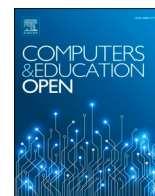**ELSEVIER**

Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Seven educational affordances of virtual classrooms

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ABSTRACT

For many teachers, the COVID-19 pandemic meant an instant shift from teaching in traditional to a virtual classroom to reduce the spread of infection. It represents a widespread and intensive case of digitalization of teaching practice and many stakeholders are asking the imminent question of which transformations that 'will stick' and become a constant in the 'new normal' onwards. However, research of online teaching in a high school context remains limited. In this study, we analyze what happens when teaching is redirected from the traditional to the virtual classroom and explore what characterizes educational affordances in the virtual classroom. The context is 15 high schools in Sweden and the empirical data includes a survey with a total of 1109 teachers. Educational affordances are used as an analytic lens to conceptualize what teaching activities that the virtual classroom afford. The main contribution includes theorizing about what activities, interactions, and procedures that the virtual classroom affords by presenting seven educational affordances and contrast these with teaching in traditional classrooms. The affordances consist of (1) Structure (2) One-to-one communication (3) Formalized reconciliations (4) Peace and quiet (5) Hidden back channels (6) Right time and (7) Reaches certain students. The seven affordances can make a foundation for reflection and discussions of how to create a didactic design adapted for different classrooms. Furthermore, we contribute with implications to teachers and school leaders.

1. Introduction

1.1. Problem statement and purpose

The COVID-19 pandemic shattered everyday life as we know it and disrupted the global school landscape. For many teachers, it meant a shift from teaching in traditional to a virtual classroom, and teachers were faced with a transition that was both immediate and full-scale. It meant a new type of teaching and learning environment with other logics for communicating, collaborating, and "being" [27]. While most higher education institutions have been offering distance education for a long time it does not constitute a mainstream element in elementary school, middle school, and high school context [31]. Thus, while the digitization of schools has been an active topic on the political agenda for decades, the question has rather been about how to intensify digitization within brick and mortar schools [1,40]. However, as of COVID-19, and the radical transformation of schooling, there is a pending question of what lessons have been made and which transformations that 'will stick' and become a constant in the 'new normal' after the obvious threats of the pandemic subsided [39]. In Sweden, new

regulations from July 1st, 2021, enable the expanded use of remote teaching in elementary school, middle school, and high school contexts, regardless of crisis but as a response to the shortage of qualified teachers. This raises many questions about the effects on education. Moreover, it raises questions about affordances concerning remote teaching and the move from the traditional classroom to the virtual classroom. By affordances, we mean the emergent and perceived potential for action in a specific environment [19]. The concept centers around the way that the potential for action is perceived, between a human actor and technology, and affordances outline the way that the action potential is actualized [35]. This study aims to analyze teaching and learning that are redirected from the traditional to the virtual classroom. It includes examining different perspectives on affordances from teachers' perspectives. The research question is as follows: *What characterizes educational affordances in the virtual classroom?*

1.2. Emergency remote teaching and the virtual classroom: a review

With the outbreak of COVID-19, there has been a surge of research that explores the sudden and widespread application of online teaching

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and learning in different schools, often using the terminology 'Emergency Remote Teaching'. Hodges et al. [23] describe the difference between online learning and emergency remote teaching and state that the main difference is the length of the planning phase. In online learning, as soon as the decision to go online has been taken, the preparation time starts. However, for emergency remote teaching, the preparation time is, in most cases non-existing and the state of chaos is overarching [6]. Furthermore, emergency remote teaching usually entails a temporary move online, while the decision for online learning, taken for non-emergency situations, usually is a lasting or permanent move to an online environment [6,23]. Benito et al. [7] analyze the level of satisfaction that people perceive through online learning during the pandemic. The results show that although the general view is that most are satisfied with learning online during extreme situations, there is a lower engagement level to be found for students in the virtual classroom in general. Moreover, Lopez Flores et al [41] analyze the swift move online and find that study patterns change significantly for students in higher education and show through click-logs that students are not shifting between subjects, but instead study each subject in a more focused manner, before moving over to the next subject, i.e., students are multi-tasking less. The long-term effects of these changes on students remain to be seen and some studies suggest that the sensible way forward, is through a blended learning environment. Furthermore, there is a stream of literature that has studied teachers' experiences. Kaden [25] shows that the transition brings an increased change and workload for the teacher. Willermark and Gellerstedt [42] explored teachers' experiences of interaction in the virtual classroom and draw a multifaceted picture of interaction that involves both increased and reduced contact with, and control over, the students and their activities. Whalen [38] studied teachers' experience during the crisis and identify an important variation in teachers' readiness to use technology to teach and facilitate learning in virtual classrooms. Although some have studied the effects on teachers and the teaching, the literature that focuses on the learning aspect and the students' perceptions is vaster.

In a historical sense, the concept of a ' virtual classroom' is not new. The concept originated from Hiltz [43] to describe a teaching and learning environment that did not have to be built of bricks and boards but could be constructed in software. Hiltz [43] reported on a research project that explored and evaluated new teaching methods, based on computer support for collaborative learning in academic courses. Already initially, theories were formulated that with the point of departure that the virtual environment brings new ways of communicating and acting. For example, Hiltz [43] argued that the virtual, unlike the traditional, classroom promotes active learning, collaboration, and communication . Today, different forms of distance education constitute an everyday element, which is integrated into higher education and although online learning platforms initially were designed for distance courses it is now also used as a complement to traditional teaching. Thus, the distinction between 'virtual' and 'traditional' is no longer as distinct (Bergmann and Sams, 2012; Willermark [45] ;Willermark and Pareto [44,50]).

