy' at the game. She thus highlights their joint accountability of working and succeeding as a team (also Etelämäki 2021).

In this extract, Paula's turn explicitly assigns blame to Mea before the application signals the mistake. It is thus not built on the rejection by the application but emerges from Mea's action on screen as a type of a multipurpose turn, which verbally initiates repair by reporting Mea's mistake (notice, however, that once an answer is selected, it cannot be corrected in the game) and attributes blame. Although explicit, the attribution is mitigated by Paula's affect display that aligns with Mea's embodied expression, rendering the experience as shared. Paula's orientation to the mistake as non-serious and her avoidance of confrontation is further underlined by her continued focus on the device (l. 18). Thus, the existing interactional space of mutual orientation towards the device and the game is sustained. Moreover, Mea's embodied self-attribution in its extreme form pre-empts further delving on the matter.

3.2. Attributing blame multimodally by building on actions on the device

Most blame attributions in the data involve verbally more indirect blaming than Extract 2, accompanied by a lamination of embodied resources and directly building on rejections by the digital application. Despite the lack of an explicit verbal report of the mistake, many blame attributions are bold, deriving much of their meaning and force from the lamination of multimodal resources. To illustrate this interplay of verbal, embodied, and digital resources, we present three examples in this section. In Extract 3, the blame attribution is noticeably mild and hinted at rather than explicitly expressed. With Extracts 4–5, the blame attributions become more aggravated, yet are somewhat quickly resolved as the pupils prioritise task progression.

In Extract 3, the combination of subtle prosodic and embodied cues together with a verbal formulation pointing at the basis for the mistake indicate that blame may be attributed. It originates from a reading comprehension activity in a 5th grade lesson, where the Socrative application is used to answer questions about a book chapter they have read. Markus and Aron are working together, using a device that Markus handles on his desk (Figure 6). Here, they need to answer the question already visible on screen: *Where did Mike learn French?* (Fin. 'Missä Mike oppi ranskaa?'). Out of three options (A 'at home', B 'when travelling', and C 'at school'), option A is correct, but Markus selects option C.

The sequence begins with Markus reading aloud to himself (l. 1) and skimming part of the text in the book (*mh mh*) before reading aloud the part he considers as providing the correct answer, emphasising the word *school* (l. 2). As he turns to the device (l. 2–3), he first checks with Aron in Finnish whether he agrees with the candidate suggestion (l. 4). Aron, gazing at his book, somewhat absent-mindedly confirms it (l. 6).

Extract 3.

```
1    Markus     >welcome to# petit café< (.) france=
     aronG      >>on his book->
     markusG    >>on his book->
     fig.                  #Fig.6
```

Figure 6. Participants gaze at books.

```
2                  =mh mh learnt (.) english+ at+ school;
     markusG                                ->+...+to tablet->

3                  ÷(0.3)
     markus        ÷hand moves toward screen->

4    Markus        koulussa,+÷
                   at school
     markusG             ->+...->
     markus               ->÷hand hovers above screen->

5                  (0.1)+(0.2)
     markusG          ->+to aron's book->

6    Aron          jep
                   yup

7                  (0.2)+÷(0.2)+(0.1)÷
     markusG          ->+......+to tablet->
     markus            ->÷...........÷taps C->

8                  (0.2)÷(0.6)          ÷(0.7)          ÷(0.2)
     markus          ->÷taps 'submit'÷retracts hand÷...->

9    Markus        näh;÷
                   nuh
     markus          ->÷touches screen->

10                 (0.4)÷►(0.6)
     markus          ->÷
     tablet             ►answer marked incorrect,
                         correct answer shown

11   Markus        hä?
                   huh

12                 (2.0)+(0.2)+•
     markusG         ->+.....+to book->
     aron                      •turns toward markus->

13                 (0.8)*(0.5)•(0.2)*÷
     aronG           ->*...........*toward markus->
     aron                ->•leans toward tablet->
     markus                       ÷retracts hand->

14                 (0.3)*÷#
     aronG           ->*to tablet->
     markus           ->÷...->
     fig.                #Fig.7
```

