Subject specific pedagogy in technical vocational education – the implementation of a new way of teaching

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ABSTRACT

Research regarding classroom pedagogy of subject specific contents in the field of technical vocational education is scarce, nationally in Sweden, but also in an international perspective. This paper presents results from a Swedish action research project and it aims at exploring the process of a learning study, which deals with the settings in MIG/MAG welding and the intervention of the new pedagogic approach CAVTA (Conversation Analysis and Variation Theory Approach). The empiric material consists of video recorded welding education in a workshop and documented meetings in a welding teacher team. The theoretical toolbox of CAVTA permeates the teaching and learning processes as the teachers in the intervention try to implement patterns of variation in the planning, enactment and evaluation of the teaching and learning processes. In combination with the variation theoretic principles embedded in the teaching, ideas inspired by conversation analysis are implemented – the main element being an enhanced interaction, thus enabling for the students to display their understanding of the subject specific contents. The results show how CAVTA can be integrated in the teaching of settings regarding MIG/MAG welding, so that certain aspects of the object of learning is visualized. Furthermore, the findings show how the integration of CAVTA support the manifestation of a student's understanding of the object of learning. How variation and the use of several senses and simultaneous different semiotic resources are activated as essential components in the teaching and learning processes, is made explicit in the paper. Plans for a recently launched research project including several different technical vocational education programs are also presented. The lack of classroom studies regarding technical vocational education calls for exploration in research, but should not avoid the ambition of development. This study captures the design and the development of a new pedagogic approach. Our hope is that the study will contribute to a growing body of knowledge within the field of technical vocational education and spur on further studies in this field of research.

Key Words: technical vocational education, CAVTA, action research, learning study

1. INTRODUCTION AND PREVIOUS RESEARCH

It is hard to estimate the quantity of welders around the world, but figures imply that the number is overwhelming. Merely the number of welding jobs in the USA was estimated to be 428 000, in 2021 (United States Department of Labor, 2023). However, recent educational research regarding welding has almost exclusively focused on the introduction of virtual reality technology (Huang et al., 2020; Rodríguez-Martín & Rodríguez-Gonzálvez, 2019; Torres et.al, 2017). It is important to conduct more studies focusing on the actual teaching and learning processes in the area of authentic practical welding and education of new welders. The focus of this study is school based practical welding education in a workshop, and thus it contributes with knowledge in a neglected area of research.

Researchers and a team of welding teachers have co-operated in the project *Learning to weld in vocational education*[1] to contribute with knowledge regarding what happens in teaching and learning situations in the workshop of Swedish practical welding education at an upper-secondary school and this paper focuses on the third and final year of the project. More specifically, the aim of the paper is to explore the process of a learning study, which deals with the settings in MIG/MAG welding and the intervention of the new pedagogic approach CAVTA (Conversation Analysis and Variation Theory Approach). In the paper we focus on the research question:

How can tools from CAVTA provide support for the teaching of settings regarding MIG/MAG welding?

2. THEORETICAL FRAMEWORK AND METHODOLOGY

CAVTA as a pedagogic approach and an analytical tool was inspired by Emanuelsson's and Sahlström's (2008) ideas of combining conversation analysis and variation theory in educational research. Ten years later Asplund and Kilbrink (2018), explored the combination of the theoretical perspectives in educational research of vocational education, and in the research project *Learning to weld in vocational education*, they went even further and formed the new pedagogic approach CAVTA (Asplund & Kilbrink, 2020; Kilbrink & Asplund, 2020). The basis of CAVTA is the position that learning includes the dimensions contents (what is to be learned), and process (how something is learned). The interaction between the person learning something, and the person teaching the contents, is given great importance in CAVTA. Conversation analysis mainly contributes with instruments regarding the how aspect, and the variation theoretical toolbox is mainly linked to the what aspect. With CAVTA, Asplund and Kilbrink found a way to explore how a combination of conversation analysis and variation theory could function as "as a fundamental point of departure in teachers' work on planning, executing and evaluating their own teaching" (Asplund & Kilbrink, 2020, s.4).

