Teaching and learning how to handle tools and machines in vocational educational workshop sessions

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ABSTRACT
The importance of students developing the knowledge required to handle different tools and machines is specified in the curriculum of vocational education as well as emphasized in research. However, there are very few studies that focus on the learning processes that take place when teachers and students attend to tools and machines as a vocational learning content in workshop teaching sessions. This article aims to shed light on these processes by exploring how tools and machines are constituted through the interaction between vocational teachers and students in Swedish upper secondary vocational education. Learning on the theoretical and methodological framework CAVTA (Conversational Analysis and Variation Theory Approach) when analysing video-recorded lessons, the study shows that the teaching about tools and machines takes place as a result of suddenly emerging problems that the students encounter. The study also shows that the teaching about tools and machines is conducted through the framing method of individualization, which leads to situations in which some students are given the opportunity to learn specific things about tools and machines, and others are not, even within the same session.

KEYWORDS
Vocational learning; tools; vocational education; vocational teaching; vocational curriculum

Introduction
In vocational education, a core element is the teaching and learning situations that take shape when teachers and students interact with each other and through which students are expected to learn and develop both practical and theoretical knowledge that are needed in order to be able to practice the profession (Johansson, 2020; Kilbrink & Asplund, 2020). Within the field of vocational education, the learning processes that are put into play when teachers and students interact in relation to learning a specific vocational learning content also concern the handling of physical objects such as hand tools and machines. Thus, vocational knowledge is also about developing the knowledge required to choose and use different tools, machines, and other material objects when practicing the profession (Berner, 2008; Heusdens et al., 2019; Johansson et al., 2019; Lindberg, 2003, 2019). This is also emphasized in vocational syllabuses in the Swedish curriculum for the upper secondary school (Skolverket, 2011). Vocational education constitutes a significant part of Swedish upper secondary education and approximately one third of all students attending upper secondary school are enrolled in a vocational programme (Skolverket, 2020). Something that distinguishes the vocational education in Sweden compared to many other countries is that it is mainly school-based and that the teachers, rather than...
mentors at workplaces, have the main responsibility for the students’ vocational learning (Johansson, 2020). What is possible to learn in workshop lessons at school is crucial when it comes to vocational students’ development of a profession.

However, despite the presence and importance of physical objects within vocational education, there is a lack of studies that focus on the teaching and learning processes that take place when teachers and students approach tools and machines as a vocational content and a vocational knowledge to learn.

In this article, we will explore how tools and machines are constituted through the interaction between vocational teachers and students in Swedish upper secondary vocational education. We will particularly focus on how vocational teachers and students interact with, and orient to, tools and machines as objects that emerge in and through social interaction. Through this focus, this article aims to shed light on the vocational teaching and learning processes that take shape when vocational teachers and students together, and socially, create a shared understanding of how tools and machines should, or could, be handled and understood in vocational educational settings. To this end, we ask the following research questions:

1. What happens in vocational workshop teaching situations when tools and machines are oriented to as objects of learning?
2. What critical aspects of the tools and machines are made relevant when they are oriented to as objects of learning, and how are they made relevant in the interaction?

Our first research question concerns the social organization when tools and machines are foregrounded in the interaction and handled as specific objects of learning. Our twofold second question highlights issues relating to vocational content connected to the knowledge required to handle a specific tool or machine in vocational education, and how that knowledge is displayed in interaction between teachers and students. The term critical aspect relates to aspects of the object of learning that are crucial to discern for students in order to learn about that particular object (Marton, 2015).

**Previous research**

In regard to vocational education, where knowledge of how to handle tools and machines constitutes a central aspect of the curriculum (Lindberg, 2003, 2019), there is a surprising lack of studies that have treated objects as the main focus, and therefore, the knowledge about how physical objects such as tools and machines are approached as a vocational learning content in itself is limited. In general, scholarly interest in vocational learning processes in interaction has been scarce (Kilbrink et al., 2021). In the last decade, however, the field has seen an increased number of such studies. When it comes to exploring how tools and machines are handled and used in vocational education, it has usually been a matter of attending to them as part of vocational education and not treating them as main objects of the study. Previous studies have shown that tools and machines in vocational educational settings are not only related to professional know-how, but also associated with safety issues (Kontio, 2016; Lundmark & Kontio, 2021), ergonomics (Asplund et al., 2021), and the capability of vocational education to keep up with and adapt to the increasing rate of technical development (Berner, 2009; Bjurulf, 2012).

In this article, we align with the increasing number of studies in the social sciences that recognize the importance and significance of embodiment and materiality as features of human social interaction (Bezemer & Kress, 2016; Nevile et al., 2014). Within this strand of research, verbal communication has been increasingly integrated with other semiotic resources such as gaze, gestures, body orientation and use of physical objects when studying how social action is locally situated and produced (Kontio & Asplund, 2019). However, despite the intensified interest in and recognition of the bodily features and material people use in order to communicate, there have not been that many interactional studies that have treated objects as the primary focus of their analysis (Nevile et al., 2014).
When it comes to the field of vocational education, Filliettaz et al. (2010) have developed an interactional approach when examining the complex nature of analogies as they are performed and negotiated among participants. Attending to participants’ actions, body positions and use of material objects and tools, Filliettaz et al. show that when trainers and teachers refer to technical objects such as tools, they often relate to concepts and practices different from those that emerge in the training situations which they engage in here and now. These connections between techniques and tools that belong to the same occupational field serve as a resource for experts when training apprentices and supporting their vocational learning in the present. Furthermore, Öhman (2017) explores the social organization of feedback in hairdressing education through the use of multimodal interaction analysis, and shows how objects such as scissors and combs are given importance as tools when displaying vocational knowledge in hairdresser education. Another study that has connections to the present study is Kontio and Evaldsson (2015) who draw on an ethnomethodological approach and integrate the use of embodied actions and material arrangements in the analysis when exploring how male and female vocational students acquire and renegotiate normative gendered conduct as they learn how to use tools in auto-mechanic workshops. As Kontio and Evaldsson show, the teacher’s instructions regarding how to handle the tools in auto-mechanic workshop classes often invoked conventional associations between masculinity and the ability to handle tools. According to Kontio and Evaldsson, however, although handling tools in a certain way is associated with normative masculinity, it also displays a form of professional identity.

The studies mentioned above illustrate the emergence of interactional studies within the field of vocational education research, where artefacts such as tools and machines are integrated in the analysis of human conduct. However, they do not explicitly attend to objects as something that participants shape when creating shared understandings of how they might be perceived and handled, or focus on the learning processes that take place when tools and machines are oriented to as such, which we do in this study. When exploring the ways in which objects are experienced and created in and for everyday social interaction, Nevile et al. (2014) illuminate the two overarching themes in recent research which use video recordings of real-life settings. According to Nevile et al., objects can be manifested as situated resources when people interact with objects, and when objects are used as resources in social interaction (by handling physical objects participants can for example, manage interactional demands or perform tasks). However, objects can also be accomplished in and through participants’ trajectories of social interaction. The latter theme, objects as practical accomplishments, refers to situations in which participants orient themselves to objects as such, and focus on “what objects are, or can or should be, and so how they might be perceived, understood, and treated” (Nevile et al., 2014, p. 14). This article can be seen as a continuation of interest in how people orient to objects as practical accomplishments in and through social interaction, with a specific focus on how tools and machines are made relevant as objects of learning through teachers’ and students’ actions in vocational educational settings.

