Exploring the Transactional Distance in Two Remote Teaching and Learning Environments of K–12 Students: The Balancing Art of Interaction

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An increasing number of K–12 students are being offered distance and remote teaching alternatives. As digital technology enables education to reach greater physical distances, to more students, and evolve into various instructional forms, it raises questions about the consistency between different distance and remote teaching modalities in terms of student learning experiences and the role of instructors. In this study, students' perceptions of the psychosocial environment are analyzed using transactional distance (TD) as a theoretical lens to understand their perceptions of closeness and/or distance in a remote teaching and learning environment. Qualitative and quantitative (descriptive) data were collected using a survey based on What Is Happening In this Class (WIHIC) and the Learning Climate Questionnaire (LCQ). The data represent 271 students (73% response rate) from 25 schools and 44 classrooms. Results show that aspects of TD vary between the learning environments, leading to various design issues for distance and remote teachers to consider. A prominent contribution is that challenges faced in the field of distance education are not solely technical in nature. While students' evaluations of technology may be quite similar, it is the interaction and perceived accessibility in the learning environment that significantly influence the learning experience. Based on the results, it is also concluded that survey could be used to strategically evaluate TD with the potential to develop remote teaching and learning practices in schools.

INTRODUCTION

Urbanization, advancement of digital technologies, and more recently the global COVID-19 pandemic has resulted in a variety of new ways for teachers to teach and learners to learn in distance and remote forms (Barbour 2022; Pettersson, 2013). The explosive development of distance and remote education is also a reminder to continue to reflect on the relationship between humans, technology, and education. As digital technology enables education to reach out to a wide range of students, in various forms and with different instructional designs, it raises questions about the differences between digital solutions as it comes to student learning experiences and the role of instructors. The challenge of integrating technology and education is how to align students' learning needs with diverse teaching methods and learning environments (Barbour, 2019; Billmyer et al., 2020). This includes for example teacher presence (From et al., 2020; Lin & Zheng, 2015), facilitator support (Borup et al., 2019; Oviatt et al., 2018; Siljebo & Pettersson, 2022), social engagement (Bergdahl & Hietajärvi, 2022), interaction and dialogue (Borup et al., 2013; Johnston et al., 2014). However, most studies have focused on teachers' experience (Lin & Zheng, 2015), and less on how K–12 students' perceptions of remote teaching and learning could contribute to the design of supportive digital learning environments (Borup et al., 2019; Borup & Stevens, 2017; Harvey et al., 2014; Lindfors & Pettersson, 2021; Toppin & Toppin, 2015).

In this study, we focus on how students understand the psychosocial learning environment in two types of remote teaching and learning environments. Students' perceptions of the psychosocial learning environment, including how they experience and perceive interactions and relationships between actors, content, and environment (cf. Borup et al., 2017; Kuo et al., 2014; Lin et al., 2017; Yilmaz & Keser, 2017), have in previous studies served as a significant predictor of positive student achievement, attitudes, and satisfaction in these environments (Ekwunife-Orakwue & Teng, 2014; Wengrowicz, 2014). In the analysis, we will use transactional distance (TD) as a theoretical lens (see Moore, 1993, 2018) with the potential to address the issue of communication gaps in remote teaching and learning environments (cf. Murphy, 2008; Swart & MacLeod, 2021; Yilmaz & Keser, 2017). With this backdrop, the aim of this study is to explore students' perceptions of TD in remote teaching and learning environments. Following research questions are posted:

  • How do aspects of TD relate to students' perceptions of the psychosocial climate in the two remote teaching and learning environments?

In this study, we focus on the two most frequently used remote teaching and learning environments in Swedish K–12 schools. In both environments, all students are enrolled in traditional schooling but have, for various

reasons, one or two lessons per week with a distance teacher (compare Barbour, 2018; Lindfors & Pettersson, 2021). In the first remote classroom, students participate together (10–15 students) from their physical classroom, with a facilitator in the room and a teacher teaching them synchronously via a video-conference system. In the other classroom, two to four students from different schools participate and communicate with the teacher and other students using their personal laptops. An on-site facilitator is available in or near their room, and a teacher teaches synchronously from a distance.

Previous Research

In studies of remote teaching and learning practices, teachers are often positioned as key players for developing teaching and learning environments that include sound and supportive relationships, communication, structures, and support (Borup, 2018; Stenman & Pettersson, 2019). Teachers need to design for meaningful interactions and pedagogical solutions that promote students' motivation and sense of community (Huang et al., 2016; Sevnarayan, 2022). In these cases, students' perceptions and experiences of the psychosocial learning environment have proven helpful for teachers to understand more clearly the types of interaction, structure, and support that students need (Yilmaz & Keser, 2017).

