To Teach and Learn Technical Vocational Content

Ongoing Research in Swedish Upper Secondary Education

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This paper describes ongoing research focusing on how vocational learning content in different technical vocational programmes in upper secondary schools is taught and learned in close interaction in the midst of practical learning situations. The study shows that the technical vocational learning content have some aspects in common – such as the interplay between theoretical and practical knowledge, the use of working tools, the problem solving and the complexity of interacting critical aspects. However, there are also differences between the learning content in the teaching of different vocational subjects, in relation to working methods and the nature of the objects of learning. Still, more studies are needed in order to claim that the differences are subject specific. Furthermore, the study shows that teachers often aimed to teach the learning content in a broad perspective, which could be at the expense of a clear focus for the student. In one of the studied programmes an intervention study was conducted. This study shows that an enhanced focus on fewer, specific critical aspects of the object of learning might support the learning process.

Keywords: Teaching, Learning, CAVTA, Vocational Education, Learning Content, Interaction

Introduction

Teaching and learning technical vocational content is an important aspect of educating future workers (cf. Kilbrink, 2013). The learning content in vocational education is often taught in interaction between teacher and students. It involves a practical doing, and thus includes practical objects of learning (Asplund & Kilbrink, 2018; Kilbrink & Asplund, 2018; Kilbrink, 2018). In the area of vocational education, there are studies focusing for example, on teachers' experiences of the educational content and what is important to learn (cf. Asghari, 2017; Kilbrink, Bjurulf, Olin-Scheller & Tengberg, 2014; Lindberg, 2003), learning at the workplace or the connection between school based or workplace based learning in vocational education (cf. Billet 2011; Heusdens, Baartman & de Bruijn 2018; Filliettaz 2013; Filliettaz, Durand & Trébert, 2015 Kilbrink, Bjurulf, Baartman & de Bruijn 2018), and Heusedens et al. (2018) describe what characterises students' vocational knowledge. However, there is a lack of knowledge about the actual teaching and learning processes in technical vocational education focusing on the learning content and how it emerges in the interaction between teacher and students in the vocational classroom (Kilbrink, 2018; Kilbrink & Asplund, 2018). Therefore, two research projects, focusing these issues were launched in Sweden in 2018; *Vocational learning* funded by the Swedish Research Council (ref no 2017-03552) and *Learning to weld in vocational education* funded by the Swedish Institute for Educational Research (ref no 2017-00056). In this paper results from those ongoing projects will be presented and discussed, in relation to *what* is being taught and *how* the teaching and learning is done in the interaction between teacher and students. We base this discussion on the research question: What similarities and/or differences between different subject specific education in the technical vocational workshops emerge in the empirical data.

Context and Methods

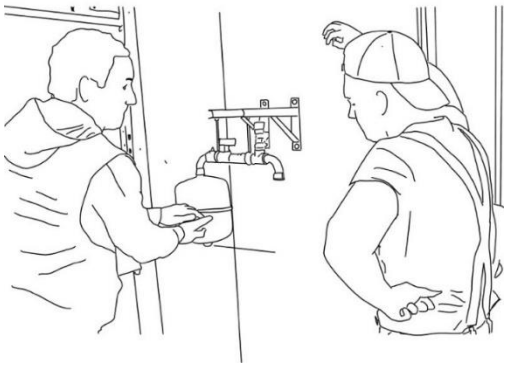
This study focuses on how technical objects of learning – the learning content – is taught in interaction in Swedish vocational education in upper secondary school. The syllabuses are vague regarding the content of the vocational education and the teachers thereby need to decide upon the specific learning content (Kilbrink, Bjurulf, Olin-Scheller & Tengberg, 2014). Furthermore, the learning content is supposed to be learned in different learning arenas, since Swedish vocational education in upper secondary school is conducted as both school based and workplace based learning (cf. Kilbrink, 2013). This study focuses solely on the school based part of the education. To be more precise, the focus is on vocational subjects in school settings (vocational workshops) in four different technical vocational programmes; plumbing, building and construction, electrical engineering, and industrial work. Technical and vocational objects of learning can be regarded as practical objects of learning, since they include an act of doing (cf. Kilbrink, 2013; 2018). Previous studies have stressed the integration of theoretical and practical knowledge in relation to teaching and learning practical objects of learning. In this context theoretical knowledge has been referred to as knowledge *on* something and practical knowledge as knowledge *in* something (cf. Kilbrink, 2013; 2018; Svensson, 2011).