**Theoretical and Methodological Approach**

Leaning on scholars such as Rogoff (2003) and Sfard and Lavie (2005), we regard learning as a social phenomenon that is constructed, maintained, and reconstructed in the interaction between people, and between people and different artefacts. Hence, learning is something that people do when interacting with each other, and when interacting with artefacts in the surrounding context (cf., Sahlström, 2011). Furthermore, in this study, learning is also viewed as a process that always includes learning about something, and we contend that the opportunities for learning created in the classroom are dependent on the teaching that is conducted (Marton & Tsui, 2004).

In this article, we focus on the actions that teachers and students carry out when interacting with each other and with artefacts in vocational settings, and on the specific practices of conduct that they use to accomplish them. In this work with identifying and describing those processes, we lean on the theoretical and methodological framework of CAVTA (Conversational Analysis and
Variation Theory Approach), which combines Conversational Analysis and Variation Theory (Asplund & Kilbrink, 2020; Asplund et al., 2021; Kilbrink et al., 2021). Through the use of CAVTA, we can reach an understanding of the learning process that includes both an aspect of how learning is done in interaction during the enacted teaching situations, and what is being learned. Below, we describe the core components of the Conversation Analysis approach and Variation Theory used in CAVTA.

**Conversation Analysis in CAVTA**

The Conversation Analysis (henceforth CA) approach deals with examining and explaining the practices and methods people use to produce and make sense of interactional contributions as orderly and meaningful (Heritage & Atkinson, 1984; Schegloff, 2007). As such, CA aims to describe the collective organization of social activities in their ordinary settings as they are achieved through publicly displayed human verbal and embodied conduct (Mondada, 2013). Central to the CA approach is that the social interaction should be studied from the participants’ perspective; what is to be studied is how participants produce and show their understanding of their own and each other’s conduct in the ongoing turn-by-turn interaction.

In order to identify the meanings and understandings that are made public at a specific moment in the interaction, CA has developed a ‘proof procedure’ method (Sacks et al., 1974, p. 729). This method rests on the intersubjective process that takes place in social interaction and takes into account the viewpoints of the participants by anchoring the analysis in the participants’ own orientations towards their joint conduct (Levin et al., 2017). Schegloff (1991), when writing about intersubjectivity in conversation, describes this as a theoretical and methodological approach to study how participants in interaction construct (and co-construct) ‘the maintenance of a world (including the developing course of the interaction itself) mutually understood by the participants as some same world’ (p. 151). Accordingly, we will approach the interaction that takes place between the teachers and students in vocational school settings from a CA perspective that investigates and understands talk, as well as embodied conduct or multimodality, as constitutive of and integral to the ongoing interaction (Goodwin, 2000; Neville et al., 2014). In particular, CA will help us examine how teachers and students socially, and together, establish a shared understanding of the tools and machines. When approaching the video recorded data from this standpoint, the participants’ sequential organization of talk and embodied conduct is transcribed in detail according to specific conventions developed within the CA tradition (e.g. Hutchby & Wooffitt, 2008).

**Variation theory in CAVTA**

The theoretical concepts from Variation Theory in CAVTA used as analytical tools in this study concern aspects of the learning content and how the learning content is enacted in teaching (Asplund & Kilbrink, 2020, 2020; Kilbrink & Asplund, 2018). In Variation Theory, a specific focus is placed on the learning content, referred to as the object of learning. The object of learning can be divided into a direct and an indirect object of learning, where the direct object of learning refers to the content and the indirect object of learning to the ability related to the direct object of learning and what the students are supposed to do with the learning content (e.g. understand, use, construct, perform; e.g. Lo, 2012; Marton & Tsui, 2004). Several studies show how it can differ between what the teacher planned for (intended object of learning), what was possible to learn in the learning situation (the enacted object of learning) and what the students actually learned (the lived object of learning; Marton & Tsui, 2004). In this study, we focus solely on the enacted object of learning (what was possible to learn in the learning situation) and what learning content is made relevant in the interaction between teacher and student(s) in an actual teaching/learning situation (Asplund & Kilbrink, 2020, 2020; Kilbrink & Asplund, 2018). In line with the theoretical and
methodological approach taken in this study, our aim is to identify what actions participants perform and to describe those particular practices of conduct that they use to accomplish them. We will not make any claims about teachers’ intentions, hence the focus on the enacted object of learning.

Aspects of the object of learning which the student does not yet know and thus needs to learn, in order to know the object of learning, are referred to as critical aspects (Marton, 2015; Pang & Ki, 2016). Those critical aspects can vary and be made visible to the learner by different patterns of variation (Lo, 2012; Marton, 2015). One pattern concerns how things can be compared to things that are not, or how you should do something can be compared to how you should not do it (contrasting as pattern of variation). Another pattern—generalization—can be used for different examples of the same thing. As an example from welding, holding a weld could be a critical aspect of welding for some students, and generalization could be about different possible ways of holding the weld when welding, while contrasting is about comparing correct and incorrect ways of holding it. Every way of holding (every value of the critical aspect holding a weld) is a critical feature of holding the weld. In relation to practical objects of learning in vocational education, there are often some values that are desired, and we have chosen to use the concept targeted critical feature for these values (which are sometimes referred to as tacit knowledge and something you have to develop through practice, e.g. Asplund & Kilbrink, 2020, 2020; Kilbrink & Asplund, 2018). When we analyse examples from enacted teaching, we use the concept critical aspects for aspects which the teacher chooses to highlight to the student(s) in the interaction, as a potential difficulty in the upcoming work for the student (compare Kilbrink et al., 2021).

**Method**

**Context and participants**

We have conducted this study in a vocational upper secondary school which is located in a relatively large city in Sweden and which offers a number of different vocational study programmes. The school was selected based on previous contacts. Following the ethical principles stated by the Swedish Research Council, all teachers and students in the classes included in the study were informed about the aims and implementation of the study, and were asked to participate by appearing in video recordings. All participants gave their written consent to participate. During the fieldwork, we have been concerned about establishing an open dialogue and developing trust with the teachers and students. The participants’ anonymity and confidentiality have been assured by anonymizing the transcriptions.