Interaction and dialogue in remote teaching and learning environments

Those studies focusing on students' perceptions have shown that the psychosocial learning environment is important for student achievement, attitudes, and satisfaction (cf. Ekwunife-Orakwue & Teng, 2014; Wengrowicz, 2014). Functional interactions between actors in the remote environment is one such example. Researchers argue that the quality of student–student, student–teacher, and student–content interactions influence students' learning and satisfaction (cf. Borup et al., 2013; Ekwunife-Orakwue & Teng, 2014; Kuo et al., 2014; Lin et al., 2017; Yilmaz & Keser, 2017). In their study, Borup et al. (2013) argued that student–student interaction and peer-to-peer learning enhanced students' grades. To enhance the quality of student–student interaction and peer-to-peer learning, Johnston et al. (2014) found three important variables: (a) students' ability to interact/participate in peer-to-peer learning, (b) the design of the digitally mediated learning environment, and (c) the social and pedagogical context in which teacher, students, and facilitators are included. From another perspective, Lindfors and Pettersson (2021) argued that students need to "learn how to learn" in remote teaching environments and that teachers need to design the learning environment in a way that enables students to learn and interact with peers from a distance (see also Lowes & Lin, 2015). Furthermore, Bouhnik and Marcus (2006) stated that student–teacher interaction leads to more

effective interaction with the content. However, as Borup et al. (2019) stated, this interaction in digital learning environments can be seen as quite demanding because it requires the teacher's clear online presence and the students' extensive involvement in course facilitation. All in all, the various interaction types are interdependent and the relationship between them is somewhat complex and context dependent.

According to several studies, relationships in digitally mediated environments often take longer to develop and require active student participation (cf. Velasquez et al., 2013), and researchers have conducted few studies to explore the development of various types of interaction in these digital K–12 contexts (Lin et al., 2017).

Support from teacher and on-site facilitator

As many researchers have expressed, teachers hold an important role in students' learning and satisfaction. As Giossos et al. (2009) suggested, student satisfaction can be seen as the production of teachers' actions as input into a system mediated by dialogue, structure, and learner autonomy. Therefore, the interpersonal teacher–student relationship and the mediating relationship between students and educational materials regarding the content are important to consider (Lindfors & Pettersson, 2021). Another important aspect is the help and support from and interaction with the on-site facilitator (Borup, 2018; Borup et al., 2019; Hendrix & Degner, 2016). The on-site facilitator is believed to be important for building a suitable learning climate and encouraging interactions between actors in remote teaching environments (Siljebo & Pettersson, 2022; Skog, 2022). Borup et al. (2019) stated, for example, "Students were largely positive when describing the support from their on-site facilitators, students were split and more critical of the support (or the lack of support) from their online teacher" (p. 253). In a similar study, Oviatt et al. (2018) showed that although teachers were available to help students, many students appeared to turn to local teachers/staff for support. Although researchers have studied on-site and online facilitators in these environments, they have concluded that knowledge is limited regarding "students' perceptions when examining student support in programs that offer students an online teacher and an on-site facilitator" (Borup, et al., 2019, p. 254; see also Borup, 2018).

Structure and classroom conditions

Another aspect discussed in the research is that local and digital context varies between classrooms (Barbour, 2022; Hilli & Åkerfeldt, 2020; Pettersson & Hjelm, 2020). It has been discussed that a challenge for the research field is that "studies vary greatly in terms of both contexts and instructional models" and that "more research conducted in a wider array of learning contexts is needed if K-12 online learning is to be properly understood"

(Lin et al., 2017, p. 731). Factors such as group size, teachers' and students' locations, access to digital devices, synchronous or asynchronous communication, and online or on-site facilitator result in different affordances and constraints for teachers and students to consider (Skog, Pettersson & From, 2024). Barbour (2022) and Åkerfeldt et al. (2022) described this in terms of various classroom environments, for example, students grouped in the same classroom, students separated in groups, and students separated from each other, meaning that all communication is mediated by digital technologies. Understanding how these affordances and constraints influence the possibilities for student interaction, learning, and satisfaction is put forth as important for teachers to understand and consider when designing for remote teaching (Hilli & Åkerfeldt, 2020).

Many studies have shown that how students perform in school is related to their perceptions of the psychosocial climate in the classroom (Chionh & Fraser, 2009). The results show that students learn better if they experience their classroom environment as favourable and supportive in terms of teacher–student interaction because it increases students' achievement and level of satisfaction (Kingir et al., 2013). In other words, students who experience positive and caring relationships with effective communication in such an environment are more involved and engaged in their own learning process (Shernoff et al., 2016). Overall, the teacher is a central part of the learning climate that is created in the classroom, which will, for example, influence and support the students' perceived autonomy and the interpersonal relationships in the classroom (Black & Deci, 2000).

Theory of Transactional Distance

This study is underpinned by the well-established interactionist theory of TD, which Moore (1993) developed in the context of a fast-changing technological environment and remains one of the major pedagogical theories and influential concepts in online learning, distance education, and remote teaching. The perception of TD concerns the psychological and communication gap that may cause misunderstandings between teachers, students, and the content elements in various spaces, which in turn is constantly changing depending on the situational environment (cf. Huang et al., 2016). Since then, the theory has been further developed to include the physical, cognitive, social, psychological, and behavioral distance the learner perceives. The extent of TD is a function of the three elements: dialogue, structure, and learner autonomy (Moore, 1993; Moore & Kearsley, 2011).