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2.1. Conversation analysis

Conversation analysis is an approach to study the interactional organization of social activities. It is often described as having a radical departure since it tries to describe and analyze the actions participants do, and how these actions, that are by and large intersubjectively recognizable, are perceived and oriented to by other participants. Thus, what CA studies is how participants produce an action and how they display their understanding of each other's actions and what this generates in terms of new actions (Goodwin, 2000; Hutchby & Wooffitt, 1998; Sahlström, 2011; Schegloff, 1997, 2007). As interaction is examined as a site where intersubjective understanding about what a speaker means to accomplish is created and maintained (Heritage & Atkinson, 1984), a key feature in CA is to examine how participants arrive at a shared understanding through publicly displayed verbal and embodied conduct (Mondada, 2013). Hence, CA uses representations of the interaction in the form of detailed transcriptions of talk and other conduct, as well as digital video frames or drawings of visual phenomena. However, CA has not only been used as a method to study social interaction; it has also been applied in concrete and actual contexts (Antaki, 2011), and this also concerns how CA is used as a pedagogic approach. The intervention of this study includes the use of CA in the analytic phase of the video recorded teaching sessions and how the teacher enables interaction in the actual teaching and learning situation.

2.2. Variation theory

Variation theory has emerged out of the phenomenographic tradition, mainly by the works of Lo and Marton (Lo, 2012; Marton, 2015). The concept formation of the theory is extensive and the presentation below is limited to the most essential concepts for this study.

Within the tenets of the theory rests the assumption that learning is the learning of something specific – the object of learning (Lo, 2012; Marton, 2015). The concepts patterns of variation, and critical aspects are essential in variation theory; in order to learn something, we need to experience that something in a new way. According to VT principles we need another thing to compare it with – we need variation in the learning situation. Regarding most objects of learning there are a great number of aspects the learner has to discern. The teacher's task is to define these aspects and identify the aspects which are critical for the learner's progression. The difficulties the learner encounters are called critical aspects and variation is the main key to support the learner, according to variation theory. By trying to single out a critical aspect the teacher can help the learner discern the aspect – something called separation. In a teaching situation the teacher is advised to vary the critical aspect by a pattern of variation called contrast, whereas the other aspects should be kept invariant (Marton, 2015). The idea is that it is easier for the learner to discern the critical aspect if it is only the critical aspect which is manifested in different dimensions of variation. By the variation, the critical aspect is brought to the forefront against a backdrop which to the highest extent is kept constant.

2.3. CAVTA in teaching

The close interaction between the teacher and the student has been emphasized as important in variation theory (Marton, 2015). One of the major findings of CAVTA in welding education

(Kilbrink et al., 2022) has been how tools from conversation analysis can help teachers improve their teaching in interaction, thus making use of the students' verbally and embodied displayed understanding to modify the teaching and learning situation. Including ways to enable interaction already in the planning, supports the teacher to be prepared to identify critical aspects. If there is an orientation towards a shared understanding and the students show signs of mastering the targeted critical feature, the correct value of a critical aspect, the students are ready to move on in their learning process.

In order to fully utilize the potential of the interaction, the teacher needs to be diligent planning and designing the teaching. The object of learning needs to be specified, and expected critical aspects need to be separated (Kilbrink et al., 2022). The visualization of critical aspects has been emphasized as important in the variation theoretic tradition (Pang & Ki, 2016; Thorsten, 2019). In the planning stage the teacher is therefore recommended to be creative finding suitable designs of exercises so that the students are supported in the discernment of critical aspects.

2.4. The learning study – three cycles of MIG/MAG welding education

The cyclic design of the learning study model (Marton & Runesson, 2015; Wood, 2014) is strongly intertwined with CAVTA, which concepts and theoretical tools permeate the complete teaching and learning process. Since the students display their skills and the way they understand the object of learning in the design of the teaching sessions of this study, there is no need for the pre- and posttests of a traditional learning study (Kilbrink et al., 2022). The cycles started with planning meetings, continued with teaching sessions and ended with evaluation meetings. The meetings were audio recorded and the teaching sessions were video recorded. The initial analyses were conducted throughout the learning study process, in co-operation between the researchers and the welding teachers. The integration of CAVTA principles and signs that learning took place was the focus of the analyses. The analyses served to further improve the integration of CAVTA into the teaching sessions. After the three cycles of the learning study had been conducted a process of selecting and transcribing relevant sequences from the empiric material followed. Sequences which exemplify the impact of CAVTA were transcribed and analyzed according to conversation analytic principles. In this paper the transcription has been translated into English.