The upper secondary school is a municipal school and the study programmes that have been included in the study are (1) Sanitary, Heating and Property Maintenance Programme, (2) Building and Construction Programme, (3) Electrical and Energy Programme and (4) Handicraft Programme with a focus on hair and makeup stylist. In the case of the Sanitary, Heating and Property Maintenance Programme, Building and Construction Programme and Electrical and Energy Programme, some vocational subjects are carried out in the school workshops and in the case of the Handicraft Programme, vocational subjects are carried out in the school makeup room. Our data material (video recordings) has been collected in those workshops and in that room.

The Sanitary, Heating and Property Maintenance workshop consists of various work booths where students are working individually pulling pipes and working with bathroom adaptations, including installation of toilets, sinks, boilers and water heaters. The Building and Construction workshop consists of a hall where students work individually or in pairs building brick walls. The Electrical and Energy workshop consists of a room where students work individually or in pairs pulling cables, working with electrical installation, and preparing a kitchen. The vocational teachers in these programmes walk around and help students who have questions about their practical work. The
Handicraft makeup room consists of a stylist hall with workstations. The students work in pairs in each workstation and put make up on each other in turn. The vocational teacher walks from workstation to workstation to help students who have questions about their practical work.

**Data**

When video recording the lessons we have used two cameras; one camera recorded a focus student’s actions during lessons, and one camera recorded the vocational teacher and his/her interaction with the students during the lessons. The video recordings lasted for 3 hours for the Sanitary, Heating and Property Maintenance programme, 1.5 hours for the Construction and Installation programme, 3 hours for the Electrical and Energy programme, and 2.5 hours for the Handicraft programme. The number of students in the lessons varied between 10 and 25 students.

When analysing the video recorded data, the research group (the authors of this article) watched and analysed the recordings several times, together as well as individually. During this process, we treated all the video-recorded data from the lessons from all programmes as one big data set. This work resulted in the categorization of several different aspects that emerged as central in the data set, where teachers’ and students’ orientations to tools and machines as objects of learning constituted one of these categorizations. One of the researchers in the research group then coded all instances of participants’ orientations towards tools and machines on a timeline. The research group then watched and analysed all the identified clips where tools and machines emerged as objects of learning several times, together as well as individually. Thereafter, selected clips were transcribed, analysed, discussed and explored further in several data sessions. The examples chosen for this article show different teaching situations from the empirical material when tools and machines are oriented to as objects of learning in and through the social interaction between vocational teachers and students in vocational workshop sessions, while also illustrating variations in how the interaction unfolds.

**CAVTA as a means to analyse vocational classroom teaching**

When analysing the interaction that take shape in the vocational education work shop, the combination of Conversation Analysis with Variation Theory into CAVTA gives us tools for analysing how teachers and students establish a shared understanding of the enacted object of learning through the simultaneous use of different semiotic resources in the interaction (Asplund & Kilbrink, 2020). What is made possible to learn (the enacted object of learning, Marton, 2015) depends on the establishment of a shared understanding of the learning content, based on what critical aspects are made public in their joint conduct in the ongoing interaction (Kilbrink et al., 2021). In this study, we analyse situations where tools and machines are made relevant as objects of learning in vocational workshop lessons, by focusing on what critical aspects (Marton, 2015) teachers and students orient to. Thereby, we can reach an understanding of the enacted learning process concerning tools and machines as they emerge in the unfolding face-to-face interaction between teachers and students in vocational education workshop settings.

In the analysis, we apply a multimodal perspective (Deppermann, 2013; Goodwin, 2000) to study how the teachers’ and students’ activities relate to their use of verbal and embodied resources to create meaning and understanding in the vocational education workshop. Furthermore, and leaning on the CA approach that rests on ‘methodological and epistemological naivety’ (Schegloff, 1997, p. 185), we take into account the viewpoints of the participants in our analysis, that is, how the action is understood by other participants in the unfolding interaction. This means that the analysis of the transcribed actions is based on evidence located in the video-recorded data material itself and then presented in such a way that the reader can follow our analysis step by step (Sidnell, 2013). Thus, our analysis focuses on how the teachers and the students display understanding of each other’s actions there and then, and how they relate to each other and objects to create meaning and understanding.
Analysis and results

In this article, we have chosen to present detailed CAVTA analyses of three examples from the data. The first example is taken from the Sanitary, Heating and Property Maintenance Programme and we have chosen to divide it into two parts (Example 1(a,b)) to make it easier for the reader to follow the analysis of teacher-student interaction. The second example (Example 2) is taken from the Building and Construction Programme, and the third example (Example 3) is taken from the Handicraft Programme.

Learning to handle a pipe threading machine as a plumber

The first example, taken from a workshop lesson in the Sanitary, Heating and Property Maintenance Programme, highlights a situation where a machine is not only oriented to as something to handle, but also as something that a plumber has to prepare properly and correctly before handling. The example begins with the student telling the teacher that he needs help. The teacher affirms the student’s request by following him to the workplace where the student is currently working. It turns out that the student is engaged in handling a large electric pipe threading machine, and as soon as the teacher gets there, the student draws attention to the die head that is attached to the machine:

Example 1. (a) How did you get that up?

1. S: hur fick man upp *den där? how did you get that up?
   *points at the die head
2. T: då lyfter man *den så you lift it like this then
   *lifts the die head out of the machine and
   puts it on the floor
3. S: där du there you are
4. T: och så ska du ha en (. ) större va (1.5) and then you should have a (. ) larger one right (1.5)
5. *en kraftigare* (. ) det är den* det* a more powerful one* (. ) that is that one
   *lifts up a larger
die head from a shelf under the machine and assembles it in the machine

   Figure 1.1

6. då ser du här* i:* then you see here in:
   *hits the locking device with a pipe
7. *(13.0)
8. d- (. ) du ställer du dig på den här sidan (. ) ställ dig 
y- (. ) you can stand here on this side (. ) come and stand 
9. här* så får du se 
here and then you shall see 
*point with his hand on his left side, the student 
walks and stops on the right side of the teacher 
10. T: så har du en gång en skala här 
and then you have a thread a scale here 
11. S: ja: 
yeah: 
12. T: å här# har du ju tvåtum (. ) då kan du skjuva den 
and here you ju have two inches (. ) then you can push it 

Figure 1.3 
13. T: här så här#* 
here like this 
*pushes the handle back and forth 

Figure 1.4 
14. T: och då (. ) åker gång:snittena ihop ser du 
and then (. ) the thread cuts come together you see 
15. S: sedärja 
there you are
As soon as the teacher and the student get to the electric pipe threading machine, the student directs his focus towards the die head that is assembled in the machine by pointing to the die head and asking ‘how did you get that up?’ Here, the student positions himself as less knowledgeable (K-; Drew, 2018) in relation to the teacher and to how the die head is attached to the machine. In line 2, the teacher positions himself as more knowledgeable (K+) as he shows the student from here onwards through the example how the work of replacing the die head and inserting a larger one should be done, and how to set the die head so that you get a desired thread of two inches (line 12). Here the teacher begins his instruction by first showing how to remove the die head by saying that you ‘lift it like this’ at the same time as he lifts the die head out of the machine (line 2). After the student in line 3 has confirmed the teacher’s action, the teacher in lines 4–5 draws the student’s attention to the fact that the student now needs ‘a larger one right (,) a more powerful one’, which makes the size of the die head a critical aspect (Kilbrink et al., 2021; Marton, 2015) of the setting of the pipe threading machine (which includes all aspects of preparing the machine for threading), where the size of the die head to be replaced is contrasted (Lo, 2012; Marton, 2015) with what the student needs instead—that is, a die head that is larger—whereupon the teacher picks up a new die head from a shelf under the pipe threading machine (line 5) which he then assembles in the machine.