According to Ekwunifeet al. (2014), four core types of interactions can occur in the classroom, which are embedded in the constructions of TD elements (dialogue, structure, and learner autonomy). Moore (1989) initially described the first three interactions. The first and most important interaction takes place *between students and content*, which is the main purpose of

education, in which the goal is to increase knowledge and skills. The second interaction takes place during the interaction *between teacher and student*, in which one of the teacher's tasks is to facilitate the student's interaction with the content to increase learning. The third interaction takes place *between students*, where they learn from each other while, for example, working in groups. Hillman et al. (1994) later added the fourth interaction for online learning due to the addition of high-tech communication systems. It addresses the extent to which content/material distribution systems are user friendly and accessible. This interaction takes place *between students and technology interface*, which concerns how well the individual student (or teacher) can navigate in the digital learning environment and with the online tools available. The technology interface has been assumed to be the key in understanding how TD relates to students' satisfaction with the learning experience because it is a mediating element in all interactions, which means that other interactions will to some extent depend on students' abilities to engage successfully with technology (Hillman et al., 1994).

Researchers have conducted few empirical studies to validate and operationalize the theory in practice, and more such studies have been requested to verify the relationships between the three elements in which the perspective of analysis is the students' (Goel et al., 2012). It has also been suggested that environmental factors and students' demographic attributes affect the perceived TD (Huang et al., 2015).

The concept of *dialogue* refers to the mutual interaction or set of teacher–learner interactions that is purposeful and constructive in nature and enhances the student's learning process. According to Goel et al. (2012), dialogue seems to be the foundational element in the theory of TD to achieve results in digital learning environments. Students need an interactive, constructive learning environment so that the co-construction of knowledge can be promoted as well as flexibility so that the individual needs and results in the learning processes can be met. Regarding the development of remote teaching and learning that provides several opportunities for interaction for students, dialogue now often includes not only the interaction between teachers and students in the actual learning environments but also the learning relationships/interactions that take place between students (Benson & Samarawickrema, 2009). In sum, more dialogue tends to decrease the perception of TD and plays a central role in achieving learning outcomes.

Structure conveys the flexibility of course design, including the course objectives, organization of tools, relevant assessments, content for individualization, and suitable instructional designs (Moore, 1993). It comprises how students respond to the technology interface and the content. TD tends to increase with more structure because it reduces the amount of flexibility for students to take command of their learning process as well as the opportunities for dialogue. This results in less effectiveness in learning, and thus lower level of student satisfaction. However, less structure does not automatically indicate reduced TD.

Finally, Moore (1993) explained that *learner autonomy* is "the extent to which in the teaching/learning relationship it is the learner rather than the teacher who determines the goals, the learning experiences, and the evaluation decisions of the learning programme" (pp. 26–27), that is, the degree of students' abilities to determine their learning goals, experiences, and evaluation. According to Moore (2018), autonomous learners find it easier to deal with lower levels of dialogue and structure along with a perception of a high TD. Learner-autonomy support from teachers is a key element in fostering positive outcomes in academic settings and is defined as students' perceptions of the extent to which their teacher makes them feel confident in their abilities and felt understood, listened to, and accepted (Su & Reeve, 2011; Williams & Deci, 1996). In other words, the degree to which the teacher facilitates a classroom environment that promotes learner autonomy. The autonomy-support behaviours teachers provide are meant to nurture students' internal motivational resources in terms of strengthening their sense of empowerment and self-control in their learning processes (Cheon et al., 2019). Lerners' autonomy is promoted if they are given the freedom to determine their behaviour and feel that the lessons are meaningful to them. Autonomy-supporting behaviours from the teacher can include, for example, listening to what students have to say about their learning processes, communicating empathy to students, acknowledging their perspective, encouraging active participation and independent work, and providing social rewards for positive behaviours (Su & Reeve, 2011).

Furthermore, students' perceptions of TD are likely to differ and involve an intricate interplay between the environment, students' behavioral patterns, experience, cultural background, and level of education (Gavrilis et al., 2020; Moore, 1993). In other words, there is no general TD, but it is generally inversely proportional to the dialogue and communication that takes place between teacher and student and proportional to the course structure and the students' perceived degree of autonomy in their learning process (Benson & Samarawickrema, 2009; Moore & Kearsley, 2005). It is important to note that perceived TD can also occur in a traditional face-to-face classroom and is then dependent on the teacher's and students' characteristics (Moore, 1993). However, TD can be considered more problematic and magnified in remote teaching environments because students are often more physically isolated and may therefore feel demotivated (Swart & MacLeod, 2021). Collaboration, interaction, and knowledge sharing between teacher-student and student-student are challenged when the lack of face-to-face interaction is a fact in learning situations that are no longer limited to physical space. In addition to a perceived TD due to geographical distance, it can also be a pedagogical distance, which can depend on the course structure's design and flexibility and how they correspond to the students' levels

of autonomy. Furthermore, the perceived distance can be psychological in nature, which then relates to how the students perceive how much the teacher is available or disengaged (level of dialogue) and to students' academic self-efficacy assessments.

