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Critical aspects of welding: negotiating an object of learning in vocational school

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Abstract
The learning process in programme-specific subjects in technical vocational education often involves treating the object of learning in student-teacher interaction. Teaching also often includes handling different tools and materials manually. In this paper, we discuss the process of learning a specific object, namely learning to weld as it emerges in interaction between a teacher and a student in a teaching situation in a technical vocational classroom. The focus is on both the what-aspect and the how-aspect of learning, where variation theory is the analytical framework for the what-aspect of learning, and conversation analysis (CA) is the analytical framework for the how-aspect. By intertwining the two methods/frameworks we can get a deeper understanding of the learning process concerning a specific object of learning.

Keywords: Vocational learning; Variation theory; Conversation analysis, Learning content, Technical vocational education.

Introduction
Teaching and learning in vocational subject areas as well as learning a technical content have been highlighted as specific in different studies and handicraft, practical experience and physical work emphasized as central parts (cf. Bjurulf, 2008; Kilbrink, 2013). Furthermore, Björkholm (2015) argues for the importance of studying technical objects of learning in order to learn more about teaching and learning technology. The object of learning (OoL) in programme specific subjects in technical vocational education is often handled in interaction between student and teacher. However, there are few studies focusing on how those learning objects are being taught and learned in the interaction between student and teacher. In this study we focus on the OoL to weld and more specifically on what is possible to learn about welding in the learning interaction and how the learning content is made relevant in the interaction.

Previous studies using the variation theory have focused on the content in teaching and learning, without focusing on the interaction between the teacher and learner (cf. Bjurulf, 2008). However, the social interaction can influence how the content is highlighted in the learning situation, and by studying how the OoL is manifested during the interaction, we can get a deeper understanding on learning processes concerning both what is being learned and how this learning is done in interaction. This can be done by integrating a variation theory analysis (VTA) with a conversation analysis (CA) of the interaction on a specific OoL in a teaching situation (Asplund & Kilbrink, 2016). By combining the two perspectives VTA and CA, we aim to reach a broader knowledge about both the what- and the how-aspects of learning a specific OoL in technical vocational education. The research question for this study is:
Which critical aspects of the OoL to weld are oriented to and how are they made relevant in the interaction between a student and a teacher in a learning situation?

**Theory and Method**

This study is based on the view that learning is a process, comprising the aspect of *what* is being learned and *how* learning is done in interaction in the actual teaching situation (Emanuelsson & Sahlström, 2008, Marton & Tsui, 2004; Sahlström, 2011). In variation theory, there is an emphasis on the learning content as the OoL. The OoL can differ between what the teacher planned for (the intended OoL), what was possible to learn in the teaching/learning situation (the enacted OoL) and what the students learned (the lived OoL) (Marton & Tsui, 2004). In this study, we focus solely on the enacted OoL and what was possible to learn in the interaction between a vocational student and his teacher. Critical aspects are the aspects that are important to understand in order to learn an OoL. Which critical aspects to focus on in teaching can differ between different students (ibid.). The critical aspects can be highlighted in teaching by using different patterns of variation. In variation theory there are four patterns of variation – *fusion*, which means that all critical aspects are present at the same time; *separation*, which means that one critical aspect of the OoL is highlighted and varied, while others are kept invariant; *contrast* means that the varied critical aspect is compared to something it is not; and finally, *generalization* means that the critical aspect is highlighted by showing different appearances of the critical aspect (ibid.). The critical aspects of the OoL that emerge in the interaction and the patterns of variation that are used in relation to those emerged critical aspects are focused on in the VTA.

CA focuses on how meaning and understanding are established, sustained and changed in and through the coordinated interaction of people and the interaction between people and artefacts in specific social and cultural contexts (Sahlström, 2009). In CA, language and body are seen as tools through which people construct and reconstruct their social reality, and a central principle in CA is that it takes a radical participant perspective. What is to be studied is how conversation participants produce an action and how they show their interpretation and understanding of other participants’ actions and of the new actions generated (Schegloff, 2007). Thus, in this paper, not only talk but also other semiotic resources such as bodies, gazes and physical objects are seen as constitutive of the activity being analysed. In this work, and in line with the CA approach, we will use detailed transcriptions of spoken data as well as visual phenomena in the interaction between the teacher and the student.

**Analysis and Results**

Two sections from a film where a vocational teacher and a student interact in relation to learning to weld were chosen and have been analysed in detail using VTA and CA. The critical aspects emerging in the interaction will be highlighted in **bold** text, and the pattern of variation used in relation to the critical aspects will be shown in *italics*. How those critical aspects and patterns of variation are oriented to in the interaction will be shown in the CA analysis, interwoven in the VTA analysis.