In this study, we regard learning as something that is done in interaction and always concerns learning about something, a learning content (an object of learning). To study the interaction when teaching and learning a technical vocational content, the interaction between teacher and students have been video recorded and analysed based on CAVTA (*Conversation Analysis and Variation Theory Approach*) (cf. Asplund & Kilbrink, 2018; 2020; Kilbrink & Asplund, 2019, June). CAVTA is based on an integration of Conversation Analysis (CA) and Variation Theory (VT). CA contributes with analytical tools helping us to understand how the learning is done in interaction, and how for example the use of different semiotic resources can contribute to a mutual understanding between teacher and students. VT contributes with analytical tools helping us to distinguish variation and to understand the object of learning and what aspects of the learning content are possible to learn in the interaction, here and now (cf. Asplund & Kilbrink, 2018; Kilbrink & Asplund, 2018). The first three examples derive from one project (*Vocational learning*), where vocational teaching and learning is studied in its natural context, and the fourth and final example in this article derives from an action research study (*Learning to weld in vocational education*) in collaboration between teachers and researchers, conducted as a Learning study with the intervention to teach how to weld on a theoretical basis. When presenting our results, we have chosen to add some drawings from each context to illustrate our data.

Results

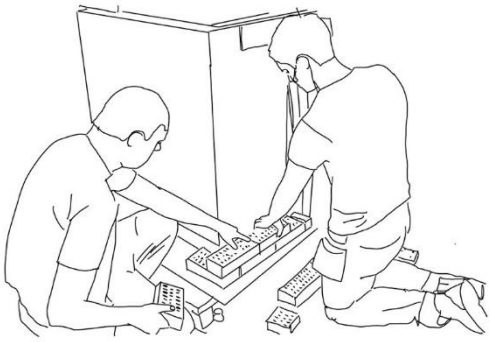
By analysing the interaction between teachers and students in relation to specific vocational learning content in vocational workshops, we can see that there are many different kinds of technical objects of learning brought into each learning situation simultaneously – regardless of the programme. There are similarities between the different subject specific education in the technical vocational workshops in our examples. In all subjects, there was a lot of interaction between teacher(s) and students, and the objects of learning had similar aspects as well. For example, the objects of learning concerned theoretical and practical knowledge (knowledge *on* and knowledge *in* something); they often related to a doing or some kind of action; they could relate to drawings, working tools, material, problem solving and esthetical aspects of the work in different ways. Furthermore, the objects of learning were often complex with several critical aspects and cooperating parts of wholeness. Hence, at a first glance, it is easy to lump the subjects into one kind. However, we also saw differences between both how and what kinds of objects of learning they teach in the different vocational classrooms.

In our examples from the vocational programme concerning plumbing (*Sanitary, Heating and Property Maintenance Programme*), the students were working on different individual tasks relating to objects of learning such as mounting water heaters, fitting pipes, installations of toilets and sinks etc (see Example 1). The students were also handling working tools, drawings, and safety regulations. One teacher was responsible, keeping the students busy progressing in their tasks. When analysing examples from when the teacher interacted with the students in need for help, he often gave them mini-lectures (cf. Asplund & Tanner, 2016) using different semiotic resources at hand, such as white board drawings, verbal and bodily communication. He also encouraged the students to help each other or to find alternative solutions when they got stuck in their work.



Example 1. Sanitary, Heating and Property Maintenance Programme

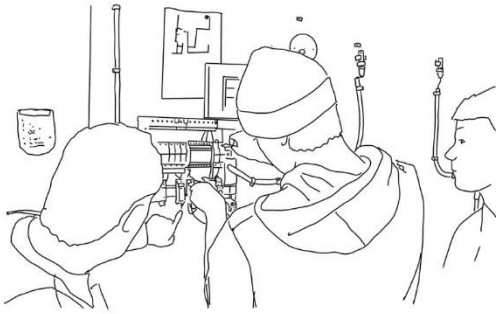
Next, in our examples from the *Building and Construction Programme*, all students had the same overall task – to brick a small wall from scratch (see Example 2). However, the students were in different phases, so they had slightly different ongoing objects of learning, as parts of the superior object of learning to brick a wall.



Example 2. Building and Construction Programme

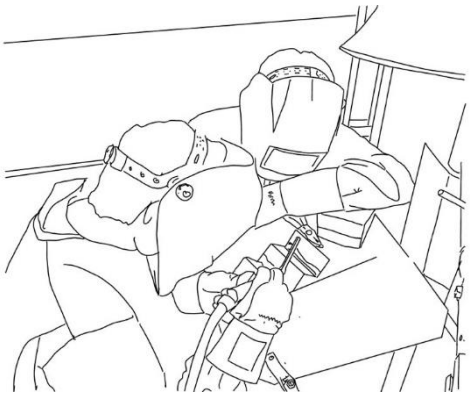
The lessons we video recorded in the building and construction workshop started with a small introduction at the whiteboard, where the teacher instructed the students on some possible critical aspects they could meet during their work in the workshop. The enacted objects of learning during the video-recorded lessons concerned for example how to brick a stable construction, how to mix mortar, how to measure and the use of different kinds of tools. The students then worked on their tasks individually, but they were also encouraged to help each other, while the teacher moved around in the classroom helping the students to go on with their tasks. The teacher often encouraged the students to reflect on solutions of their own or asked for their own ideas about how to solve the problems they encountered during their work.