Methods

Context of remote teaching and learning in Sweden

In Sweden, K–12 remote teaching is allowed in specific subjects (theoretical subjects in Grades 7–9 and modern languages, mother tongue tuition, and study guidance in Grades 1–6) in those cases in which certified teachers are not available or when the student base is so limited for a particular school unit that regular teaching leads to significant organizational or financial difficulties for the principal. The Swedish Educational Act regulates remote teaching. According to the regulation, remote teaching must (a) be conducted synchronously (students and teachers are separated in physical space but not by time), (b) be organized with students located in premises that school units have at their disposal (it is not possible for students to receive regular education from home), and (c) have a facilitator in the same room as the students.

Remote teachers have the same tasks as teachers in local education. Remote teachers must, like other teachers, collaborate with the teacher team, parents, school principals, and student health whenever needed. The on-site facilitator must be present in the same physical room as the students and ensure that students have a good and calm work environment. Just like a teacher in regular education, the on-site facilitator can temporarily leave the room to pick up learning materials or guide students to the library, etc. The on-site facilitator can also assist the remote teacher in the teaching and contribute to high quality in the communication between teachers and students. There are no special eligibility requirements for on-site facilitators, but they should, according to the regulation, be a person suitable for the task and someone used to work with children and students.

Two classroom environments

In this study, we focus on the two most frequently used remote classroom environments for language learning in Swedish K–12 schools. In the first remote classroom, the class sizes vary between 10 and 15 students. Students are in their physical classroom with an on-facilitator in the room and a teacher at a distance, teaching them synchronously via a video-conference system. The teacher is projected on the big screen in front of the class. Students have opportunities to interact with the teacher on the big screen or with their personal laptops used during lessons.

In the other remote classroom, the class sizes are small, often containing two to four students, who participate either from the same or different schools in the municipality. An on-site facilitator is available in or near their rooms, and the teacher is teaching synchronously at a distance. Students participate and communicate with the teacher and peers through a personal laptop.

Participants

Data in this study was collected in one region in northern Sweden. The area is 62,600 km2 in size and has a population of approximately 47,772 people. Municipalities range from 2500 to 12000 citizens and many of them are challenged by decreased birthrate due to increased urbanization. The region is also characterized by small school units, long distances between schools, and lack of certified teachers. The joint municipal challenges have contributed to collaboration and partnership in the region. One example is the development of remote teaching in which students receive one to three lectures a week remotely.

For this study, all students in the region taking language classes remotely during the school year were invited to respond to the online self-report survey with both opened- and close-ended questions. Students were 12 to 16 years old (grade 6 to 9). The survey was deployed and responded by students from February through March 2021. The data represent 271 students (73% response rate) from 25 schools and 44 classrooms. Before deploying the questionnaire, parents and students were given written information about the general aim of the survey and were informed that data, on group level, would be used for research. We did not include participants' names, schools, or other personal characteristics in the data. We also assured them that we would handle the data to protect their privacy. They participated voluntarily, and we provided no compensation.

Collecting data

This study employed a mixed-methods approach, with data acquired and analyzed using both quantitative and qualitative methodologies. The rationale for utilizing a mixed technique was to triangulate both quantitative and qualitative data, consistent with the triangulation procedure described by Creswell & Creswell (2017). In learning environments research, combining quantitative and qualitative data gathering methodologies has been promoted and employed successfully (Aldridge et al. 1999; Tobin and Fraser 1998). Therefore, open-ended questions were employed to help to substantiate and embellish the findings based on the quantitative data. A Swedish adaption of the two surveys What Is Happening In this Class (WIHIC) questionnaire by Fraser et al. (1996), and the Learning Climate Questionnaire (Williams & Deci, 1996) was used to descriptively and in qualitative man-

ner assess students' perceptions of their learning environment. The WIHIC is a multidimensional survey which covers broad areas in educational assessment and evaluation that include several interactions between students and their teachers. It has been used across several subject areas, various grade levels, and technology in education in multiple countries (e.g., Charalampous & Kokkinos, 2017; Fraser & Raaflaub, 2013). The Learning Climate Questionnaire (LCQ, Williams & Deci, 1996) was developed to assess autonomy-supportive structures. Specifically, it examines students' perceptions of the extent to which their teachers provide a classroom environment that promotes autonomy in them. With inspiration from WIHIC and LCQ, questions were asked about students' experiences of teacher support, involvement in their own learning process, task orientation, cooperation with others and degree of autonomy.

The survey included five dimensions: teacher support, involvement, task orientation, cooperation, and autonomy support.