**Example one**

The video recorded film starts when the teacher (T), seated on a bench, starts to weld on a small weld metal, while the student (S) stands to the left watching:
In the recorded scene there is work in process in which the teacher positions himself as the more knowledgeable other and thus gains epistemic authority (Vähviläinen, 2009) while the student takes the role of being the less skilled of the two. This is a relationship that is established as soon as the teacher takes the position as the expert, sits down and shows the student how the welding should be done.

When the teacher then takes the role of the expert and shows the student how to weld, his welding becomes a model of how the welding process should proceed, and from a VTA perspective there are several critical aspects of the learning object to weld present simultaneously. The variation pattern that is made visible in this situation is fusion and the student sees the teacher as a role model who demonstrates the actions that the student himself is expected to do.

When the teacher has finished his welding, a sequence follows where he verbalises to the student what to think about when welding as follows:

1. T: If this is ( . ) if this is the welding nozzle ((Bends the top of the welding wire in a 45 degree angle.))
2. S: Yea:h.
3. T: Then you have about the same, ( . ) First you should have ninety degrees like.
4. his

In this example, the critical aspect of welding highlighted in the teaching situation is the angle of the welding nozzle. This is the focus in the interaction between the student and the teacher. The example begins with the teacher “transforming” (line 1) the welding wire that he is holding in his hand into a welding nozzle by saying “if this is the welding nozzle” while bending the upper part of the welding wire in a 45 degree angle, and simultaneously using different kinds of semiotic resources (talk, embodied actions and artefact) in order to demonstrate the process of the transformation of the welding wire. The welding wire, from this point on, is thus the basis and starting point for the continued instruction of how to weld, i.e. the teacher and the student continue to relate to the welding wire as a welding nozzle. In this way, the angle at which the welding nozzle is supposed to be held is separated from all other critical aspects. By using generalisation the teacher illustrates how the angle should be – both with the real nozzle, and with the wire that he bends like the welding nozzle in order to show the right the angle to the student.

**Example 2:**
In the second example, Robin has been welding on his own in front of the teacher for a short time and then Robin is encouraged by his teacher to “get some rest”:
1. T: Now it will be hot. You can take some rest. ( . ) Do you know what is strange, Robin!?
2. S: No?
3. T: When you have: ( . ) Hmm. ( . ) When you have the weld too high -
4. S: Yes:?
5. T: Then it gets too hot.
6. S: Yes. ((Lifts the plate and looks at it.))
7. T: And when you push the weld down ( . ) then it gets cooler.
8. S: Yes?
9. T: You have to fool the brain a little.
11. T: Because you know ((looks at Robins face)) when it gets hot then you want to pull away, don't you?
12. S: Yes.
13. T: But when you pull away then it gets even hotter.
15. T: Try again, we'll see.
16. S: ((Robin starts to weld again.))
17. T: Angle more Robin. Yes, so. ( . )
18. ((Grabs Robin’s right hand which is holding the weld. Moves the hand down towards the bench at angel from Robin’s body.)) Aim like that ( . ) That’s right

When Robin has welded for a while, the teacher makes Robin aware that “it” will be hot and that he should rest for a while from the welding process (line 1). In this sequence, heat emerges as a critical aspect of welding in the interaction, by being singled out from other critical aspects using separation as pattern of variation. The teacher follows up his request with a rhetorical question (“Do you know what is strange, Robin?”) which leads to a situation in which the teacher again is given the epistemic authority – he is positioning himself as the more knowledgeable (teacher) who can show his skills by instructing the student how to weld. But in this section he is not doing it as a role model, where all critical aspects are shown by fusion, but by emphazising different critical aspects one by one, using separation. In the turns that follow, it is the welding nozzle’s distance to the goods being welded that the teacher and the student orient towards, and, according to the teacher’s action, it is also made clear that the distance to the plate that they orient to, follows a “different” logic and therefore also demands a “different” way of thinking.

In lines 4 and 6 the teacher informs the student that if he holds the welding nozzle “too high” during the act of welding, it then “gets too hot”. Here the heat is highlighted as a critical aspect by separation. This critical aspect is emphasized as a consequence of the distance of the welding flame to the plate, which also emerges as a critical aspect. If he would then “push the weld down ( . ) it gets cooler” (line 8). The teacher then follows up this statement in
line 10 with the suggestion that “You have to fool the brain a little”. Hence, the values that the critical aspect **distance to the plate** can gain are: too high, to low and something in-between that is correct, but it is not explicitly made clear what it is. The pattern of variation that appears in relation to the distance to the plate could be seen as **contrasting** an expected experience that the teacher highlights in line 1 (“Do you know what is strange?”), in line 10 (“You have to fool the brain a little”) and in line 12-13 (“when it gets hot, you want to pull away, don’t you?”). Hence, the contrast is not made to something that is happening in the actual situation, but to something that the teacher expects the student to experience. Thus, this pattern of variation requires that the student is simultaneously aware of what happens here and now, and something that the teacher expects him to already know.