From line 6 onwards, the teacher then instructs the student how to get the desired thread cut on the die head. He does this by first opening the locking device on the die head with a pipe (line 6), after which he in lines 9–10 urges the student to change position so that the student can see the location of the die head in the machine from the same perspective as the teacher himself. When the student has found his position, the teacher then directs his focus to the scale engraved on the die head. He points to the scale while saying ‘you have a thread a scale here’ (line 10). Here, the scale emerges as another critical aspect (Kilbrink et al., 2021; Marton, 2015) of the setting of the pipe threading machine, which affects the size of the die head. The teacher confirms the teacher’s action, producing a continuer at the end of the teacher’s phrase, thus showing the teacher that he still has the floor (Goodwin, 1986). The teacher then continues his ongoing turn by first repeating ‘here’ followed by ‘you have ju two inches’ and after that he shows the student how to set the desired thread (lines 12–14). Here, the teacher’s instruction includes the Swedish epistemic adverb ‘ju’, which is commonly used to appeal to participants’ shared knowledge (Heinemann et al., 2011). He does this by sliding the lever for the setting of the thread on the die head back and forth (by doing that the teacher contrasts different values on the scale) at the same time as he says: ‘then you can push it here this like this and then the thread cuts come together you see’. During this sequence, the student focuses his attention on what the teacher says and does by directing both gaze and body towards the die head the teacher is working with. In line 15, the student then says ‘there you are’ and thus shows the teacher that he has understood. Through the simultaneous use of different semiotic resources (speech, body, artefact) and by contrasting different values on the size of the die head and on the scale of the thread, critical aspects (what the student needs to learn about the setting of the pipe threading machine) in the interaction between teacher and student are made visible.

The teacher and the student will then continue to focus on the pipe threading machine and how to prepare it for threading. After the teacher has instructed the student how to set up the machine so that he can get the desired thread cut, they discuss what pipe dimension the student should use. In the following example (Example 1(b)), they have just agreed upon a one-inch pipe and the teacher then asks the student if he wants him to show how to assemble the pipe in the machine properly before it is ready to thread:
Example 1. (b) Shall I show you once?

1. T: ja (. ) åsså sätter du i röret (. ) ska jag visa dig yeah (. ) and then you assemble the pipe (. ) shall I show you once?
2. en gång? you once?
3. S: nej därifrån kommer jag ihåg för jag har gjort den där no I remember from there because I have done that one
4. T: sätter å (. ) åsså skjuter du den fram å tillbaka sen and then you push it back and forth *pushes the scale back and forth, gives the assembles (. ) pipe to the student
5. S: ja yeah
6. T: ja (. ) det var bara *bytet av (. ) den som du var unsure of? head
7. yeah (. ) it was just the switch (. ) of that that you were *walks forward and points at the die
8. osäker på? head
9. S: ja yeah
10. T: ja yeah
11. *the student assembles the pipe in the machine, the teacher backs off and watches *(8.0)

Figure 1.5

12. T: centrerar den ordentligt *jag brukar göra så här jag center it properly I usually do it like this *walks forward and interrupts the students work, grabs the die head
13: det räcker inte att dra utan man tar tillbaka* lite å så: it's not enough to pull but you pull back a bit and then: *pulls the thread arm back and forth fast and hard three times *(1.8)

Figure 1.6

14. [så knackar man till så and then you knock it like that
15. S: [(x)
16. T: ja (1.0) man får vara lite bruttal yes (1.0) you may be a bit bruttal
As soon as the teacher in line 1 asks the student if he wants him to demonstrate how to assemble the pipe in the threading machine, the student immediately declines the offer with the justification: ‘I remember from there because I have done that one’ (line 3). Here the student thus makes an epistemic claim (Drew, 2018; Stivers et al., 2011) to know how to handle the machine ‘from there’ because he has ‘done that one’ (line 3) and that he therefore also remembers how to do it. The student not only positions himself as a knowledgeable student, but also claims to have acquired those skills from previously doing this kind of work through longitudinal orientations to former activities (Asplund et al., 2021; Jakonen, 2018).

The teacher ends the instruction by showing the student how to move the pipe forward in the pipe threading machine when the pipe is to be threaded before the student starts his work. The teacher then moves backwards from the machine and through bodily modes of position, posture, and movement gives the student full access to the machine (Flewitt, 2011). When the student then begins to assemble the pipe in the pipe threading machine in line 10–11, he is however immediately interrupted by the teacher who takes over the work by showing how he usually does it when he locks the pipe in the pipe threading machine himself (lines 12–14). Here the teacher again positions himself as more knowledgeable (Drew, 2018) in relation to the student and the way he handles the machine, with a specific focus on preparing the machine for threading, thus taking a different epistemic stance vis-à-vis the student (who is positioned as less knowledgeable), as well as the evolving organization of how to handle the machine (Drew, 2018). At the same time, the teacher uses the variation pattern contrast (Kilbrink et al., 2021; Marton, 2015), where he contrasts what the student does (how the student assembles the pipe) with how the student should assemble the pipe (which the teacher shows). The teacher thus models (Bjurulf, 2012; Chan, 2017; Fillettz et al., 2015) the targeted critical feature (Kilbrink & Asplund, 2020) of the critical aspect how to assemble the pipe (the right way to do it) for the student, while at the same time clarifying and amplifying the bodily movement verbally.

**Learning to handle folding pliers as a bricklayer**

The next example is taken from the Building and Construction programme and shows how a student, when asking the teacher for help, gets a mini-lecture about how to use the tool folding pliers as a bricklayer. During this mini-lecture, the teacher also imparts knowledge about how another profession (sheet metal workers) would have performed a similar task with the same tool. The example illustrates that learning how to use a tool as a professional may also include the acquisition of knowledge about how other professions use the same tool. The work includes laying sheet metal under the walls that the student is to construct with bricks, and after cutting a piece of sheet metal, the student goes to a pair of pliers that are on a work table (see picture 1 below).

**Picture 1**

The student picks up the pliers and then walks towards the teacher who is on the other side of the room, and just before he reaches the teacher, he asks the teacher what the pliers should be used for:
Example 2. It is a folding pliers.