Table 1

Five Dimensions Included in the Survey

Subscale	Description
Teacher support (WIHIC)	The degree to which students perceive that their teacher relates to, helps, and is interested in them.
Involvement (WIHIC)	The degree to which students have attentive interest, participate in learning activities, do additional work, and enjoy the class
Task Orientation (WIHIC)	The degree to which it is vital for students to complete planned activities and stay on to the subject matter.
Cooperation (WIHIC)	The degree to which students cooperate with and learn from each other rather than compete with one another in learning tasks.
Autonomy support (LCQ)	The degree to which students perceive that their teacher support students' autonomy in the classroom.

Note. The survey consisted of 24 positively worded statements rated on a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree) as well as three open-ended questions.

Analysing free-response answers

Before we conducted the analysis, we manually processed all answers (N = 546) from the three open-ended questions in a data cleaning procedure. Nonsense statements such as "???," "I don't know," "I don't really care," and "Bla bla bla" were removed from the data set. After the data cleaning procedure, 408 statements (344 from modern language and 64 for mother tongue tuition) remained for a thematic analysis. Using the data analysis program NVivo, statements were read several times. Statements code names, such as support, dialogue, interaction, technology, and structure. As a next step, we combined codes into themes and analysed them again. We merged some themes (support, dialogue, and communication) and split others in two. For example, interaction was divided into teacher–student and student–student interaction. This process resulted in four subthemes: (a) clarity and structure (student–content interaction); (b) support, dialogue, and communication (student–teacher interaction); (c) interaction between the students; and (d) interaction between student/teacher and the technology interface. For a deeper understanding of students' perceptions of their psychosocial environment, a meta-analysis was conducted by comparing and combining results from the analysis of statements (average of subscales and items) and free-response answers.

RESULTS

In this section, results from the items and free-response answers are presented. It is noteworthy that all students rated items relatively high in both classrooms. It is also notable that students' answers are relatively homogeneous within the classes and teaching environments (i.e., the answers rarely stand out from the average).

Table 2
Average of Subscale and Items for the Large Classroom

Subscale	Item	Average
Teacher support Average 3.77	The teacher helps me when I have trouble with the work.	4.02
	The teacher is interested in my problems.	3.94
	The teacher checks in with me.	3.59
	The teacher's questions help me understand.	3.57
	The teacher helps me when I have technical problems	3.55
Involvement Average 3.34	I discuss ideas in class.	3.43
	I give my opinions during class discussions.	3.19
	I ask the teacher questions.	3.4
Task Orientation Average 3.89	Getting a certain amount of work done is important to me.	4.05
	I know the goals for this class.	3.64
	I am ready to start this class according to the schedule.	3.9
	I pay attention during this class.	3.95
Cooperation Average 3.88	When I work in groups in this class, there is teamwork.	4.07
	I work with other students in this class.	3.82
	I cooperate with other students when doing assignment work.	3.76
Autonomy support Average 3.5	My teacher makes sure there is a good working climate in the classroom.	3.53
	If I do not know what to do during the lesson, my teacher will see it and come and help me.	3.46
	If I do not work during the lesson, the teacher helps me get started.	3.64
	My teacher makes sure that I learn what I am supposed to during the lessons.	3.53
	I feel that my teacher provides me choices and options.	3.31
	I feel understood by my teacher.	3.53
	My teacher encourages me to ask questions	3.05
	My on-site facilitator makes sure there is a good working climate in the classroom.	3.79
	If I do not know what to do during the lesson, my on-site facilitator will see it and come and help me.	3.76

In the large classroom, students rated task orientation and cooperation between students highest. Students cooperated to a large extent in these classrooms, and when they do cooperate, there seems to be teamwork. The students rated autonomy support, aspects of making one's choices, and being encouraged to ask the teacher questions lower. Compared to the small classroom, the on-site facilitator holds an important role for students' autonomy.

Table 3
Average Subscale and Items for the Small Classroom

Subscale	Item	Average
Teacher support Average 4.68	The teacher helps me when I have trouble with the work.	4.8
	The teacher is interested in my problems.	4.73
	The teacher checks in with me.	4.68
	The teacher's questions help me understand.	4.65
	The teacher helps me when I have technical problems	4.54
Involvement Average 4.29	I discuss ideas in class.	4.5
	I give my opinions during class discussions.	4.16
	I ask the teacher questions.	4.22
Task Orientation Average 4.46	Getting a certain amount of work done is important to me.	4.38
	I know the goals for this class.	4.38
	I am ready to start this class according to the schedule.	4.54
	I pay attention during this class.	4.6
Cooperation Average 3.5	When I work in groups in this class, there is teamwork.	3.86
	I work with other students in this class.	3.06
	I cooperate with other students when doing assignment work.	3.59
Autonomy Support Average 4.1	My teacher ensures there is a good working climate in the classroom.	4.54
	If I do not know what to do during the lesson, my teacher will see it and come help me.	4.62
	If I do not work during the class, my teacher helps me get started.	4.6
	My teacher ensures that I learn what I am supposed to learn during the lessons.	4.54
	I feel that my teacher provides me choices and options.	4.14
	I feel my teacher understands me.	4.54
	My teacher encourages me to ask questions	4.41
	My on-site facilitator ensures there is a good working climate in the classroom.	3.22
	If I do not know what to do during the lesson, my on-site facilitator will see it and come help me.	2.53

In the small classroom, students rated teacher support and task orientation very high. They rated cooperation among students in the classroom lower. The statements convey that students work with other students to a smaller extent but when they do work together, there is teamwork. Compared to the teacher, the on-site facilitator holds a less important role for autonomy in this classroom.