Robin’s reaction in line 11 (a somewhat cautious “oka:y”) is an expression of displayed attention but also a readiness to listen further. Robin’s somewhat cautious response is followed up by the teacher who continues his efforts to explain how to think when one is welding. He begins this in lines 12-13, where he is positioning Robin as someone who “knows” that when “it gets hot, you want to pull away”. Hence, what the teacher is doing in the example is to start from what one could say is a completely normal and natural reaction; if you are confronted with a situation where something gets too hot, the normal reaction would be to retract from the heat you are exposed to. In this specific situation, which the teacher and the student are oriented to, this means that if/when the temperature gets too hot at the welding point during the welding act, the normal/natural reaction is to remove the welding nozzle and its flame from the goods. The teacher makes the student aware that both he and the student already “know” this. Also, the teacher uses the expression “don’t you” when saying that “when it gets hot, you want to pull away, don’t you?” which is our translation of the Swedish epistemic adverb “ju” and it underlines that what is being said is something known by the other present participants (Aijmer, 1996, p. 421). Thus, the teacher’s utterance is affirmed by Robin in the following turn. Then, the teacher shifts his reasoning when saying, “But when you pull away then it gets even hotter”. Robin affirms this with a more distinguished “okay” than he did before (line 16) and in connection with this, the teacher asks him to “try again” (line 17). The teacher’s expression “try again, then we’ll see” encourages the student to continue welding. In the act of welding, the previously **separated** critical aspects are now included at the same time by the variation pattern **fusion**.

Soon the teacher tells the student to “angle more”, and the **angle** emerges as a critical aspect. In relation to this recommendation, the teacher grabs the student’s arm and moves it into another position than the student has chosen himself, which could be interpreted as if verbal instructions were not enough. Thereby, the teacher uses **contrast** as a pattern of variation, when he compares to how it should be done the actual act (both verbally by saying “angle more” and physically, by helping the student find the right value of the angle with his hands). As soon as the teacher has done this he asks the student to “Aim like that”, and when the teacher says “that’s right”, he seems to be satisfied with the result, and the critical aspect **angle** has been ascribed its right value.

**Discussion and conclusion**

In the example the teacher starts by showing the whole process of welding as a role model. Then all the critical aspects are fused in the teacher’s welding action. Thereafter the critical aspects are highlighted one by one in the teaching situation, when the student tries to weld under supervision. When separating the critical aspects, the teacher mostly uses contrast to highlight how something should be done, in relation to how it should not be done. The critical aspects that emerge in the interaction and how the actors orient to them can be seen in Table 1:
Table 1 Critical aspects of welding

<table>
<thead>
<tr>
<th>Critical aspect</th>
<th>Pattern of variation</th>
<th>How it is done in interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Angle</strong> of the tool</td>
<td><strong>Generalization</strong> (different tools to show the angle)</td>
<td>Different kinds of semiotic resources (talk, embodied actions and artefact) mutually contextualizing one another</td>
</tr>
<tr>
<td><strong>Heat</strong></td>
<td><strong>contrasting</strong> what happens in the teaching situation to expected knowledge</td>
<td>epistemic authority (teacher), when showing his welding skills</td>
</tr>
<tr>
<td><strong>Distance</strong> to the plate</td>
<td><strong>contrasting</strong> to an expected reaction</td>
<td>epistemic authority (teacher), when instructing the student how to weld.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The use of the utterance &quot;don't you&quot; and its function</td>
</tr>
<tr>
<td><strong>Angle</strong> of the hand</td>
<td><strong>contrasting</strong> to the actual act, both verbally and physically</td>
<td>Different kinds of semiotic resources (talk, embodied actions and artefact) mutually contextualizing one another</td>
</tr>
</tbody>
</table>

The critical aspects in relation to welding that emerge in the teaching situation (the enacted OoL) are negotiated in interaction between the teacher and the student and depending on the student’s actions and handling of the tools and material involved in the process of learning to weld.

By combining the VTA and the CA, we can reach a broader knowledge about both the what-and the how-aspect of learning in technical vocational education. We also argue that this method gives us a hint of how tacit knowledge can be taught in interaction. However, more studies are needed to learn about the OoL, because the critical aspects that already have the right value in the interaction are not highlighted in the situation.

References


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. *NorDiNa, 8*(1), 17-25.