The research interest in the virtual classroom has continued to be relevant and instances of the virtual classroom have been researched under various terms including distance education, online learning, emergency remote teaching within a higher education context. Common arguments put forward for online learning includes reducing the time and costs for travel, offering students flexibility, and increasing opportunities to collaborate with professionals globally [16]. The disadvantages that are often stressed include troublesome feelings of isolation, and technology gaps [11].

In a recent literature review, Castro and Tumibay [11] explore the efficacy of online learning courses in a higher education context. In their work, they highlight that many studies have been carried out that compared online learning with the traditional classroom by exploring the efficacy of learning outcome and student satisfaction which shows that online learning is at least as effective as teaching in a traditional classroom. Furthermore, the authors summarize the state-of-the-art as the most promising approaches to cultivating learning in online environments includes structured online discussions with clear guidelines and express expectations and continuous teacher engagement with personalized, timely, and formative feedback [11]. While their findings are truly relevant, there is a difference between the educational contexts and that focus on the educational affordances derived from a complex mix of tools and teaching configurations for teachers, in high schools. This paper targets that gap in the literature, through a focus on the way the virtual classroom setting affords certain teaching activities over others, from teachers' perspectives.

2. Theoretical framing

The increased digitalization of schools affords new teaching and learning activities. More specifically, these new activities enable new ways of interaction and communication extended to new behaviors ,[30, 37,48]. Furthermore, the digitalization, and recent move online, not only affords new teaching and learning activities but can be seen as behavioral channeling. The concept centers around the perceived potential for action, between a human actor and technology, and affordances outline that action potential, and how it is actualized Islind et al [35,36,46]. The concept originates from Gibson's seminal work where he describes the features of natural environments which are perceptible by animals, to actualize specific behavior [19]. Additionally, the concept entails both good or evil potential for action, and because of the complexity of interactions between humans and technology of various kinds, the concept has evolved into a central lens for understanding the difference between the digital, and the analog and the interactions with humans ([10,46]. Affordances do not determine specific behavior, but instead shape the potentials of channeling specific behavior towards action [15,47]. The discussion of whether affordances exist on their own, or if they are actualized through interactions of a human actor, and the technology at hand, has existed in the literature since Gibson's influential work was originally published. Our standpoint is that affordances do not exist on their own, instead, they are dependent on the relational element between a human actor, and the technology and we convey affordances as this aforementioned potential for action, which emergences through interactions.

Affordances in an educational setting, and especially in the virtual classroom can be understood through the specifics of educational affordances. In a recent study by Harris et al. [22], they provide empirical evidence about how one school's distance education teachers define and support engagement. On a similar note, a study by Ames et al. [2] explores teachers' perspectives regarding their use of technological tools to support their students' learning via focus groups. They find that technology-assisted teaching assists not only the teaching practice but also provides a foundation for relationship building with students and families and illustrates these relationship changes through the lens of affordances [2]. Although both studies provide relevant in-depth evidence about engagement, there is a need for large-scale studies that illustrate the affordances of the virtual classroom on a larger scale. Educational affordances have been explored through the different potential for action that is enabled, depending on the educational technology at hand [3,17]. For instance, chalk in comparison to multi-colored whiteboard markers enables different potentials for action when teaching [8,13]. The relationship is bidirectional, the teacher can use these tools in different ways and the tool enables a variety of use cases. Likewise, the technology enables a variety of interactions with other tools, like a whiteboard [12]. Although these examples are simple, the embeddedness of their meaning in educational settings, through more complex examples, makes the interaction with educational technology far from simple [18,24]. Moreover, when moving towards the difference between analog and digital technology, an analog calculator in comparison to a digital calculator enables different interaction patterns [14]. The digital calculator is located in a mobile phone, and there

the complexity arises. Similarly, a digital writing tool differs from the potential for action that arises from interactions with an analog writing pad and the digital writing tool is a part of a set of tools [21]. The affordances that arise in interactions between a human actor, and digital educational tools, are opaque and multifaceted [5], and to unpack the change in the teachers' practice that has been triggered by the recent move online, we will use the lens of affordances. Furthermore, we outline seven affordances that are specific to the virtual classroom, and these affordances, are derived from the potential for action in the virtual classroom, between a specific teacher and a specific type of technology. Consequently, we use these affordances, to detect and contrast teaching in the traditional classroom.