1. S: vad ska vi ha den här till? (. ) är å böja den runt
what should we have this for? (. ) is to bend around
2. hörnet? the corner?
3. T: [vi- (. ) vad tror du *den är till för?
we- (. ) what do you think it is for?
  *smiles and points at the tool
4. S: böja plåten (. ) på nått sätt (. ) men *h-(. ) ex[akt] (. )>
bend the plate (. ) in a way (. ) but h- (. ) exactly (. )>
5. T: *walks towards the
  student and grabs the folding pliers
    [om: ]
      if:
6. S: >var?
    >where?
7. T: den det är en falstång
  it it is a pair of clinching pliers
8. S: ja:
yeah:
9. T: ((grabs the plate that the student holds)) s-om
   so-if
10. du tänker dig den där va
    you think of this one right
11. S: ja den ska ju böjas till
     yeah that one should be bended
12. T: ser du där va?
     you see there right?
13. S: ja
    yeah
14. T: den (. ) är ju liksom gjord för att (. ) få ett *grepp så
    it (. ) is ju kind of made to (. ) get a grip like this
    *drops the
    plate and holds it with the pliers

Figure 2.1

15. S: ja
    yeah
16. T: så man kan (. ) *bocka ner en plåt så
    and then you can (. ) bend the sheet metal plate like this
    *bends the plate downward repeatedly
17. S: men vi ska bara #bocka den precis vi:[d
   but we are just supposed to bend it right a:t

18. T: [Å du gör ju bara
   and you ju just do
19. det (.) dels den (.) biten #du ska vrida #runt* där
   that (.) partly this (.) part you should bend around there
   *tweaks the
   sheet metal and looks at the student

20. S: ja
   yeah
21. T: kan använda den där för då får du (.) om du
   can use this one there because then you get (.) if you
22. sätter den #där den ska vara så
   put it there it should be like this
23. S: ja då får man
   yes then you get
24. T: å vriden (. ) då blir det nittio (1.2) grader
   and bend (. ) then it will be ninety (1.2) degrees
25. S: ja
   yeah
26. T: eller ja den blir vass i böj i böjen nittio
   well yes it gets sharp in the bend in the bend ninety
27. grader beror ju på hur långt du vrier
   degrees depends ju on how much you bend
28. S: ja
   yeah
29. T: men det blir [den blir- ] det blir en skarp (. )
   but it gets it gets-
   it gets a sharp
30. S: [det blir en skarp x]
   it gets a sharp
31. T: kant ja (1.4) hade det varit en plåtslagare då som hade
   edge yes (1.4) had it been a sheet metal worker then who
32. hade gjort det då hade dom ju lagt den så då hade dom
   had done it then they ju had laid it like this then they
33. böjt runt den och sen hade dom använt ett
   bent around den and then they had used a
34. mothagå ett *knoaster
   recistence a seaming hammer
   *moves one hand in short movements towards the
   plate
35. S: mm
   mm
36. T: alltså e: en som i- en metall (1.3) e- rak metallgrej
   like ehm: a like in a metal (1.3) e- straight metal thing
37. kan man säga
   one can say
38. S: ja
   yes
39. T: som en klubba sen hade dom *sla:git runt den (. ) med en
   like a hammer then they would have hit around it (. ) with
   *slår med handen mot plåten
40. plastklubba gummiklubba för då blir det jämnt
    a plastic faced hammer rubber mallet because then it
    becomes smooth
In the same way as in our first example (Example 1), the student concedes his lack of knowledge (Antaki, 2012) and seeks the teacher's attention to get support and guidance when asking what the tool he is holding in his hand should be used for (line 1). In this example, it is a folding pliers that is the focus of the interaction between teacher and student, but unlike the student in Example 1, the student in this example shows a greater uncertainty about the tool and how it should be used. However, the student delivers a guess at the end of his first turn (lines 1–2), claiming that the tool may be used for bending sheet metal plates, a claim of knowledge (Drew, 2018) that the teacher does not really follow up but instead encourages the student to elaborate further on what the tool could be used for. By doing this, the teacher addresses the student as competent to reason about his thoughts about the tool, at the same time as the teacher can get more detailed information about the student’s knowledge about the tool. The student delivers an answer in line 4 that the tool should be used to ‘bend the plate’ but at the same time also shows a continued uncertainty about this in the continuation of the turn when he adds ‘in a way’, and follows it up with ‘but exactly () where’, making publicly visible his uncertainty, and displaying his knowledge in relation to the object of learning. At the end of the student’s turn (lines 5–6), the teacher grabs the tool and removes it from the student’s hand. This visible embodied conduct (grabbing the tool) signals a pre-beginning of talk and claims for the floor (Day & Wagner, 2014), and as soon as the teacher gains possession of the tool, he then tells the students that the tool ‘is a folding pliers’. This is followed by a longer sequence where the teacher instructs the student what the folding pliers are made for, and how they can be used to perform a specific job. During this instruction, the teacher also takes the sheet metal plate from the student, thus emphasizing that he still has the floor (Day & Wagner, 2014), but this embodied conduct also gives him the opportunity to show the student visually how the tool should be used on the plate. Hence, bending down a sheet metal plate (line 16) is made into an object of learning, and in lines 19–31, the teacher develops his instruction where he clarifies that the folding pliers are ‘made to () get a grip’ (line 14) and how to use the folding pliers to bend the sheet metal so that the bend is 90 degrees (lines 21–22 and 24). Here, however, the teacher corrects himself in lines 26–27 and clarifies that the sheet metal ‘gets sharp in the bend’ through the use of the folding pliers, and that the size of the angle of the sheet metal depends on ‘how much’ you ‘bend’ the plate with the folding pliers.

In lines 29 and 31, the teacher then clarifies and reinforces exactly how the tool as such makes it possible to create a ‘sharp edge’.

However, the instruction that takes place here is not a one-way transmission from the teacher to the student, but rather an example of an unfolding interaction in which the teacher and the student socially and together construct a joint orientation towards the situation as a teaching and learning activity (Sahlström, 2011). Besides providing minimal responses such as ‘yeah’ (lines 8, 13, 15, 20) and nodding as ways to display understanding but also reveal ‘preference for progressivity’ (Stivers & Robinson, 2006), the student makes epistemic claims that he knows that the sheet metal should be bent (line 11) and where it should be bent (line 17). In line 30, the student also produces a continuer of the teacher’s turn in line 29, which the teacher then accepts by repeating parts of it when launching his next turn, and in this way an alignment is established (Stivers, 2008). Moreover, the teacher produces tag questions (lines 10 and 12), which are questions used to indicate a common knowledge or experience, and through which he also seeks and receives confirmation from the student (lines 11 and 13) (Heinemann et al., 2011).

In line 31 and onwards, the teacher then highlights another profession, namely sheet metal workers, by telling the student how sheet metal workers would have performed a similar job with the same tool. The teacher clarifies that sheet metal workers after ‘they’ had ‘laid it like this’ (line 32) and ‘bent it around’ (line 33) would also have worked with other tools, which the teacher also mentions by name; ‘seaming hammer’ (line 34), ‘plastic faced hammer’ (line 40) and ‘rubber mallet’ (line 40). Here the teacher explains the function of these tools, and also visualizes for the student, using both verbal and embodied resources simultaneously, how a sheet metal worker would have worked with the tools and the sheet metal so that ‘it’ would be ‘smooth’ (line 40).