Figure 7. Aron gazes at device.

```
15                (0.7)÷(0.2)•
     markus         ->÷touches book->
     aron                ->•

16                (0.4)•(0.6)*(0.6)*
     aron             •leans back against chair->
     aronG               ->*.....*down->

17                (0.3)•*(0.4)*(0.4)
     aron           ->•
     aronG           ->*.....*to book->

18   Aron         I +÷learned+ en*glish=
     markusG      ->+........+to tablet->
     markus        ->÷hand moves toward screen->
     aronG                    ->*...->

19                =at *•÷[s+cho+#ol; ]=

20   Markus           *•÷[ä+ä
     aronG          ->*to markus->
     aron             •tilts head left->
     markus           ->÷
     markusG             ->+..+to aron->
     markusF                    %smiles->
     fig.                    #Fig.8
```

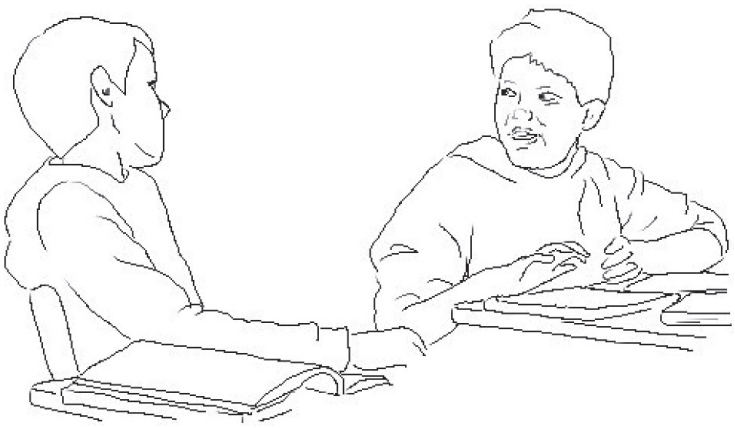

Figure 8. Mutual gaze.

```
21   Aron       hh•*h+h♥ £(mh h +h)£÷%♥
     aron       ->•
     aronG       ->*down->
     markusG       ->+.........+to tablet->>
     aronF             ♥smiles--------♥
     markus                          ÷taps 'ok'->
     markusF                        ->%

22                (0.4)*%(0.1)÷►
     aronG           ->*...->
     markusF           %smiles->>
     markus                ->÷
     tablet                   ►new question appears

23   Markus     £yeah* hmh£
     aronG           ->*to book->>
```

After Aron's confirmation, Markus selects option C (l. 7) and presses the submit button (l. 8). There seems to be trouble with the device, however, as Markus produces a nasalised non-lexical vocalisation and touches the screen again (l. 9). When the application signals the mistake (l. 10), he performs another vocalisation with higher pitch and questioning intonation (l. 11) that serves as a trouble-alert (Kendrick and Drew 2016) and demonstrates Markus' surprise. Although Aron has been reading his book, the alert draws his attention as he slowly leans closer to the device (l. 13–15, Figure 7). He then resumes his home position (l. 16–17). The embodied shift in Aron's orientation towards the device indicates a change in the interactional space and establishes a joint focus towards solving the problem. This becomes evident when both pupils direct their gaze at their books (lines 12 and 17, respectively).

Aron's turn in line 18 can then be seen as a multipurpose turn that verbally corrects the answer and implies blame. It builds on the rejection by the application and the chapter text as Aron repeats the sentence Markus read earlier (l. 18–19). Aron's tone of voice is slightly marked, however, and he emphasises two key words in the sentence: *English* and *school*. Moreover, he shifts gaze towards Markus and tilts his head slightly. Together these actions mark the mistake in relation to the task question as an obvious one that should have been avoided. In overlap with the end of Aron's turn, Markus performs a vocalisation and gazes towards Aron, and the two establish mutual gaze (l. 20, Figure 8). Markus also begins to smile (l. 20), which together with the gaze serves as an acknowledgement and mitigation of his mistake. Aron aligns and returns the smile (l. 21), which can also manifest their shared understanding of the 'silliness' of the mistake. Withdrawing their gazes and reorienting to the book and the device, respectively, both mark the trouble resolved.