3. Method

On Tuesday 17 March 2020, the Swedish government announces that high schools would conduct their teaching exclusively at a distance, starting the following day, as part of an attempt to reduce the spread of COVID-19. The decision was based on recommendations from the Swedish Public Health Agency. On 29 May 2020 the Minister of Education announced that from 15 June 2020, schools should return to teach in a brick-and-mortar school, to close again in December 2020 due to the increased spread of infection. This study explores teachers' experiences from the first period of transition to virtual classrooms. Sweden has a long history of initiatives linked to the digitalization of schools, over 40 years have passed since the first major Swedish government investment in the 'computerization' of schools and since then, many state and local initiatives have been initiated. The Swedish education system is one of the most digitalized in the European Union. Most schools have 1:1 i.e., that is one computer (or tablet) per student. At the same time, there are major differences in terms of equipment and the use of digital technology both within and between schools [44](. Based on this knowledge, a strategic selection was applied aiming at gaining breadth and spread among different schools across Sweden to analyze teaching and learning that are redirected from the traditional to the virtual classroom. The empirical data, utilized for this paper, consists of a teacher survey that contains both fixed and open-ended response types, enabling both quantitative and qualitative analysis [9,20,28]. In this way, we have been able to explore what characterizes educational affordances in the virtual classroom through a breadth of data, which represents different contexts including different teaching conditions, experiences, and subjects. At the same time, we did not want to anticipate the answers but let teachers, in their own words, describe their experiences why qualitative data and qualitative analyzes came to be the most important source of data. An online survey was distributed to a total of 2536 teachers at 15 high schools in Sweden, during weeks 20–22 in 2020. The questionnaire was accompanied by a letter explaining the purpose of the questionnaire, how long it would be available, that participation was voluntary and an estimate of time for completion. A total of 1109 of the teachers responded to the survey with a response rate of 43%. The respondents were scattered across the country, from both metropolitan and sparsely populated areas, representing both practical and theoretically oriented schools and teachers with varying teaching experiences. The questionnaire aimed to examine teachers' experiences, thoughts, and lessons learned from the shift to virtual classrooms. It included a background question of within which school organization the teacher worked and 14 questions where teachers were asked to share their experiences from teaching in a virtual context. Of these, six questions were of particular interest to capture the affordance of teaching in a virtual classroom;

(1) In summary, how do you feel that teaching in the virtual classroom has worked?
(2) How do you perceive the technology you needed to teach in the virtual classroom has worked?

(3) How do you perceive the contact with the students who have worked in the virtual classroom?
(4) How do you perceive your opportunities to give students the support needed in the virtual classroom?
(5) How do you perceive students' opportunity to keep up and be active in teaching in the virtual classroom?
(6) How do you perceive that it has worked with students' attendance and meeting deadlines?

In the results section, the quotes from the open-ended options are coded with R (=respondent) and the unique ID (number) of the teacher behind the quote.

The data analysis was divided into three phases (see Fig. 1 for clarification). The data analysis was based on an iterative process where the aim was to alternate between a quantitative analysis on the one hand and qualitative analysis on the other hand [9,28]. All of the phases were carried out to conduct as rich an analysis as possible. Moreover, the aim was to interpret the complex data, iteratively. Below, we elaborate on the three phases.

In the first phase, an initial understanding of the material was formed by compiling fixed answers and reviewing descriptive statistics. Furthermore, the open-ended free-text answers were examined to familiarize ourselves with the data. In this stage, the analysis involved roughly clustering the free text answers to identify different perspectives on teachers' experiences, i.e., different types of problems and opportunities link to, for example, workload, study environment, and examination.

In the second phase, the clustered free-text answers were classified into emerging categorize to identify the occurrence and type of response in a large amount of qualitative data. In this process, we used the analysis software MAXQDA, supporting computer-assisted mixed methods data (See Fig. 2).

In the third phase, we focused on capturing the essence that characterizes the traditional and the virtual classroom based on the established categories. Moreover, in this phase, we used the analytical lens of affordances actively, where we analyzed the categories across the board to extract the affordances of the virtual classroom on the one hand and of the traditional classroom on the other hand. Thus, affordances as an analytical lens emerged from the data.

4. Results

Although the transition to teaching in virtual classrooms was abrupt, most teachers state that the transition went 'very' or 'quite' well (69%). 24% of the teachers state that it has worked out 'OK' while 7% state that it has worked out 'pretty bad' or 'very bad'. Overall, the teachers state that they have learned a variety of new things, both linked to the digital tools used as well as related to planning and structuring teaching activities and related to communication and feedback. At the same time, many describe a highly intense period that is characterized both by a feeling of pride in having handled different situations well, but also a feeling of inadequacy. The teacher's response from the free-text answers included technological functionalities, interaction with students, and the possibilities to provide the student with proper support as well as answers related to students' engagement, attendance, and the ability to meet deadlines, making it possible to analyze aspects of educational

1. Phase
• Exploring descriptive statistics
• Initial clustering free-text responses

2. Phase
• Categorization of free text responses

3. Phase
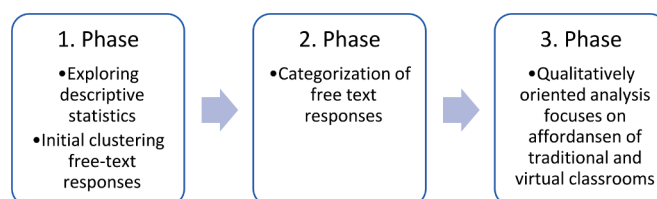• Qualitatively oriented analysis focuses on affordansen of traditional and virtual classrooms