The empiric material of the third year consists of two hours and 42 minutes video recorded material from three teaching sessions and two hours and 52 minutes audio recorded material from researcher and teacher team meetings. The selection of students was purposive. Four students, aged 16-18, who had not been taught in the welding method MIG/MAG previously, participated in each cycle, and accordingly, the four students were substituted for the following cycle. Ethical issues were taken into regard and addressed according to the guidelines of the Swedish Research Council (Vetenskapsrådet, 2002; 2017). This paper gives a brief overview of the complete process, and gives space to a clarifying example of the use of CAVTA in an actual teaching and learning situation.

In the syllabuses of welding education at Swedish upper-secondary schools the text describing the contents of practical welding is vague. Thus, the individual teachers are handed the responsibility to select the contents and design the practical welding education. In the first meeting of the three cycles, the welding teachers made the decision that the object of learning

would deal with the welding method MIG/MAG. According to the learning study tradition (Marton & Runesson, 2015) and variation theory (Lo, 2012), the object of learning in a learning study ought to be something that students generally experience difficulties with, or something that the teachers have found problematic to teach (Carlgren, 2018). The teachers agreed that the settings of the equipment regarding MIG/MAG welding pose difficulties for many students and that the settings ought to be addressed early in the learning process of MIG/MAG welding. Thus, the object of learning was specified as the settings of MIG/MAG welding, in 3 mm, low alloy construction steel, in the welding position PA.

Preparation and planning the integration of CAVTA principles followed. Expected critical aspects (Kilbrink et al., 2022) were defined and ways of visualizing these through separation and contrast were discussed. How to keep other aspects constant was also discussed, since that is an essential recommendation of variation theory (Marton, 2015). Although the sound of welding is not mentioned at all in the syllabus of the course, the teachers agreed on including sound as subject specific contents when teaching the settings of MIG/MAG welding.

3. ANALYSIS AND RESULTS

Throughout the three cycles, the empiric material shows how the teacher team and the individual teacher continuously revise the teaching. They develop and redesign exercises in order to support the discernment of expected critical aspects. The teacher enacting the teaching sessions improves the interaction with the students and makes use of different semiotic resources in letting the students display their understanding. The narrow object of learning is the focus, but the dynamic nature of it (Lo, 2012) can be observed. For example, the teachers realize that the sound should be brought to the foreground to an even higher degree than they expected from the beginning. A more extensive presentation of the complete process has already been published (Axelsson et al., 2023). In the following we will concentrate on an analysis of a clarifying example of how the teacher was supported by CAVTA.

The example is an excerpt from the teaching session of cycle 2 (see Figure 1). In the excerpt, a student (S) is welding individually (see Figure 2). Simultaneously, the teacher (T) adjusts one of the settings, the wire speed. Preceding this excerpt, the teacher had demonstrated the adjustment of the wire speed in a gathering with the rest of the students, presenting ‘a reference sound’, the sound of the welding when the settings are correct. He had contrasted this correct sound with the sound of the welding when the wire speed was too low and too fast. The setting of the wire speed has a correlation with the setting of the voltage, but the teacher had decided to adjust only the wire speed in order to help the students discern that aspect of setting the equipment correctly.

Figure 1.
Teaching session (a modified video screenshot)

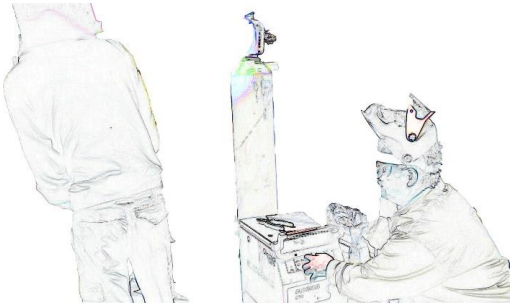

Figure 2.
Transcript 1

1		((the welding begins (4.0) – the sound is hissing, mixed with irregular popping sounds))
2	T:	more wire (.) or less?
3		((S turns his head towards T, but continues welding))
4	S:	more
5	T:	more
6		((S is welding (4.0), while T slowly turns the knob controlling the wire speed, the sound changes
7		towards a much more regular and sizzling sound))
8	S:	and more
9	T:	more?
10	S:	yes:
11		((S nods and continues welding (5.5) the continous change in the sound towards the regular
12		sizzling sound is simultaneous with T's increase of the wire speed))
13	S:	more
14	T:	more
15		((S is welding (3.5), T slowly continues adjusting the wire speed, and the the sizzling sound
16		becomes even more regular))
17	S:	more
18		((S continues welding (4.5), T still turns the knob which raises the wire speed and the frequency
19		of the short circuits which cause the sizzling sound is much higher than at the beginning of the
20		welding))
21	S:	more
22		((14 seconds excluded from the excerpt))
23	S:	yes, that's about it, then
24	T:	yes, you can stop, then