By relating here the work the student can perform and is expected to perform with the folding pliers as a bricklayer to how a sheet metal worker in his profession would perform similar work (and with the help of other tools), the teacher shows other possibilities and other ways to bend sheet
metal. As a pattern of variation (Marton, 2015), the teacher uses both generalization and contrast at the same time in relation to the critical aspect how to handle folding pliers to bend sheet metal as a bricklayer. When it comes to the object of learning how to handle folding pliers, there are different possible ways to handle this tool (generalization), but in relation to who handles it, these different ways are linked to the profession. Thus, if a sheet metal worker were to use this tool, he would handle it in a way that contrasts with how the student in the role of bricklayer would handle it in a different way.

**Learning how to handle a brush as a hair and makeup stylist**

The third example is taken from the Craft programme (specialization hair and makeup stylist), and has been chosen since it illustrates how a tool can be shaped and changed by the hair and makeup stylist using the tool and thus have different functions. The students have been given the task of applying makeup on each other and in the example that we have chosen to take a closer look at, the teacher has placed herself next to one of the pairs of students who work together in the classroom. For a few seconds, she follows one of the student’s work with applying makeup on the other student, after which she then steps in and directs her focus to the brush that the student uses for this task.

**Example 3.** A completely different kind of brush.

1. T: om du tycker penseln nu:
   *if you think the brush now:
2. S: 
   mm
   mm
3. T: blir för den blir ju gan[sk]a yvig [(.)] så
   gets because it get ju quite unwieldy (.) like
4. S: [ja:] [mm]
   yeah: mm
5. T: *du kan ju forma den
   *you can ju shape it
   *takes the brush from the student
6. S: mm((nods and looks at the teacher))
   mm
7. T: genom att göra så #hår (.) *för då får du en #helt
   by doing like this (.) because then you get a completely
   *moves the brush back and forth
   under the model’s left eye

Figure 3.1

Figure 3.2
8. annan typ av pensel
different kind of brush
9. S: mm ((nods))
10. T: eller använda en (. ) har du ditt- (. ) hölster (. ) olika
or use a (. ) do you have your- (. ) holster (. ) different
11. eller foundationpenseln som redan är (. ) men då den är
or the foundation brush that already is (. ) but then it is
12. ju lite hårdare å lite stummare [( . ) så men just för att
ju a bit harder and a bit less flexible (. ) so but just to
13. S: [ja: yeah:]
14. T: använda den #här ytan [( . ) så att den inte blir #så yvig
use this surface (. ) so it doesn’t get too unwieldy
15. S:
[mm

Figure 3.3

Figure 3.4

16. T: för det är lite svårt för nu blir det lite *duttigt (. ) så
because it’s a bit difficult because now it gets a bit
17. S: dabbed (. ) so
* dabs with the
brush in the air towards the student

18. T: här så att man istället liksom (. ) att man får en li:nje
here so that you instead kind of (. ) so you get a li:ne
19. 
#här att man jobbar he:ila vägen
here that you work the who:le way

Figure 3.4

20. S: ja
yeah
21. T: mm ((gives the brush back to the student))
mm
Unlike the examples above (Examples 1(a,b) and 2), in this example it is the teacher who first initiates an orientation towards the handling of a tool (in this case a brush) as an object of learning by making the student aware that the brush is a tool that can both be adapted to facilitate the work of applying makeup and also replaced with another brush with other qualities. The teacher does this by first telling the student that the brush in the way in which the student now uses it ‘gets ju quite unwieldy () like’ whereupon she takes the brush from the student. To address this problem, one ‘can ju shape’ (line 5) the brush and change its function ‘by doing like this’ (line 7), says the teacher, while she presses her thumb against the lower part of the brush straws. By doing so, you get a ‘completely different kind of brush’ (lines 7-8) the teacher then clarifies. The teacher here uses contrast as pattern of variation (Marton, 2015) through using both verbal and bodily communication to make visible the qualities of the brush and how they can affect its function. The Swedish epistemic adverb ‘ju’ as it is used by the teacher (lines 3, 5) appeals to the teacher’s and the student’s shared understanding (Heinemann et al., 2011) 1) that the makeup becomes ‘quite unwieldy’ as a result of the student’s use of the brush, and 2) that it is possible to (re)shape the brush. Hence, the student affirms the teacher’s turns by producing minimal responses (Stivers & Robinson, 2006; ‘yeah’ and ‘mm’ in line 4, ‘mm’ and nodding in line 6). The visible embodied conduct of removing the brush from the student (line 5), not only gives the teacher the possession of the brush (and the opportunity to use it herself when instructing the student) but also functions as a way to emphasize that she still has the floor (Day & Wagner, 2014). In this work, the learning content—as enacted object of learning and its critical aspects—is highlighted (cf Marton, 2015) using different patterns of variation (Lo, 2012; Marton, 2015).

When the teacher varies how she holds the brush to shape it, the shape of the brush emerges as a critical aspect (Kilbrink et al., 2021; Marton, 2015) of handling a brush to apply makeup. The teacher then says that it is also possible to use a foundation brush ‘that already is’ (line 11) but clarifies in connection to this the disadvantages; that is, it then becomes ‘a bit harder and a bit less flexible’ (line 12). Here the teacher makes clear to the student that there is an alternative tool that the student can use to complete the task, at the same time as she also clarifies that this particular tool carries different qualities which can be seen as indication that the teacher is using the variation pattern generalization (Lo, 2012; Marton, 2015) when she shows different ways to achieve similar results, and contrast as the pattern of variation (ibid.) when she highlights the different qualities of the critical aspect. However, the different ways lead to a clear difference in the quality of how to do this—there is thus a better and a worse, but still acceptable, possible way of doing it (the right value, or the critical feature, of the critical aspect, cf Asplund & Kilbrink, 2020), which is made publicly visible in the teacher’s turn. In line 14, the teacher then orients herself again towards the brush that the student worked with by first pressing the straws of the brush yet again together so that they get a fan-like shape at the same time as she runs her index finger along the straws and says ‘use this surface’. After a short pause, during which the teacher releases the grip on the brush straws so that the brush regains its original shape, she says: ‘so it doesn’t get too unwieldy’ (also note here how the teacher now, instead of pointing with her index finger at the brush straws, opens her hand while she says this) followed by ‘because it’s a bit difficult because now it gets a bit dabbed’. The words ‘unwieldy’ and ‘dabbed’ refer to the student’s way of using the brush and to avoid this “dabbed” use of the brush, the student, the teacher says, can ‘instead’ create a ‘line here’ by working ‘the whole way’. At the same time as the teacher says this, she also shows the student how the brush can be used when she moves it (again fan-shaped) back and forth against the face of the student sitting in the make-up chair. Here, the teacher uses the pattern of variation contrast (Lo, 2012; Marton, 2015) when she compares the way the student uses the brush to how she could use it instead. In this way, talk and embodied practices (including the handling of the tool) mutually contextualize each other, providing public resources for the student to be able to follow the teacher’s ongoing situated activity of instructing (Goodwin, 2006). When the teacher here also extends the
emphasis of the words ‘li:ne’ and ‘who:le’ at the same time as she instructs how to use the brush, she also reinforces the line movement she makes relevant in the instruction. When doing this, she also changes the object of learning that should be focused upon; from the brush as such and how it should be used (or can be changed), to how the makeup itself should be applied on the student sitting in the chair. There is also an interplay between these two objects of learning through the interaction as a whole—even if they alternate between what is in the foreground and what is in the background (cf Kilbrink et al., 2021; Lo & Chik, 2016). When the student then confirms the teacher (note also how the student on several occasions displays understanding during the teacher’s instruction through providing minimal responses), the teacher gives the student the brush, which can be interpreted as giving the student the floor (Day & Wagner, 2014) (which in this case involves to continue applying makeup on the classmate, based on the teacher’s instruction).