Aron's blame attribution is mild and verbally indirect, yet its prosodic and embodied features indicate that blame is attributed. A reason for the mildness could be that Aron has not paid attention to the question and has confirmed Markus' candidate answer without further consideration, which makes them both responsible. The reciprocal smile and the lack of an account for the mistake by either participant seem to display a shared sense of moral accountability and acknowledgement of the mistake.

In comparison, the combination of verbal, prosodic, and embodied resources in Extract 4 offers us a clearer case of blaming, where the rejection of the answer by the application is harnessed to construct the blame attribution. Verbally, the blame attribution is again indirect. The extract features Heidi and Ella, who are playing a Kahoot! as a team on a tablet computer (Figure 9). As their next task, they are to pick the correct English translation of the Finnish question *Söitkö eilen suklaata?* ('Did you eat chocolate yesterday?') out of four options (Figure 10). Heidi starts producing a verbal candidate translation before seeing the answer options (l. 1). As the options appear on screen, she cuts off her turn.

Extract 4.

```
1    Heidi      did ↑you (.) ea:t (.) ▶las:::#t,
     heidiG     >>on tablet->
     ellaG      >>ontablet->
     tablet                           ▶answer options appear
     fig.                                    #Fig.9&10
```

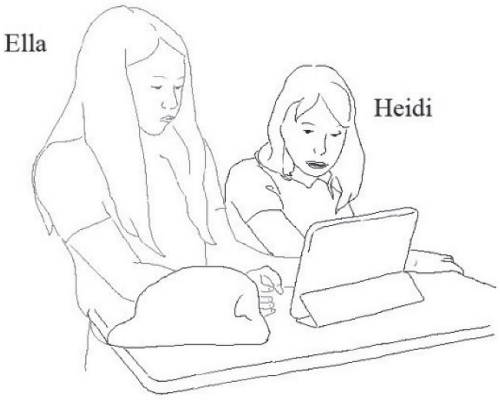

Figure 9. Participants gaze at device.

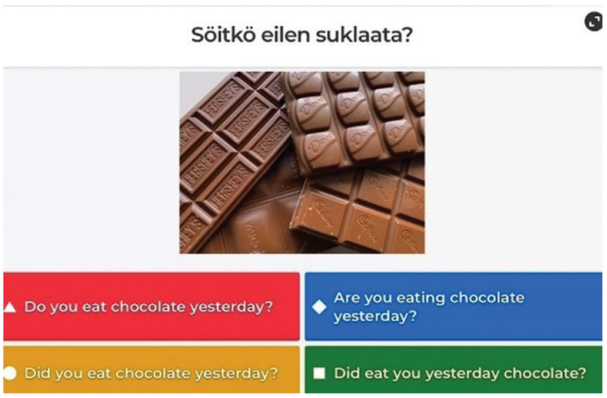

Figure 10. Answer options.

```
2                (1.9)÷(0.7)÷ (.)        ÷(0.6)
     ella             ÷.....÷taps screen÷

3    Heidi       @do you eat@►
     tablet                   ►sound for incorrect answer

4                (.)÷►
     ella           ÷,,,->
     tablet          ►answer marked incorrect,
                      correct answer shown

5    Heidi       chocolate÷ yester-÷
     ella                  ->÷adjusts posture÷

6                (1.0)÷*(0.2)♥(0.2)*
     ella             ÷adjusts posture->
     heidiG          ->*...........*to ella->
     heidiF                   ♥smiles, eyes half-closed->

7                #(0.5)*♥
     heidiG          ->*to tablet->
     heidiF           ->♥
     fig.        #Fig.11

8    Heidi       n%ii.♥
                 yeah
     ellaF        %smiles->>
     heidiF           ♥presses lips together->

9                (0.3)#(0.3)♥*(0.3)*
     heidiF                ->♥upper lip rolled up on teeth->>
     heidiG                 ->*.....*up->
     fig.             #Fig.12
```

Figure 11. Heidi gazes at Ella.