During the first four seconds of the excerpt (line 1) nothing is said, but S starts to weld. By posing the question ”more wire or less?”, in line 2, T shows he wants information regarding the wire speed from the student. In line 3, S confirms he has noticed T's question, when he in the midst of the welding turns his head towards T. S then stresses the answer ”more” (line 4), thus displaying he wishes T to increase the wire speed. T responses by a confirming ”more”, in line 5. Then (line 6), T raises the wire speed and the sound changes to a more regular sizzling sound. S

simultaneously continues to weld for four seconds and then utters ”and more” (line 8); an utterance T seeks to confirm by the question ”more?”, in line 9. S confirms T’s question, in line 10, and reinforces the confirmation by nodding his head (line 11), still keeping his gaze at the welding he performs. In line 13, S demands higher wire speed which is confirmed by T repeating ”more” (line 14), whereupon he increases the wire speed (line 15). When S demands more (higher wire speed), in the lines 17 and 21, we can see that T no longer replies S verbally, instead he just responds to the demand by carefully and slowly adjusting the setting of the wire speed (line 18). In line 23, S shows his satisfaction with the settings, thereby displaying his understanding of the wire speed setting.

In the excerpt, the intervention of CAVTA includes that the already narrow object of learning, in this case the settings of the MIG/MAG equipment, has been decomposed even further into the expected critical aspect adjustment of the wire speed. This expected critical aspect is visualized by the pattern of variation called contrast (more or less wire speed), by letting the wire speed adjustment be the only aspect to be varied. Thus, according to the tenets of variation theory (Lo, 2012), the learner is supported in discerning the varied aspect. The variation of a critical aspect against a backdrop of other invariant aspects brings it to the forefront. The visualizing of the expected critical aspect occurs at the same time that the teacher encourages interaction by letting the student display his understanding of the object of learning. Thereby, the teacher can pay attention to whether or not there is an ongoing orientation towards a shared understanding. In this interaction, and the analysis of it, the use of conversation analytic procedure displays how the participants use different semiotic resources and different artefacts to create meaning in their orientation towards a shared understanding. Apart from the verbal language, the excerpt displays how head movements, sound, and different parts of the equipment are important in the process of establishing a shared understanding regarding the settings of the MIG/MAG equipment. Furthermore, in the continuing sequence of this excerpt the teacher and the student engage in a dialogue evaluating the exercise. In that interaction the sound of the welding is focused when the teacher and the student, using verbal language and gestures, try to agree on the targeted critical feature. In conversation analytic terminology, they negotiate in an orientation towards a shared understanding.

4. DISCUSSION AND CONCLUSION

In this study, we can see how CAVTA concepts such as separation and contrast in combination with an active ambition to enhance interaction in the pedagogic approach seem to support teachers when designing and enacting teaching and learning situations regarding practical objects of learning in welding.

The intertwined combination of conversation analytic and variation theoretic perspectives seems to help the teacher probing into the students’ learning progression, thus supporting the teacher to revise the teaching. The combined focus of the learning contents, and the focus on the students’ displayed understanding, when the expected critical aspects are being dealt with in the practical welding, is useful. The teaching and learning situations provide the teacher with helpful information in what way to proceed in the teaching and learning process.

In an ideal learning environment, these issues are dealt with in full-blown learning studies. The rich toolbox of CAVTA is probably best used with rich empiric data such as video recorded teaching sessions. Full-blown learning studies may be difficult to organize and to get means to, though. Nevertheless, CAVTA may also function as a more general approach for welding teachers. Paying extra attention to a narrow object of learning and a focus of variation in demonstrations in combination with a focus of how to interact with the students when designing teaching and learning situations, may serve to improve the practical welding education.

5. FURTHER RESEARCH

Results from this project could be relevant for other teaching areas including practical objects of learning. The importance of studying teaching and learning processes in relation to technical vocational objects of learning as a response to the lack of research in this area has been emphasized (Kilbrink et al., 2022). Therefore, based on the results from this study on welding, we have launched a new project, *Approaches to subject-specific teaching in vocational education*[2], in collaboration with teachers from other technical vocational programs and aim to further study and develop teaching in different vocational subject-specific areas. In the next step we will focus on the uniqueness of each subject and on aspects that could be similar when dealing with practical objects of learning within different areas, with the purpose of developing vocational teaching and learning on a scientific basis.

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