Results from free-response answers

The following sections present subthemes generated from the analysis of students' free-response answers, namely (a) clarity and structure (student–content interaction); (b) support, dialogue, and communication (student–teacher interaction); (c) interaction between the students; and (d) interaction between student/teacher and the technology interface. These subthemes are then combined with the results from the three predetermined subscales in the survey: (1) teacher support, (2) cooperation and involvement, and (3) task orientation and autonomy support. Data presented in Table 4 provides an overview of the main themes identified from the analysis of free-response answers, aligned with the corresponding survey subcategories. It highlights the average ratings from the survey for both small and large classrooms, illustrating how the students' qualitative feedback supports and complements the quantitative findings. This combined approach offers a better understanding of the students' experiences in different classroom environments.

Table 4
Integration of Survey Ratings and Free-Response Feedback

Free-Response Theme	Survey Subcategory	Small Classroom Rating (from Survey)	Large Classroom Rating (from Survey)	Combined Insights
Clarity and Structure	Task Orientation and Autonomy Support	Task Orientation: 4.46 Autonomy Support: 4.1	Task Orientation: 3.89 Autonomy Support: 3.5	Small classrooms value clear structure and benefit from well-planned lessons and autonomy, while large classrooms struggle with both structure and autonomy due to working climate.
Support, Dialogue, and Communication	Teacher Support	4.68	3.77	Small classrooms benefit from teacher availability; large classrooms need more physical presence. Both value digital communication.
Interaction between Students	Cooperation and Involvement	Cooperation: 3.5 Involvement: 4.25	Cooperation: 3.88 Involvement: 3.78	In small classrooms, student-teacher interaction is prominent, while large classrooms encourage community and group collaboration, with higher cooperation and frequent group work compared to small classrooms.
Interaction between Student and the Technology Interface	N/A	N/A	N/A	Technology aids learning but can cause issues. Small classrooms value digital materials, large classrooms appreciate teacher interaction through technology.

Clarity and structure (student–content interaction)

This subtheme includes students' opportunities to understand and interact with the content. In the small classroom, the students rated task orientation (4.46) and autonomy support (4.1) very high. In the free-response statements, students stated, *"It is very easy to follow and keep track, which makes it easier for me to learn", "everything I need is on the computer"* and *"it works very well when everything is well planned"*. When the working climate is good, students can keep working with tasks and assignments and the teacher is available when students need guidance. In this classroom, students rated the on-site facilitator's role lowest for students' sense of autonomy support. The teacher seems to be the one checking in with the students and ensuring there is a sound working climate.

In the large classroom, the students rated task orientation (3.89) high. For example, students stated, *"The teacher explains what is to be done during lessons," "I know what I should do during lessons, and I do my best to get the work done"* and, *"The instructions are clear. If we don't understand we get further instructions"*. Regarding autonomy support, the students rated their opportunities to make choices during lessons a bit lower (3.5). Having several students means that the learning climate can be problematic sometimes: *"A better working climate would help me to concentrate and hear what the teacher says"* and *"A better working climate would make it easier to concentrate on my schoolwork and what to do during lessons."* The on-site facilitator holds an important role for students' sense of autonomy. They monitor the working climate and check in with students when they need help.

In sum, the students perceive clarity, structure, and their sense of interaction with the content as quite similar in the two remote teaching and learning environments. What differentiates them is how they perceive the importance of the on-site facilitator versus the teacher's role in interacting with the content.

Support, dialogue, and communication (student–teacher interaction)

This subtheme includes aspects influencing the interaction between the teacher and students. Students highly value teacher support (4.68) in the small-classroom environment. The teacher is constantly availability, and students experience a good communication climate. Based on the teacher's instructions, it is easy to understand and follow the lesson's aims. Furthermore, students experience many opportunities to speak if they want to and to show off their abilities and knowledge to the teacher. Due to support and the supportive working atmosphere, students can also think for themselves in peace and quiet: *"What works best is that I can find better work peace through remote learning"*.

In the large classroom, students' experience of teacher support (3.77) is somewhat lower. Many students believe that it would be better if the teacher were in the classroom, walking around, and obtaining a better overview of class: *"I wish that the teacher could be here to come help me by my desk"*. However, students appreciate opportunities to ask the teacher questions either on the big screen or in a more discreet way through the chat function: *"I don't feel as singled out when I can communicate with the teacher in writing instead of raising hand and speaking in front of everyone."* Free-response answers also show that the on-site facilitator contributes to a suitable learning climate and facilitates the dialogue between the teacher and students, for example by walking around the classroom, seeing when students need help when the teacher does not see it, and helping students be in contact with the teacher.