Figure 12. Heidi presses lips together.

```
10   Ella        (no ku ÷mä) (xx)=
                 (well cause I)
     ella             ->÷taps 'next´->

11               =(näh÷*ny sieltä)*(.)(ku-)
                  (see there)           (cause)
     ella          ->÷
     heidiG         ->*to tablet--*right->>
```

Heidi's candidate translation is followed by a gap (l. 2), during which Ella picks the answer *Do you eat chocolate yesterday?* While Heidi aligns with the choice by beginning to read it aloud (l. 3–5), the application marks the answer incorrect first through a sound (l. 3) and then visually with a cross next to the selected answer and highlighting the correct answer in green (l. 4). Heidi builds on this rejection to perform a blame attribution by shifting her gaze to Ella (Figure 11) and smiling 'smugly' with her eyes half-closed and chin slightly up. The gaze shift becomes particularly relevant in this side-by-side formation (Auer and Zima 2021), indicating trouble (Vänttinen 2022), while the facial expression and the position of her head explicitly assign the blame to Ella. Verbally the attribution includes a short response particle *nii* ('yeah') that is prosodically emphasised and loaded with meaning: it not only underlines the rejection of the answer by the application by aligning with it (cf. VISK 2004, §798) but also reasserts the fact that Heidi provided the correct answer, whereas Ella chose the wrong one (cf. Sorjonen 2001, 197). Heidi also presses her lips together (l. 8–9; Figure 12) and grimaces with her upper lip rolled up on her teeth (l. 9), displaying annoyance or disappointment.

In response to the application signalling the mistake, and potentially to seeing Heidi's embodied expression from her peripheral vision, Ella smiles (l. 8) and accounts for the mistake by referring to not having seen, most likely, the correct option (l. 10). The account together with the smile function in two ways: acknowledging Ella's responsibility for the mistake while also mitigating it. Simultaneously, Ella presses the 'next' button, prioritising task progression. Interestingly, the pupils do not establish mutual gaze, which enables Ella to avoid further confrontation. It also ostensibly shows how the interactional space gets modified when Heidi orients towards Ella to blame her, whereas Ella continues to focus on the device.

Our final example, Extract 5 illustrates a blame attribution realised as an embodied extreme-case expression through a notably extensive variety of resources. In a 4th grade lesson, Ellen and Fiona are playing a Kahoot! on a single tablet computer. They are shown hidden pictures of animals that are revealed piece by piece, and they need to pick the right English name for each out of four alternatives (Figure 13). Ellen is handling the tablet, holding it on Fiona's desk with the screen facing herself. Fiona is on her knees on a chair, leaning over the desk to have visual access to the screen (Figure 14).

Extract 5.

```
1    Ellen      [mikä? ]#
                 what

2    Fiona      [toi on]# •kotka,
                 that is an eagle
     fionaG     >>on tablet->
     ellenG     >>on tablet->
     ellen                •taps 'a hen'->
     tablet     >>piece of hidden picture shown->
     fig.                 #Fig.13&14
```

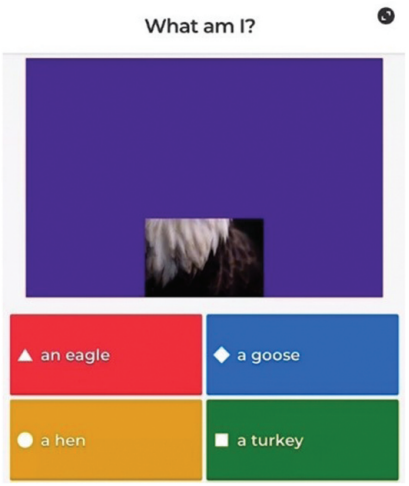

Figure 13. Hidden picture on screen.