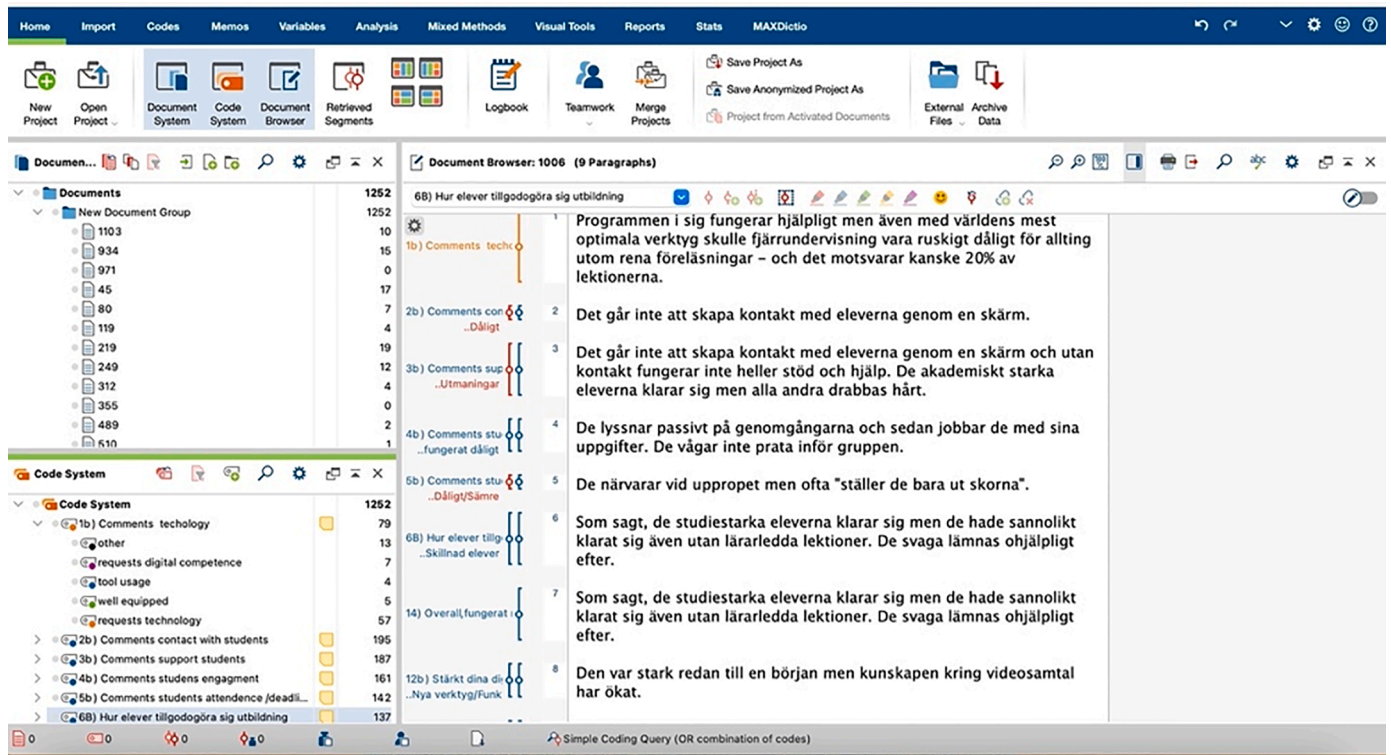**Fig. 1.** Illustration of data analysis.

Fig. 2. Illustration of the free-text coding in MAXQDA.

affordances in the virtual classrooms from teacher's perspective (See Table 1 for an overview of categorization).

The rest of the results is divided into five main themes: (i) the functionality of technology in the virtual classroom; (ii) interactions with students in the virtual classroom; (iii) chances to provide students with support in the virtual classroom; (iv) students' engagement in the virtual classroom and; (v) attendance and deadlines in the virtual classroom.

4.1. The functionality of technology in the virtual classroom

Numerous excerpts include a testimony where teachers feel that they were *well equipped* for the situation when it arose, even though it was

Table 1
Categorization of data.

Categorization of data	
Category	Number of excerpts
The functionality of technology in the virtual classroom	
Well equipped	87
Request for increased digital competence	27
Requests on the technology	260
Interactions with students in the virtual classroom	
Works well	181
Works bad	328
Works different	120
Chances to provide students with support in the virtual classroom	
Opportunities	261
Challenges	372
Students' engagement in the virtual classroom?	
Engagement is good	87
Engagement is bad	161
Differences among students	119
Attendance and deadlines in the virtual classroom	
Good/better	204
Same	115
Bad/Worse	116
Total	**2438**

new to them. In general, the teachers state that they have previously used digital tools to a relatively large extent before the situation arose. A typical statement in this category can be illustrated by: "*The development work we have done in the high school over the past 2 years with a focus on improved digital teaching strategies meant that we were well equipped to adjust to distance education*" (R33). At the same time, several teachers address a '*request for increased digital competence*', to effectively cope with the situation. It includes everything from general digital skills, to learning specific features in the learning platform or help in handling subject-specific software, as illustrated by: "*I'm not very good at technology*" (R1080) or "*I borrowed a writing tablet (Wacom Cintiq 16) and it is very useful in math. Too bad I have not had time to learn to use it and other tools well before. I do not know what is wrong when it is sometimes not possible to write on it but can only solve it by restarting the computer*" (R935). Additionally, many teachers express additional '*requests on the technology*' to implement teaching in the virtual classroom in a wholesome way. It includes both functional hardware and software for the teacher and the students but also access to appropriate digital teaching materials. Furthermore, it includes additional features of frequently used software, which can be illustrated by: "*My computer gets a blues screen from time to time, in the middle of the lessons. It is important to have good computers if you are going to work in a tech and digital way*" (R1098) or "*I lack the power to be able to silence students, I cannot send private messages or create subchannels to talk to individual students*" (R984).