Discussion

As the Swedish curriculum for the upper secondary school (Swedish National Agency for Education, 2011) and research (e.g. Lindberg, 2003, 2019) reminds us, the knowledge required to choose and use different tools and machines when practicing a profession constitutes an essential part of vocational knowledge, thus making this knowledge an important dimension of vocational education. In the teaching that we have followed and video-recorded, we have also seen that these dimensions are central when vocational teachers and students interact with each other in different teaching and learning situations in vocational workshop sessions. The use of CAVTA has enabled us to study both how learning is done and what is made possible to learn, hence this study contributes important empirical knowledge of what happens in situations when teachers and students orient towards tools and machines as objects of learning. Building on previous studies which outline how to handle tools and machines as important vocational knowledge as well as a central aspect of the curriculum within vocational education (e.g. Filliettaz et al., 2010; Heusdens et al., 2019; Lindberg, 2003, 2019; Johansson et al., 2019), and previous studies within the field of vocational education that have considered tools as important aspects in interaction (Filliettaz et al., 2010; Kontio & Evaldsson, 2015; Ohman, 2017), this study attends explicitly to tools and machines as objects of learning that participants shape when interacting with each other. This approach has made it possible to describe, in great detail, the teaching and learning processes that take shape when tools and machines are oriented to as a learning content when teachers and students interact in workshop sessions.

In relation to our first research question regarding what happens in vocational workshop teaching situations when tools and machines are oriented to as objects of learning, our findings show that tools emerge as objects of learning (Marton, 2015) in suddenly arising situations—that is, as context-bound and situated, and as related to a problem that has arisen or been identified by teachers and/or students there and then.

The close and detailed CAVTA analyses of the three examples from the three different vocational programmes have in common that they show how teachers and students together create a learning pact (see, Asplund & Kilbrink, 2020; Marton, 2010) through displaying their knowledge about the object of learning, where teachers are positioned as more knowledgeable (K+) members of the pact who have to teach students how to choose and handle a tool or machine, while students are positioned as less knowledgeable (K-) and as those who have to learn (Drew, 2018; Stivers et al., 2011). These are not predetermined positions that already ‘exist’ out there, but they are the result of the teachers’ and students’ joint, and after the initial turn in each example, continued interactional work (e.g. Chan, 2017; Filliettaz et al., 2015).

In line with Nevile et al. (2014) and the distinction between objects as situated resources and objects as practical accomplishments, it is clear that the tools are approached as objects as practical accomplishments when a problem arises regarding the handling of the tools and the machines. In these situations, and linking back to our twofold second research question that concerns what
critical aspects are made relevant and how when tools and machines are oriented to as objects of learning, the tools and the machines (the objects) are oriented to as emerging in and through trajectories of social interaction. In these situations, the teachers and students are working to establish a shared understanding (Schegloff, 1991) of what the specific tool or machine is, or should be, in order to make clear how it might be understood and used in the profession. In these processes, critical aspects of the objects of learning emerge. In Example 1(a), it is the size of the die head and then the scale engraved on the die head that are oriented to as critical aspects. In Example 1(b) it is how to assemble the pipe that is highlighted as the critical aspect. In Example 2 that concerns the plier, the critical aspect is related to another profession, thus the teacher makes how to handle a folding pliers to bend sheet metal specifically as a bricklayer relevant as the critical aspect. And finally, in the third example, the shape of the brush that the student uses when applying makeup on her classmate is made relevant as the critical aspect. When these critical aspects emerge in the unfolding interaction between the teachers and the students, the teachers are using different patterns of variations (contrast in Example 1, contrast and generalization in Examples 2 and 3). By varying certain critical aspects of the object of learning, while keeping other aspects invariant, the teacher can help the students discern different critical aspects of the object of learning which may enhance their learning processes (Lo, 2012; Marton, 2015).

In a sense, one could argue that the problems with the handling of tools that students encounter (Examples 1 and 2) or which are identified by the teacher (Example 3) create specific teaching opportunities, and therefore also learning opportunities through which students can gain the knowledge required to choose and use different tools (and machines) when practicing a profession. What the analyses show is that teachers, when these situations arise, tend to expand the teaching and add information about the tool/machine (information that the students do not explicitly request). This also involves relating the handling of tools/machines (compare Example 2) through the use of the pattern of variation contrast, to other professions. We see this as a process through which the teacher relates what is to be learned and done here and now to a wider context in which the present task becomes a part.

According to Lo and Chik (2016), students through such processes are given increased conditions for a deeper learning about the specific object of learning if the object of learning and its critical aspects are not only handled and varied in relation to each other but also in relation to a wider context (see, also Asplund et al., 2021). This may also include relating how to handle tools and machines to different professionals. As shown in Example 2, the teacher uses patterns of variation (Marton, 2015) in relation to handling folding pliers and displaying different possible ways (generalization) of handling the tool, but the different ways of handling it are related to specific professions (contrasting in relation to who would use the tool).