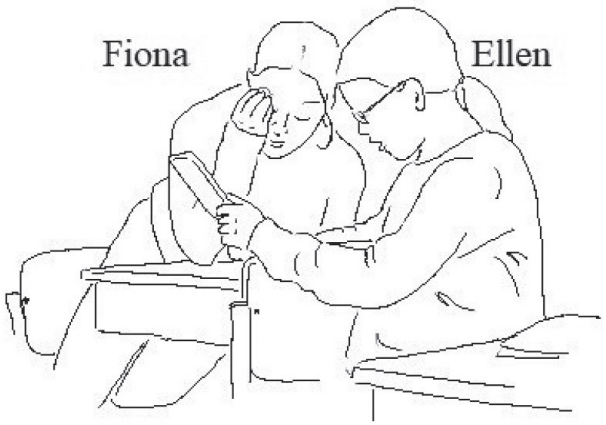

Figure 14. Participants gaze at device.

```
3                  (0.2)►•(0.2)±
     ellen           ->•
     tablet        ->►2nd piece of picture revealed

4    Ellen         ei► oo ku-
                   no it's not but-
     tablet          ►picture of an eagle revealed

5                  (0.2)

6    Ellen         mi↑tä!♥►
                   what
     ellenF              ♥mouth open, frowns->
     tablet               ►answer marked incorrect

7                  (0.4)÷(0.3)
     fiona               ÷straightens back->

8    Fiona         ↑KOT÷KA;=
                   eagle
     Fiona           ->÷pounds at desk 4 times with fist
                       in rhythm with talk->

9                  =#MÄÄ SA÷NOIN ÷ETTÄ♥ se oli=
                    I said        that it was
     fiona               ->÷.....÷rests arms on desk->
     ellenF                        ->♥lips pressed together->
     fig.           #Fig.15

10                 =÷↑KOT+♥KA;      ÷%•#
                      an eagle
     fiona          ÷nods in rhythm÷
     fionaG            ->+to ellen->
     ellenF             ->♥smiles->
     fionaF                        %mouth open->
     ellen                          •taps 'next'->
     fig.                           #Fig.16
```

Figure 15. Fiona pounds desk with fist.

Figure 16. Fiona gazes at Ellen with open mouth.

```
11                (0.4) •(0.4)►(0.3)+(0.4)+ •(0.3)%      •
     ellenF         ->♥grimaces->
     ellen           ->•shrugs, shakes head•taps 'next'•
     fionaG                      ->+.....+to tablet->
     fionaF                                      ->%
     tablet                  ►scoreboard appears

11   Fiona        oikeesti el♥[len virtanen.      ]♠
                  seriously ellen virtanen

12   Ellen                    ♥[ei se meitä► tapa.]♠
                                it won't kill us
     ellenF                ->♥
     miloG                                          ♠...->
     tablet                                  ►new question

13                (0.2)♠(0.1)
     miloG          ->♠to fiona->

14   Fiona        ↑TAP+PAA!=
                   yes it will ((lit. 'kills'))
     fionaG         ->+toward milo->

15                =↑YKS+♠*♥•        ÷VÄÄ*  ♥•RI=
                    one incorrect
     fionaG          ->+to tablet->
     miloG            ->♠
     ellenG            ->*left---------*to tablet->>
     ellenF               ♥raised eyebrows♥smiles->>
     ellen                 •shrugs---------•
     fiona                          ÷pounds fist on desk->

16                =ja KAIKKI ME+nee pieleen%+
                   and everything goes wrong
     fionaG                    ->+toward milo-+...->
     fionaF                                %smiles->

17                (0.5)÷+
     fiona             ÷pounds fist on desk->
     fionaG           ->+to tablet->>

18   Fiona        el►le:n ÷(.)% ä•
                  ellen (.)    uh
     fiona              ->÷
     fionaF                ->%
     ellen                       •taps 'a cow'->
     tablet        ►piece of hidden picture revealed

19                (.)•
     ellen         ->•
```

```
20   Fiona     lehmä;►
               cow
     tablet          ►picture of a cow revealed
```

The mistake occurs when Ellen presses the option *a hen* (l. 2–3) and verbally rejects (l. 4) Fiona's candidate answer ('an eagle'; l. 2). The mistake is revealed as a picture of an eagle appears on screen (l. 4). Ellen displays her surprise through a response cry, or a surprise token (Wilkinson and Kitzinger 2006), *mitä!* ('what'), and by frowning with her mouth open (see e.g. Heath et al. 2012) as the answer is marked incorrect (l. 6). After a short gap and staring at the device, Fiona produces a highly marked blame attribution (l. 7–11). Verbally the turn is designed to underline her having offered the correct answer (*mää sanoin*, 'I said'), which Ellen rejected. The embodied extreme-case expression is manifested in the lamination of several embodied resources: the changes in body posture (l. 7 and 9), the raised volume and higher pitch of voice (l. 8–10), the pounding on the desk (l. 8 and 9; Figure 15), the gaze shift and sustained gaze to Ellen (l. 10–11), the nods emphasising each syllable in the word *kotka* ('eagle'; l. 10), and the wide open mouth displaying disbelief (l. 10–11; Figure 16). Fiona's embodied actions signal a strong emotional reaction and display the urgency of accounting for the mistake. She orients away from the game, giving priority to finding the 'guilty' party. She thus modifies the interactional space, as they move from a shared focus on the device to only Ellen orienting to it, while Fiona's attention shifts to Ellen and dealing with the mistake.