4.2. Interactions with students in the virtual classroom

There is a great deal of variation in the way the teachers report regarding the interaction with the students in the virtual classroom. Some teachers feel that it has worked well or even better than in a traditional classroom, while others feel that it has worked poorly or worse compared to teaching in the traditional classroom. In addition, some statements only describe a changed interaction without making any assessment of it. Excerpts that include testimony about the notion that interactions in the virtual classroom work well often address an

increased attendance among the students, (a prerequisite for interaction) as is illustrated by: "*On the plus side: attendance is better, and the activity is as good or slightly better on average*" (R258) or "[there are] *increased attendance among students during class*" (R509) or "*Some students with long-term school absenteeism have benefited from the distance education*" (R53). Furthermore, teachers' address that the shift to the virtual classroom brings more one-to-one communication, often with short and recurring reconciliations both via video calls, telephone, and via messages, which seem fruitful for the interaction, as illustrated by: "*I find it easier to get in touch one-on-one digitally than in the classroom. Now more students dare to admit that they do not understand when they are in a private forum with me*" (R436) or "*[the interaction is] above my expectations, I get closer to the students in individual conversations compared to a [traditional] classroom. However, this takes both energy and time*" (R562) or "*Better opportunity for individual conversations*" (R896) and "*I have better contact with more students than before*" (R557). To keep the interaction going teaches describe different approaches which include a mixture of the open and closed communication channel at the same time as illustrated by: "*They [students] ask questions in a private comment, but also open in [google] meet and in chat*" (R795) or "*I have developed a system that the students have become accustomed to, a combination of a digital rising hand, a private chat link on the digital board and the google chat function if students want to ask me individual questions*" (R1004).

However, many statements testify that the interaction in the virtual classroom works badly. Reduced contact with many students is highlighted, as illustrated by: "*Some students who have previously shown a lack of attendance have been completely absent due to distance education*" (R470) or "*The students who do not want contact have it far too easy to get away with it. If 'the mic is broken' or 'the internet is not working, then there is not much I can do as a teacher*" (R134). Furthermore, teachers stress the lack of an overview of the class in the virtual classroom followed by bad dynamics, hampering interaction as illustrated by: "*I lose the natural overview that I otherwise have in a [traditional] classroom and it is easy to miss the students who do not ask for help*" (R186) and "*Given the circumstances, it has worked well but it will not be the same quality in discussions because it is difficult to interact dynamically*" (R611). Additionally, teachers describe how the informal communication between the lessons has suffered through the transition to a virtual classroom, as illustrated by: "*It is difficult to get the personal contact and small talk you have during breaks and after class*" (R556). Lastly, some teachers address that the communication in the virtual classroom differs from the traditional classroom. Instead of putting a hand on a shoulder, you send a direct message, and that instead of reading body language, you need to ask questions. They also describe how places such as the corridor and the physical classroom constituted the hub of the traditional school and that these elements have only partly found new forms in the virtual classroom, as illustrated by: "*It becomes a different kind of interaction when it takes place online and more conversations become text-based than before*" (R927) and "*The spontaneous meeting in the corridor, which I would say is the hub of our organization, is completely gone. And very difficult to replace digitally. At the same time, attendance is higher and often very easy to get a hold of students*" (R166).

4.3. Chances to provide students with support in the virtual classroom

Several excerpts address both opportunities and challenges of providing students proper support in the virtual classroom. The teachers repeatedly emphasize that the crucial point is that the students seek support, as illustrated by: "*Those who seek help get it*" (R716) or "*If the student wants, it is easy to give support online*" (R529). It is stressed that the virtual classroom is increasingly flexible and independent of space, as illustrated by: "*An advantage now is that you are always just a [Google] meet away. You do not have to be in the same room, at the same time*" (R668). Thus, even though the teaching in the virtual classroom often centers around synchronous participation in lectures, group work, etc. there is also an increased opportunity to participate in teaching 'on

demand' – a consequence of 'flipped classroom' inspired approaches where teaching material is both being created and shared digitally. It provides increased opportunities for the teachers to follow students' activities, review their progress, and support them when needed as illustrated by: "*Unlike before, I am in the students' digital documents and see, comment and help them directly. During regular teaching, of course, I move around the classroom and then I can ask students how it goes, get a short 'good' answer, to only towards the end of the lesson be able to state that little or nothing has been done*" (R116). Furthermore, the virtual classroom seems to bring increased flexibility in participation and provide the possibility of rehearsing lectures as illustrated by: "*Recorded lessons increase the likelihood that students will take part in the material they need by going back to selected parts*" (R140) or "*I [use] video-recorded lectures so students who need to rehearse or have missed the lesson can catch up*" (R272).