In sum, the results show that interaction and support from the teacher is important in both environments. However, in the large classroom, the on-site facilitator holds an important role in facilitating the interaction between the teacher and students and creating a suitable learning climate in class.

Interaction between students

This subtheme includes aspects of interaction between students in the classroom. In the small-classroom environment, students experience very high involvement (4.25) regarding discussing and giving their opinions in class. However, they rated cooperation between students lower (3.5). Therefore, involvement seems mainly based on communication between the student and teacher rather than a student and another student. Students mean they often have other students in the classroom, but tasks and assignments seem not developed to encourage cooperation between students, and it seems easier to turn to the teacher for help. However, in those cases when students work together, it works very well. Some also argues, *"I would like to have someone to work with"* and, *"More cooperation is needed for the possibility to train and discuss"*.

In the large classroom, students experience involvement (3.78) and cooperation (3.88) between each other relatively frequently. In free-response answers, students argued, *"We have a strong sense of community"* and stated that they *"get help from the other students in class"*. In this classroom environment, students are in the same physical room, and many of them describe a high amount of group work: *"As we sit in tables of four, we can help each other"*. They also stated, *"Due to group assignments, I have possibilities to talk a lot and learn from the others"*. Some students also argued for less student work.

In sum, differences exist in how students interact with each other in the two classroom environments. Students seem to turn to each other when in the same physical classroom, and when they are not, they would rather turn to the teacher.

Interaction between student and the technology interface

This subtheme includes aspects of how well the individual students (or teachers) can navigate in the digital learning environment and the tools available. In the small classroom, students appreciate using digital materials: *"I don't need to bring all the learning materials with me each lesson,"* and *"Everything [learning materials] can be found on the computer."* However, the students also experience difficulties with the technology interface. For some languages, there are no keyboards with the correct alphabet. In addition, students use technology to interact with their peers. The technology is a mediating element in all interactions, meaning that the students need to know how to engage with and feel comfortable engaging with technology.

According to students in the large-classroom environment, using technology facilitates interactions with the teacher when they are trying to help and supports students' learning processes: *"It is easier for the teacher to see what we have done/are not doing when using Teams [the learning platform]." "When writing in documents, my teacher can see it directly."* However, the technology interface is also what immediately influences lessons in cases of bad sound, slow internet connection, and other technology problems. Students also appreciate possibilities to ask for help and communicate with teachers in private instead of raising their hands in front of the entire class: *"Writing questions to the teacher in the chat function have worked very well."*

DISCUSSION

There has been increased emphasis on the use of K–12 distance and remote teaching in research, practice, and educational reforms (Barbour, 2022; Billmyer et al., 2020). As digital technology enables education to evolve into various instructional forms, it raises questions about the consistency between different distance and remote teaching modalities in terms of student learning experiences, the role of instructors and facilitators. A prominent contribution of this study is that the challenges faced in the field of distance education are not solely technical in nature. While students' evaluations of technology may be quite similar, it is the interaction and perceived accessibility in the learning environment that significantly influence the learning experience. Thus, this study enlightens us to pay greater attention to psychosocial aspects, particularly in terms of course design and delivery. Some of these aspects are discussed below.

The role of technology

Previous studies have established a link between students' achievement in school and their perceptions of the psychosocial learning environment (cf. Lin et al., 2017; Yilmaz & Keser, 2017). Students who experience positive relationships with teachers and peers are for example more involved and engaged in the classroom environment (Shernoff et al., 2016), which in turn decreases their perceived TD (Yilmaz & Keser, 2017). However, as also put forth is that distance and remote teaching and learning changes the fundamental nature of interaction among students, teacher, and content when being digitally mediated (Lindfors & Pettersson, 2021; Siljebo, 2023). Thus, a consensus revealed in this and other studies, is that regardless of learning environment, the interaction between the students and the technology interface including well-functioning technology is essential and yet primary for the quality of all other forms of interaction. As revealed in this study, this includes technologies for many different types of interaction and communication, such as verbally in class but also through more discreet solutions, such as using chat or learning platforms during class (see also Siljebo & Pettersson, 2022).

Designs for collaboration and interaction

In this study, the *interaction between student and content* are high and the perceptions of suitable structure indicate extensive interaction between students and content in both learning environments. Both student groups appreciate the *teacher–student interaction*, including teachers' strategies tailored to ascertain clarity and effectiveness in the learning environments. However, there are two main differences between the two learning environments: the aim and meaning of the on-site facilitator and the interaction between students.