The examples from the *Electrical and Energy Programme* show how the students, like in the examples from the Sanitary, Heating and Property Maintenance Programme, were working on different kinds of tasks. However, in the Electrical and Energy Programme the students were often working in pairs (see Example 3), and the tasks were different in complexity and had different kinds of security levels. They started with lower amperage due to safety. Safety reasons also explain that two teachers were present in the workshop lessons, together with the 16-18 students. Like in the examples above, the teachers moved around in the classroom helping the students to go on with their tasks. Most of the tasks took point of departure in a drawing, from which the students were supposed to work. The objects of learning concerned for example plugging in toggle switches and time controlled lamps, wiring cables in and outside walls or for different kinds of kitchen machines.



Example 3. Electrical and Energy Programme

Finally, the examples we have analysed from welding education at the *Industrial Programme* are a bit different in character. They derive from an intervention study, where the teaching was based on CAVTA, conducted in iterative cycles in collaboration between teachers and researchers. Hence, we did not film teaching in its natural settings, but worked together with a welding teacher team to develop the welding education on a scientific basis in relation to the specific welding method TIG-welding, using the Learning study method (cf. Asplund & Kilbrink, 2020; Kilbrink & Asplund, 2019, June for further descriptions). In the project, one of the participating teachers tested the use of theories in teaching together with 3-4 students per iterative cycle. In the first cycle, there were a lot of objects of learning set into play in the teaching situation (see Kilbrink & Asplund, 2018, June), but the further into the Learning study, the more focused the teaching. Furthermore, the complex relation between different aspects of TIG-welding were made visible, both to the teachers and students, as well as to the researchers. Moreover, the actual teaching changed from a lot of teacher instruction to more active student participation, both in the lecture parts of the lessons and in the parts when the students were welding individually in the different welding booths (see Example 4).



Example 4. Industrial Programme

By letting the students show and verbalise their knowledge in relation to the object of learning in focus in the interaction with the teacher, the teacher could reach the students' understanding of the object of learning and thereby adapt the teaching to the students' knowledge and focus on the relevant critical aspects in teaching.

Discussion and conclusion

From the examples presented above, we can see that both similarities and/or differences between different subject specific education in the technical vocational workshops emerge in the interaction between teacher and students in relation to *what* is being taught and *how* the teaching and learning is done. For example, some common aspects emerge – such as the interplay between theoretical and practical knowledge, the use of working tools, the problem solving and the complexity of interacting critical aspects (cf. Asplund & Kilbrink, 2020; Kilbrink, 2013; 2018). However, there are also differences between the learning content in the teaching of different vocational subjects, in relation to working methods and the nature of the objects of learning. The results show that to teach and learn a technical vocational content are complex processes, consisting of many interacting aspects concerning both theoretical and practical knowledge in relation to the objects of learning. In the vocational classrooms in our studies, the students were working with different projects, and the teachers had to handle different objects of learning and individual students' different understanding of the learning content at hand. In addition, the critical aspects of the objects of learning were also often depending on each other and could have a hierarchical interrelationship.

We do not argue that the differences between the examples from different vocational subjects in this study are subject specific, more studies are needed in order to make claims like this. The differences can also be related to how different schools, or different individual teachers plan and execute their teaching, depending on, for example, pedagogical views or how the material resources give them possibilities to structure their teaching. However, we can see that there is a deeper complexity than to talk about technical vocational education as one uniform thing.

In order to adapt the teaching to the individual students in the vocational classroom, we argue that it is important to endeavour to reach the students' understanding of the object of learning in interaction (cf. Asplund & Kilbrink, 2020). Though partly already existing in the teaching of a technical vocational content in the examples of our study, this can be done more systematically, by the use of different communicative resources, as seen in the welding examples, where this was part of the intervention. Gradually, the teaching was modified towards a higher degree of student participation in the interaction. Thus, teacher and student moved closer to a mutual understanding of the object of learning, supported by the tools of CAVTA.

Moreover, we saw that teachers often taught the learning content in a broad perspective, which could be at the expense of a clear focus for the student. As observed in the intervention study, an enhanced focus on fewer, specific critical aspects of the object of learning, and their hierarchical interrelationship, might support the learning process. The students are guided towards what to focus in the specific learning situation and progression is thereby supported. Arguably, our results suggest that discerning critical aspects and their hierarchical interrelationship in actual teaching situations could be a time consuming, but rewarding challenge for the vocational teachers, and may support technical vocational education students' learning processes.

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