In many cases, teachers make the assessment that students' study peace has increased when teaching and learning in the virtual classroom making students more receptive to support, and that it is generally one of the great treasures of the virtual classroom, as illustrated by: "*They have better study peace and are not disturbed by their classmates in the same way as in the physical classroom at school*" (R860) or "*Students' study peace is much better and my task as a teacher is easier when I do not have to act to create study peace during a lesson session*" (R871) or "*Many, almost all, have appreciated the study peace they received at home when perhaps parents have worked and younger siblings have been in school*" (R1108) and "*It gets harder for the students to disturb each other*" (R438). Additionally, the possibility of one-to-one interaction is also highlighted as a strength in the work of supporting and meeting the needs of the individual student, as illustrated by: "*It is much easier to give individual support to students who want it when I can so clearly focus on one student at a time*" (R3) or "*It is possible to have more controlled and focused conversations individually*" (R97) and "*The support itself has not deteriorated, for some students, it may have become better and more concentrated*" (R1057). However, the teachers also stress a variety of complex challenges that are linked to the chances of providing students with support in the virtual classroom. In contrast to the many teachers who experience that the students get an increased study peace in the virtual classroom, a few teachers highlight that this does not apply to all students, where home conditions may instead lead to poorer study peace in some cases, as illustrated by: "*Some have difficulty achieving peace of mind at home with quarrelsome little siblings and congested internet*" (R517).

Furthermore, the teachers stress the difficulty regarding identifying, approaching and motivating students who need support, as illustrated by: "*It is more difficult because you do not have the opportunity to see for yourself when someone needs help. Now I have rather been left to react when the students sought help*" (R67) and "*For students in need of extra support, it has become more difficult. Many students make themselves uncontactable, which means that the teacher cannot support with simple things that happen in [the traditional] classroom such as get-started-help, extra instructions, keep-going-help, etc.*" (R92) and "*The spontaneous outreach support when walking around the classroom disappears*" (R393). In addition to identifying and getting in touch with students, difficulties in the support situation in the virtual classroom are stressed. Teachers feel limited and left out of options with the digital tools, an aspect which becomes especially visible in practical subjects, as illustrated by: "*[it is] difficult to draw, difficult to show with body language. Words are seldom enough*" (R340) or "*in practical subjects it is extra difficult*" (R890) or "*you completely miss the chance to walk around the classroom, point, and let the students learn with the body. It becomes extra clear that the weak students will suffer from this*" (R248).

4.4. Students' engagement in the virtual classroom

Teachers report various indicators of students' engagement in the virtual classroom. For instance, through initiated questions, traces of activity in the forum, and through student's performance. Examinations

show engagement in the teaching and learning activities. Some teachers state that they perceive a higher degree of activity among the students in the virtual classroom and reason about possible explanations as illustrated by: *"There is higher productivity now than before. Maybe it's because it's the students who sat at the back of the classroom, that now are sitting at the front of the classroom"* (R954) or *"I have several students who perform worse in regular teaching. Maybe it's because their attention is now focused on the screen and there are fewer disturbing moments around them"* (R1091) and *"They are more concentrated, more focused and interrupt each other to a lesser extent"* (R234). At the same time, teachers also report less engagement in the virtual classroom. Teachers experience that they lose spontaneous input from the students, find it more difficult to keep group discussions going, and that students generally become more inactive, as illustrated by: *"The spontaneous conversation during lectures lacks"* (R1067) or *"It is difficult to have good group discussions"* (R782) and *"It will not be the same response as all the students are on a mute and then have to make an effort to say something. It's mostly me as a teacher who talks and then maybe a student asks something. IRL [in real life], there will be a greater dynamic in the classroom where students are involved in a completely different way"* (R389). Furthermore, the teachers also describe that they lack insight into student's engagement in the virtual classroom, as illustrated by: *"I had a hard time determining how active the students really are"* (R467). Lastly, the teachers describe extensive variations in engagement between students, with some seeming to be more engaged while others seem less engaged in the virtual classroom, as illustrated by: *"The commitment varies between students, some concentrate better at home, some completely lose focus"* (R3) or *"It has gotten much better for some students but others, it has been a disaster…"* (R220) and *"No problems at all for the ambitious and the talented, but the low-performing students lag even further behind"* (R491).

4.5. Attendance and deadlines in the virtual classroom

Many teachers state that student's attendance and/or their ability to meet deadlines is better in the virtual classroom, as illustrated by: *"Better than before"* (R176) or *"Attendance was flawless. This is what surprises me the most"* (R1029) or *"I have seen a real increase in attendance, both that the students arrive more on time and that they participate more in lessons"* (R779). Many teachers identify that teaching in the virtual classroom calls for structure and planning in order to be successfully executed. It includes explicit rules of conduct regarding how to communicate, taking turns, etc. in the virtual setting, but also regarding how the lessons are structured, how information is communicated, and how tasks are handled, as illustrated by: *"An even greater clarity in the communication of a lesson plan and its purpose, more structured conversations about challenges with the execution of a task"* (R822) or *"It seems that everything becomes clearer when they can read on the computer, in 'schoolsoft' [the learning management system] unlike when I just provide oral instructions in the classroom"* (R278). However, some teachers state that the situation is the same regardless of whether the teaching is conducted in a traditional or a virtual classroom, i.e., consolidates established patterns; *"The students who usually show up on time and meet deadlines do so even now while the students who previously had difficulty with this issued still struggle"* (R842). Lastly, teachers also provide examples of worse attendance and meeting deadlines as illustrated by: *"There are too many who have slipped out of our hands, especially now that we are approaching the end of the semester. Too many have stopped showing up"* (R218) and *"They have a harder time meeting deadline. This may be because the teaching takes place differently, and it becomes more difficult for the students. Alternatively, it is because the personal responsibility becomes too heavy, and it becomes difficult for the students to work effectively during the lessons"* (R848).