In the large-classroom environment, the on-site facilitator seems very important for reducing the sense of TD by helping teachers support students and facilitate interaction and dialogue between *students and the teacher*. The on-site facilitator is in the classroom during the lesson, checks in with students, makes note of when students struggle with tasks, and helps the teacher and students keep in touch during lessons (in comparison, see Borup et al., 2019). The facilitating role is often described in research but is more seldom studied as a key player for reducing TD during lessons, and it is not studied much as a key player for students' learning, satisfaction, and sense of community (Borup, 2018; Borup et al., 2019; Siljebo & Pettersson, 2022). This actor's role varies between schools and countries as well as their location in the classroom with students, nearby the classroom, in the school building, as part of school administration, online, and so on

and therefore with different responsibilities for students' learning environments (cf. Borup, 2018; Hendrix & Degner, 2016). Due to the central but fragmented understanding of this actor, a desirable future research focus would be, for example, studies on on-site facilitators' various roles; how the teacher and on-site facilitator collaborate; how they interact before, during, and after lessons; and how those aspects influence TD. Borup (2018) argued for more research to understand better how the relation and collaboration between the teacher and on-site facilitator influence students' learning environment and sense of community.

The other difference between the two learning environments is the *interaction and collaboration between students*. Compared to the large classroom, students in the small classroom are often separated from each other and use technologies to communicate. Teachers included in this study have much experience in planning and designing for remote teaching and learning. However, students lack paths and structures for collaboration, or they may not feel comfortable collaborating and discussing when not sitting in the same physical room, meaning that the teacher becomes the students' natural "learning buddy." The teacher taking on such a role has advantages and disadvantages. One advantage, for example, is that the students feel that the teacher sees them and their learning capacity, and as a result, they feel they get the help they need; however, they do not have opportunities to collaborate and talk with other students (for comparison, see Lin et al., 2017). In addition, Swart and MacLeod (2021) stated that TD can be considered more problematic in remote teaching and learning environments because students are often more physically isolated and therefore may feel demotivated. For the teacher, this means a greater focus on creating conditions in the learning environment that promote the students' cooperation through careful and well-thought-out choices regarding teaching strategies and lesson content. In turn, this can lead to increased learning, a higher degree of autonomy, and a greater sense of belonging among the students. Important tasks for future teachers, regardless of the teaching environment, are to educate and teach students to navigate in a digital teaching environment, give students tools for an increased autonomy in their own learning as well as and give students knowledge about how to socialize and cooperate with others in these environments. These can be considered important skills for the students' futures based on the current rapid digital societal development. This is critical, especially in these environments, as autonomous learners have been shown to find it easier to manage lower levels of dialogue and structure along with a perception of a high TD (Moore, 2018).

Implications for practice

Even though the findings in this study are based on a limited amount of data, it is possible to elaborate on implications for practitioners, policymakers, and other stakeholders in the field. *First*, new technologies have made it possible to enable teaching and learning from various locations, but these alone do not bring about changes in teaching and learning themselves. As mentioned earlier, the challenges and opportunities do not lie in the technical aspects but in the development of educational and psychosocial aspects of learning experiences. This is an important insight that stakeholders and politicians should be aware of when making plans, budgets, and strategies for developing remote teaching in school and education.

Second, remote teaching and learning is a broad concept (and practice) in the sense that classroom characteristics can vary in class size, access to technologies, physical placement of teachers, students, and facilitators, and much more, which impact on the very nature of TD. It is also very different from traditional classroom teaching as new roles and new interactions appear. From this point of view, it is crucial for teachers to be trained and supported before, during and after the processes of developing course designs that reduces students' sense of TD. One concrete suggestion is to use an evaluation tool (in this case WIHIC and LCQ) that can help teachers and school leaders to understand their students' perceptions of TD. Evaluation of students' perceptions of TD can enable teachers and school leaders to strategically develop remote teaching practices.

Third, it will be crucial for school leaders and school organizations to analyze existing and required competences and resources (staff, technology etc.) and subsequently reallocate them for designing, conducting, and supporting sustainable development of remote teaching and learning. Remote teaching is complex since it influences and is influenced by various roles and tasks in school. Therefore, it needs to be seen as an organizational assignment where there is a shared responsibility.

Fourth, given the study's findings combined with the explosion of distance and remote teaching practices in Sweden and worldwide, it is essential to develop specific strategies for teacher training in online and distance engagement. Today, many, if not to say most of the universities in Sweden lack formal training in digital and online teaching, thus leaving many student teachers unprepared for the reality in school.

CONCLUSION, LIMITATIONS AND FUTURE RESEARCH

A prominent contribution of this study is that the challenges faced in the field of distance education are not solely technical in nature. While students' evaluations of technology may be quite similar, it is the interaction and perceived accessibility in the learning environment that significantly influence

the learning experience. Thus, an important contribution to distance education is the attention to psychosocial aspects. For example, this study advances our understanding of TD in the specific context of K-12 remote learning and offers a quantitative tool to strategically evaluate TD and potentially develop remote teaching and learning practices in schools.

For future research, more advanced statistical analyses are necessary for a better understanding of students' perceptions of remote teaching and learning contexts. The analysis in this paper is of descriptive character. Statistical analyses of basic demographic such as student gender, grade level, family background, etc. could contribute to in-depth knowledge in this field.

Data Availability Statement

Data is collected, managed, and analyzed in accordance with GDPR. The datasets generated and analysed during the current study are not publicly available, this is due to securing the participants anonymity. Meta data are available from the corresponding author on reasonable request.

DECLARATIONS

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