Ellen's embodied response in the form of a smile (l. 10), a mischievous grimace (l. 11), a shrug, and headshakes (l. 11) downgrades the gravity of the mistake. By maintaining her gaze on the tablet and pressing 'next' (l. 10–11), she displays a continued orientation to the game and resists taking the blame. Consequently, Fiona expands the blaming sequence, more explicitly allocating the blame by uttering *oikeesti* ('seriously') and Ellen's whole name (l. 11). In overlap, Ellen further downplays the situation by stating 'it won't kill' them (l. 12), which Fiona objects to (l. 14–16). Interestingly, Fiona glances at another student close by and starts smiling at the end of her turn (l. 16), as if to mitigate the otherwise emotional turn or to add a humorous aspect to it for overhearers. Nevertheless, she once more pounds her fist on the desk (l. 17) and repeats Ellen's name (l. 18). Ellen's persistent focus on the game finally defuses the situation: when a piece of another hidden picture appears on screen (l. 18), Fiona offers a candidate answer (l. 20).

Again, the application's rejection of the answer enables the blamer to avoid announcing the mistake as this is visible to both participants on the screen. Fiona produces the blame attribution by verbally referring to the correct answer she had given and by implying the perpetrator and the severity of the mistake through embodied conduct. The downplay of the situation by Ellen and her disregard for their roles as team members lead to an expansion of the blaming sequence by Fiona. In this way, Extract 5 differs from Extracts 2–4, where the blamed participant displays an orientation to having made a mistake.

While the blame attributions in Extracts 3 to 5 differ in terms of their force, they share some important characteristics. First, they involve an intertwinement of the embodied with the technological in that the notifications of mistakes by the application are used as

parts of the blaming sequence, whereby explicit verbal reports of mistakes become unnecessary. Second, they are formed as combinations of verbal formulations that do not directly attribute blame and embodied resources, which are tailored according to each context. Action formation relies on gaze shifts, facial expressions, and tone of voice, for instance, with gestures and movements of the head and body emphasising the conveyed message. Finally, the conduct of the blamed participant affects the organisation of the blaming sequence: accepting the blame and accounting for the mistake result in a quicker closure (Extracts 3–4) whereas downplaying the situation may lead to bolder actions and sequence expansions (Extract 5).

4. Discussion and conclusion

This study has investigated blame attributions in classroom peer interactions during digital collaborative tasks. We have used multimodal conversation analysis to elaborate on the structure of blamings suggested by Pomerantz (1978), illustrating their context-sensitive and multimodal nature. We have shown that blame attributions can be produced immediately after the 'unhappy incident' (cf. Atkinson and Drew 1979; Evaldsson 2007; Pomerantz 1978), and more importantly, that rejections of answers by digital applications can be built on by participants to attribute blame for a mistake without verbally announcing that mistake. This has been highlighted in the analysis of the two types of blame attributions found in the data. The first are the few cases where blame is attributed to a participant before the digital application rejects an answer and where, consequently, the attribution is verbally direct and involves fewer embodied resources. The main data set, on the other hand, consists of verbally indirect blame attributions where action formation and ascription rely more on embodied resources and the digital notification of a mistake by the application. The visibility of the 'unhappy incident' (Pomerantz 1978) to all participants, then, renders an explicit verbal report redundant. The digital therefore becomes a powerful resource for the maintenance of social cohesion – the participants avoid having to explicitly announce the mistake and who is to blame for it since the application has already indicated the mistake.