5. Discussion

As stated at the beginning of this paper, the digitalization of schools

brings new activities and behaviors to the teaching and learning situation [30,33]. More specifically, it challenges traditional definitions of a situation, and the way teachers and students are expected to interact and can interact [26,40]. To explore that further, we illustrate the way these interactions change, through characterizing educational affordances in the virtual classroom.

Fig. 3 presents the educational affordances that can be derived from our findings. As stated earlier, we view affordances as the perceived potential for action, between a human actor and technology, and affordances outline that action potential, and how it is actualized [35]. More specifically, affordances in an educational setting, and especially in the virtual classroom can be understood through the specifics of educational affordances, which have been explored through the different potential for action that is enabled and embedded, depending on the educational technology at hand [8,17]. We rely on the vast literature on affordances in general, instead of merely on the literature on educational affordances in particular, due to its scarcity. Based on that notion, in the model below, we contrast the affordances with the educational affordances in the traditional classroom, with a focus on the role of the teacher as a facilitator and a critical actor in both instances of the classroom.

Firstly, in the traditional classroom, there is flexibility to be found. The flexibility relates to the way teaching is conducted, what is taught, and the way teaching elements are intertwined. However, the virtual classroom calls for increased structure, both regarding the way teaching is conducted, and concerning what is being taught. To that extent, several teachers identify that teaching the virtual classroom calls for structure and planning to be fruitful. More specifically it incorporates explicate rules of conduct in the virtual setting, but also how the lessons are structured, how information is communicated, and how tasks are handled.

Secondly, communication in the traditional classroom both affords one-to-one communication as well as one-to-many communication, and so does the virtual classroom. However, many teachers report that the transition to the virtual classroom includes a shift towards individual interactions one-to-one, often with short and recurring reconciliations via video calls, via telephone, or via messages. Related to that, the teachers describe how they see the individual to a larger extent, while at the same time they are missing the overview of the class as a whole.

Thirdly, the traditional classroom affords informal reconciliations which sometimes consists of exchanging a few words or reading body language whereas the virtual classroom affords formalized reconciliations instead, for example by the use of 'entrance ticket', 'hinge question' and 'exit tickets' to get insight into students understanding at an aggregated or individual level and that students report their progression in another way.

Fourth, the traditional classroom provides structure in everyday life, through the schedule, the physical location, lunchtimes, etc. it gives structure to the day as a whole. However, the virtual classroom does not afford the same structure creation but instead (in most cases) affords a study environment characterized by peace and quiet.

Fifth, the traditional classroom affords visible bonding between the students, which also allows for visible exclusion at times, whereas the virtual classroom affords hidden backchannels, making it is impossible to notice what is going on 'behind the screen' for the uninvited. Through the same interaction patterns, it enables cheating.

Sixth, the traditional classroom affords teaching in real-time, where time and place govern the whole situation, while the virtual classroom affords the 'right time'. Right time refers to the fact that the students can watch the lectures (if recorded) when they need them; or take part of the teaching material independent of time and place when they need the content, and at their own pace.

Seventh, both settings, seem to fit certain student groups. Many students can adapt to each situation. However, there is a vulnerable student group that is disadvantaged by teaching and learning in virtual classrooms. The characteristics include reduced activity in school, while for
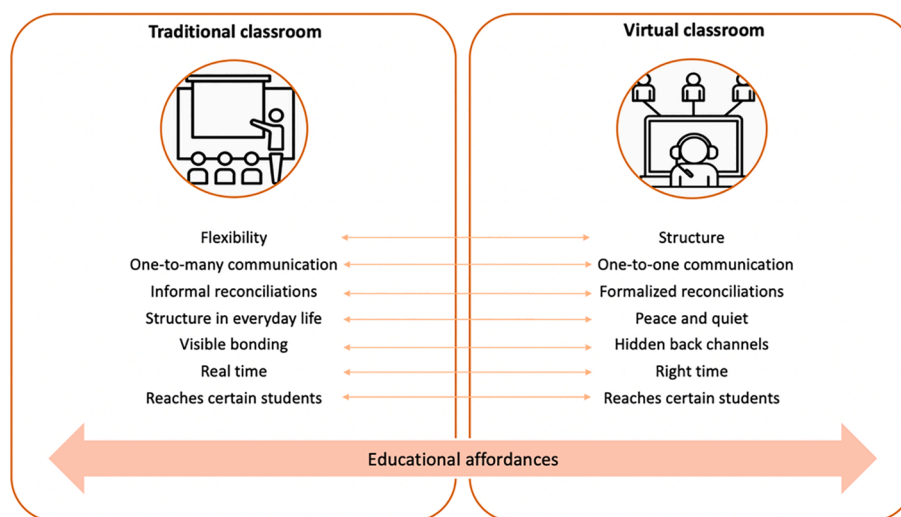
Fig. 3. Educational affordances in the traditional classroom versus virtual classroom.

other students the teaching in the virtual classrooms removes barriers for participation, through increased activity in school. Thus, each of these settings caters to different needs and affords different teaching and learning behaviors, and fits different students although the purpose and activity - teaching and learning are the same.