However, our results also raise questions about what teaching and what learning opportunities about tools and machines are offered to the different students in the same class. A dominant framing method of the teaching that took place in the observed classrooms, which also seem to be a prominent framing method in other Swedish vocational education settings (Eiriksdóttir & Rosvall, 2019) is individualization. As Eiriksdóttir and Rosvall (2019) emphasize, individualization has the benefit of giving all students the same opportunity to learn since they have to complete the same tasks, albeit at their own pace, but individualization also creates situations in which different students learn different things. Given that such a large part of teaching about tools and machines tends to take place as a result of suddenly identified or emerging problems, in the framing teaching method of individualization, different students are also given different opportunities to learn specific things about tools and machines. As such, our study draws attention to the opportunities created by these situations, emerging through and in the framework of individualization, for vocational teachers to also highlight more collective elements in the vocational education where issues of choosing and handling tools and machines can be made publicly visible, discussed and specified together with students on a larger group basis.
Altogether, this study illustrates the value and relevance of studies within the field of vocational education that attend to tools and machines as constituted through the interaction between vocational teachers and students. Throwing light on the teaching and learning processes that take place in workshop lessons when teachers and students attend to tools and machines as such deepens our knowledge about the (different) learning opportunities students are given in order to gain knowledge required to choose and use different tools and machines when practicing a profession. Our findings indicate that students, although they attend the same workshop session, may not get access to the same learning possibilities, which points to the need for more studies with a focus on how to ensure that every student is offered the teaching and learning opportunities needed for a future professional career, as well as for reaching the learning goals stated in the curriculum.

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References

Antaki, C. (2012). Affiliative and disaffiliative candidate understandings. Discourse Studies, 14(5), 531–547.
Asplund, S.-B., & Kilbrink, N. (2020). Lessons from the welding booth: Theories in practice in vocational education. Empirical Research in Vocational Education and Training, 12(1), 1-23. https://doi.org/10.1186/s40461-020-00087-x
Asplund, S. B., Kilbrink, N., & Asghari, H. (2021). Visualising the intended practical doing: Future-oriented movements in Swedish vocational school workshop settings. International journal for research in vocational education and training, 8(2), 160–185. https://doi.org/10.13152/URVET.8.2.2
Bern, B. (2008). Working knowledge as performance: On the practical understanding of machines. Work, Employment & Society, 22(2), 319–336. https://doi.org/10.1177/0950017008089107
Bern, B. (2009). Learning control: Sense-making, CNC machines, and changes in vocational training for industrial work. Vocations and Learning, 2(3), 177–194. https://doi.org/10.1007/s12186-009-9023-8
Bezemer, J., & Kress, G. (2016). Multimodality, learning and communication: A social semiotic frame. Routledge.
Bjurulf, V. (2012). “You’ll just have to practice until you find your own way to do it!” A narrative study about how teaching is carried out in Technical Vocational Education. Nordic Studies in Science Education, 8(1), 17–25. https://doi.org/10.5617/nordina.356
Lindberg, V. (2019). Traditional assignments in Swedish vocational carpentry education of today but changed vocational knowing. Facets and aspects of research on vocational education and training at Stockholm University, 24. In L. M. Herrera, M. Teräs, & P. Gougonlakis (Eds.), Emerging Issues in Research on Vocational Education & Training (Vol. 4, pp. 174–216). Premiss förlag.

Lo, M. L. (2012). Variation theory and the improvement of teaching and learning. Acta universitatis Gothoburgensis.

Lo, M. L., & Chik, P. P. M. (2016). Two horizons of fusion. Scandinavian Journal of Educational Research, 60(3), 296–308. https://doi.org/10.1080/00313831.2015.1119730

Lundmark, S., & Kontio, J. (2021). Risker med mobiltelefoner i yrkesklassrummet: Användningen av mobiltelefoner i yrkesklassrums vardagsinteraktion. [Risks with smartphones in vocational education classrooms. In J. Kontio & S. Lundmark (Eds.), Yrkesdidaktiska dilemma (pp. 279–298). Natur & Kultur.

Marton, F. (2010). Samtalsanalyse och pedagogik [Conversation analysis and pedagogy]. In H. Melander, and F. Sahlström (Eds.), Lärande i interaktion [Learning in interaction] (pp. 216–242). Liber.

Marton, F. (2015). Necessary conditions of learning. Routledge.

Marton, F., & Tsui, A. B. M. (Eds.). (2004). Classroom discourse and the space of learning. Erlbaum.

Mondada, L. (2013). The conversation analytic approach to data collection. In J. Sidnell & T. Stivers (Eds.), The handbook of conversation analysis (pp. 32–56). Blackwell & Wiley.

Neville, M., Haddington, P., Heinemann, T., & Raunio, M. (Eds.). (2014). Interacting with objects: Language, materiality, and social activity. John Benjamins Publishing Company.

Öhman, A. (2017). Återkoppling i interaktion: En studie av klassrumssbaserad bedömning i frisörutbildningen [Doctoral dissertation]. Karlstads universitet.

Pang, M. F., & Kl, W. W. (2016). Revisiting the idea of "critical aspects". Scandinavian Journal of Educational Research, 60(3), 323–336. https://doi.org/10.1080/00313831.2015.1119724

Rogoff, B. (2003). The cultural nature of human development. Oxford University Press.

Sacks, H., Schegloff, E. A., & Jefferson, G. (1974). A simplest systematics for the organization of turn-taking in conversation. Language, 50(4), 696–735. https://doi.org/10.1353/lan.1974.0010

Sahlström, F. (2011). Learning as social action. In J. K. Hall, J. Hellermann, & S. P. Doehler (Eds.), L2 interactional competence and development (pp. 43–62). Multilingual Matters.

Schegloff, E. A. (1991). Conversation analysis and socially shared cognition. In L. B. Resnick, J. M. Levine, & S. D. Teasley (Eds.), Perspectives on socially shared cognition (pp. 150–171). American Psychological Association.

Schegloff, E. A. (1997). Whose text? Whose context? Discourse & Society, 8(2), 165–187. https://doi.org/10.1177% 2F095792659700802002

Schegloff, E. A. (2007). Sequence organization in interaction. A primer in conversation analysis (Vol. 1). Cambridge University Press.

Sfard, A., & Lavie, I. (2005). Why cannot children see as the same what grown-ups cannot see as different? Early numerical thinking revisited. Cognition and Instruction, 23(2), 237–309. https://doi.org/10.1207/s1532690xci2302_3

Sidnell, J. (2013). Basic conversation analytic methods. In J. Sidnell, and T. Stivers (Eds.), The handbook of conversation analysis (pp. 77–99). Blackwell-Blackwell.

Skolverket. (2011). Gymnasieskola 2011 [Upper Secondary school 2011]. Skolverket [the Swedish National Agency for Education]. Retrieved November 11, 2021. Retrieved https://www.skolverket.se/publikationsserier/styrdokument/ 2011/gymnasieskola-2011

Skolverket (2020). Elever i gymnasieskolans 2019/2020 [Students in Upper Secondary School 2019/2020]. Beskrivande statistik (Dnr 2019:00860).

Stivers, T. (2008). Stance, alignment, and affiliation during storytelling: When nodding is a token of affiliation. Research on language and social interaction, 41(1), 31–57. https://doi.org/10.1080/08351810701691123

Stivers, T., Mondada, L., & Steensig, J. (2011). Knowledge, morality and affiliation in social interaction. The morality of knowledge in conversation, 29, 3–24.

Stivers, T., & Robinson, J. D. (2006). A preference for progressivity in interaction. Language in society, 35(3), 367–392. https://doi.org/10.1017/S0047404506060179