The findings contribute to conversation analytic research investigating interaction among children. It is in line with such studies as M. H. Goodwin (1983) and Church (2009) that have shown the unmitigated and bold nature of children's disagreements. In addition, however, we have offered new insights into how this boldness results from a lamination of varied multimodal resources (C. Goodwin 2013) rather than from direct verbal actions. Moreover, we have shown that children's blame attributions can also be mitigated: in particular, the verbally explicit blame attributions in the data were rather mild and mitigated, perhaps to avoid confrontation (Extract 2).

By exploring blaming sequences during technology-supported tasks, the study has shed light on the role of the digital in social interaction. It has revealed how the dualism between the digital and the physical becomes blurred, and how the actions on screen are treated by participants as interactional resources, seamlessly intertwining with talk, embodiment, and material resources. Thus, the merging of the embodied and the digital as a 'phygital' entity can 'make possible new kinds of meaning-making processes' (Due and Toft 2021, 14), but not only in the form of single actions but also on the sequential level, where verbal, embodied, and digital actions alternate and co-occur. In this way, the

participants harness the affordances of technology as resources for action formation in context-sensitive ways.

In addition to highlighting the role of technology as a resource, the analysis has revealed the relevance of blamings for managing the moral order of the classroom (see also Evaldsson 2016; Niemi and Bateman 2015). A key issue impacting the interactions in the data is the pupils' shared responsibility as team members, particularly when they orient to tasks as competition against others. The shared as well as the individual responsibility of each participant for their actions (including mistakes) can be alluded to in the dynamic, local tailoring of blame attributions: milder, mitigated attributions occur after participants accidentally choose incorrect options (Extract 2) or when team members agree on the answer (Extract 3), whereas individuals' faulty actions that result from ignoring a peer's suggestion can lead to multimodally bolder blame attributions (Extracts 4 and 5). Furthermore, while mobile devices only afford haptic access to one person at a time, whereby that participant becomes responsible for answering on behalf of the team, it does not eliminate the need to negotiate joint decisions. This is visible in the aggravated blame attributions that occur when negotiation has been ignored. Similarly, if a pupil downplays the mistake and resists taking the blame (Extract 5), the blame attribution tends to be expanded, whereby the existing interactional space is also remodified. Finally, even though the orientation to the games as competition may be a reason for why the blaming sequences tend to be resolved quickly – since the participants prioritise completing the tasks – the game-like nature of the tasks may also make questions of responsibility and blame relevant.

Overall, our study has investigated blame attributions in a hitherto unexplored context, namely that of collaborative digital tasks in EFL classrooms. It has provided new insights into the multimodal accomplishment of attributions of responsibility and how their design may be built on digital actions. It has therefore significantly contributed to our understanding of blaming as an interactional phenomenon, particularly in a classroom context with young learners. Moreover, while the study has shown that pupils can creatively use technology as a resource for peer interaction, it has also revealed how collaborating on a device not originally designed for teamwork in classrooms can lead to intricate negotiations of rights and responsibilities – issues that future research on classroom interaction needs to investigate in more detail.

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Appendix

The conventions for transcribing participants' talk and embodiment (see e.g., Mondada 2022).

.	final falling intonation
,	continuing intonation
;	slightly falling intonation
?	interrogative intonation
!	animated speech tone
↑	rising intonation
↓	falling intonation
hhh	outbreath
.hhh	inbreath
what	word emphasis
>what<	speech that is quicker than the surrounding talk
<what>	speech that is slower than the surrounding talk
WHAT	speech that is louder than the surrounding talk
wha:t	prolonged vowel or consonant
wha-	cut-off word
(what)	uncertain hearing
[what]	overlapping talk
=	no break between utterances or units of talk
((incorrect))	transcriber's comments
(1.5)	silence in seconds
(.)	micro pause
*•♥+%÷	Each participant in an extract is assigned a symbol. The symbol in a line of talk indicates the beginning/end of a focal embodied action that is explained underneath the line for talk.
ellenG	Gaze of the participant is marked in this line.
ellenF	Facial expressions of the participant are marked in this line
ellen	Other embodied actions of the participant are marked in this line.
-> ->	Action continues across subsequent lines until the same symbol is reached.
>>	Action begins before the beginning of the extract.
->>	Action continues after the extract ends.
. . .	Action's preparation.
~	Action's retraction.
#	Indicates the temporal placement of a figure in a line of talk.