The respective classroom type raises opportunities, questions, and dilemmas about flexibility versus structure, personal responsibility versus support, while also showing the importance of participation. As we see it, these seven contrasting educational affordances center around the perceived potential for action and the possibility of actualizing them through human technology configurations [35,36,46]. Identifying the affordances of a virtual classroom at an aggregate level is important for raising awareness of how teaching and learning are affected by different environments, in a high school context. In a time marked by an increased political interest in expanding online learning outside the university more and more, educators will be struggling with questions about *if, when,* and *how* a transition from a traditional to a virtual classroom will be fruitful. Knowledge about what characterizes the different classrooms will thus be important when deciding upon delivery type concerning contextual aspects such as class level, student groups and subject. Furthermore, knowledge about what characterizes the different classrooms can also be of importance to navigate in the concrete teaching situation. Accordingly, it means that the teacher can reinforce and benefit from the classroom's characteristics but also curb problems that may arise in the teaching situation. In the virtual classroom, it could include helping bring students structure to everyday life through synchrony's start and endpoint of the school day or promote more spontaneous or informal conversations by setting aside time to meet without an agenda. The opposite also applies, i.e., how to get more elements of structure or 'right time' in the traditional classroom if needed. The seven affordances can construct a foundation for reflection and discussions of how to create a didactic design adapted for different classrooms. Thus, the affordances are not absolute or definitive, instead, teachers increased knowledge means a capability to discern more or refined affordances. The fact that teachers' overall experience of switching to teaching in virtual classrooms has reasonably many and complex answers. As discussed by Willermark [40] the conditions for teaching in the virtual classroom differ among the teachers. Aspects such as the number of students, the class composition, and the subject, condition the teacher's possibilities of action. For example, teachers face different challenges when teaching theoretical versus teaching practical-esthetic subjects in the virtual classroom, where the latter has been shown to require a greater degree of innovation. It is consistent with the findings from a recent OECD report which shows that vocational education, has

faced particular challenges in connection with the pandemic. The report points to difficulties in reaching the practical-oriented parts of the curricula in addition to limited opportunities for work-based learning due to strains engaging apprenticeship places [34]. Such contextual circumstances can hardly be overestimated. At the same time, teachers' different experiences must be understood based on the teacher's different ability to identify the different potential for action that is enabled, depending on the educational technology at hand [3,17]. Since the educational affordances arise in the interactions between a teacher, and digital environment, they are opaque and multifaceted [5].

5. Conclusion

In this study, we have explored what characterizes educational affordances in virtual classrooms based on a detailed analysis of a comprehensive amount of data. 1109 teachers, from 15 high schools in Sweden elaborated on their experiences of teaching in a virtual classroom. The theoretical contribution consists of identifying and discussing seven educational affordances of teaching in virtual classrooms and contrast these with the educational affordances in the traditional classroom. The practical contributions include presenting a framework that can be useful for planning and critical evaluation teaching in a virtual classroom and can be used both on a micro and meso level, to guide others towards an informed decision about what teaching and learning in the virtual classroom afford. The research contribution is of interest to teachers, school leaders, and school organizers striving to advance digitalization in schools.

5.1. Implications to practice

Regarding implications for practice, it is important to consider that different classrooms invite different activities and actions. For *teachers,* it becomes important to actively reflect on which affordances can be uncovered in the virtual classroom to take advantage of opportunities and anticipate problems. The seven affordances presented in this paper could be used as a basis for individual reflection as well as for discussion among colleagues on how to develop teaching in the virtual classroom. For *school leaders*, issues of when and how it is suitable to initiate teaching in virtual classrooms become important. Furthermore, when applying teaching in virtual classrooms it becomes crucial to take a school-wide responsibility to create favorable conditions for teaching in the virtual classroom i.e., strategies and routines for how to conduct examinations in a legally secure manner and bring about the dissemination of good innovations of teaching strategies. Furthermore, issues of

how to compensate for students' different socio economic conditions can be addressed to remove barriers to participation.

5.2. Limitations and future work

The results of this paper are specific in several aspects. First, the data that supports the findings of this paper is gathered in a Swedish school context. Second, the findings are drawn during the global pandemic of COVID-19, which indicates that it was gathered during an extreme situation. Still, the objective of this paper is not to generalize the results to a larger population, nor is it to illustrate normal through the abnormal but instead the aim is to achieve "theoretical generalization" [29] through our educational affordances. As such, the empirical finding illustrated in this study should be understood as theoretical generalization through a qualitative study that illustrates educational affordances through a case in Sweden, instead of being understood as an illustration that can be generalized to the whole population. Instead, the explanatory power of the findings is discussed through theoretical reasoning where we explicate the educational affordances of virtual classrooms and contrast those with the educational affordances that in the traditional classroom. Future work could include validating the main contribution elaborated on in this paper, to other contexts. Additionally, a future area of interest includes exploring affordances of virtual classrooms based on for example demographic data, classroom size, or teaching subject.

Consent to participate

Information on concent of the participants is included in method section of the paper.

Declaration of Competing Interest

Both authors state that there is no conflict of interest to disclose.

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