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# Norwegian and Swedish student teachers' explanations of the solution of a linear equation: A qualitative approach

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The purpose of this study is to explore how student teachers explain the solution to a linear equation. Previous analyses with a quantitative approach have reported what aspects the participants included in their explanations (Larson & Larsson, 2021), applying a set of low inference codes developed by constant comparison (Andrews & Larson, 2019). This report focuses qualitative aspects in these explanations. The participants were 146 Norwegian and 161 Swedish student teachers for compulsory school. They were given a correct but deficit three step solution to a linear equation:

$$x + 5 = 4x - 1 ; \quad 5 = 3x - 1 ; \quad 6 = 3x ; \quad 2 = x$$

The participants were invited to explain the solution to a fictive friend, who was absent when the topic was introduced to the class. The analytic tool (Andrews & Larson, 2019) included codes of how the operations in the solution were explained, and 'explanatory codes' identifying e.g. if the student teacher clarified that the purpose of solving an equation is to find the value of  $x$ , and that you in the solving process want to separate unknowns from knowns. The quantitative analyses showed that less than half of the participants clarified that the purpose of solving an equation is to find the value of  $x$  (the code 'conceptual objective'), while a majority explained that you want to separate unknowns from knowns in the solving procedure ('procedural objective'). Even though previous reports revealed relevant results, including differences between the two countries (Larson & Larsson, 2021), quantitative analyses produce only rough descriptions of the participants' replies. If a script was coded as 'conceptual objective', there might still be differences in how this was expressed. Identifying such differences requires a qualitative approach, where the wording that yielded a specific code is scrutinised. The purpose of this report is to highlight some initial results from this qualitative analysis.

## Conceptual objective

This code deals with the purpose of solving an equation, that is to find the value of  $x$ . Since the task was to explain how to solve the current equation, it is a strength if the purpose of the solution was stated early in the reply. One good example is a script that was well organised in bullet points. The first point said: "When you want to solve an equation, you want to find the value of  $x$ ." This immediately enlightened the purpose of the solving process for the fictive friend or a potential student. Two other examples were: "In the task above we want to find the answer to  $x$ . That is what number  $x$  is." and "Here, we have to find out which  $x$ -value makes the equation work out and the values of each side to become equal." Despite the wording in the former excerpt might not be the best, it still explains that the purpose is to find the value of  $x$ . That is also true for the latter, which in addition mentions the balance property of an equation.

The excerpt " $x$  is a variable we want to find out." includes the notion of variable. It might, however, be unclear because it does not explain what it means to 'find out a variable'. This also applies to the

student teacher who as first sentence wrote “What is sought is the symbol ‘ $x$ ’.”, and later in the script wrote “To get  $x$  ...”. These excerpts deal with the purpose of solving an equation, but the descriptions are imprecise and might not help a student who does not already know what it means to ‘get  $x$ ’.

An example of lower quality is where the ‘conceptual objective’ first is mentioned in the last assertion, after several operational steps: “We do not wish to be left with  $3x = 6$ , we wish to be left with how much  $x$  is. That is  $x = 2$ .” Despite this is a fair explanation of the last step, the reply does not provide the fictive friend an initial information of the purpose of all the operational steps.

## **Procedural objective**

This will be illustrated by just one example. The first sentence said: “Collect all  $x$  on one side.” The following assertions were numbered. Point 1 began with: “Move the  $x$  which is easiest to move (the one that stands alone).” In addition to handling the separation of unknowns and knowns, this assertion also touched how this should be accomplished. Point 2 began: “Collect all detached numbers on one side.” And point 3 said: “To get  $x$  alone, divide both sides by the number in front of  $x \rightarrow 3$ .” Overall, this is a thorough description of the procedure in the solution, that is to separate unknowns from knowns. Several scripts included only the third point from the example above. In spite all these scripts were coded as ‘procedural objective’, providing this description at the end only is an explanation of lower quality than the one providing the idea of separating unknowns from knowns in each step of its explanation.

Finally, there were excerpts mentioning both the ‘conceptual’ and the ‘procedural’ objective, as the one starting “Equations mean to find out what the unknown is, that is  $x$ . We do this by getting  $x$  to stand alone on one side of the equals sign.” Although the language has some shortcomings, this explanation early highlights both the purpose and the process of the solution, which is likely to be beneficial for the student.

## **Summary and implications**

This paper suggests it is important as well *what* is included in the explanation of the solution, as *where* in the solution it appears. It highlights, that before the operational steps you should stress that the purpose of solving an equation is to find the value of  $x$ , and to do that you want to separate unknown terms from known. That will justify the operational steps and is hence likely to be beneficial for the learner. This means the results presented might be useful for teachers, and in teacher education.

## **References**

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