Student teachers' explanations of linear equations evaluated by comparative judgement

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This presentation reports from an ongoing study where Norwegian and Swedish student teachers evaluate scripts from an earlier data collection, where other groups of student teachers were invited to explain the steps of the solution to a linear equation. In the current study, the participants are invited to evaluate these previous scripts by repeated pairwise comparisons. This comparative judgement generates a ranking of the scripts. The purpose of this study is to explore the student teachers' ranking of the explanations of solutions to a linear equation, and what differences appear between judges from the two countries. Initial results indicate that Norwegian judges tend to rank Norwegian scripts higher. This suggests that differences between the two countries identified in the explanations collected earlier remain when another group evaluates these scripts.

Introduction and previous studies

This paper draws on data from two entirely different data collections. First, student teachers at one university in Norway and one in Sweden were provided a correct but deficit four-line solution of a linear equation, with no annotations of the steps included:

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

The participants were invited to explain the steps of the solution to a friend, who was absent when the topic was introduced. These data were analysed by a set of low-inference codes (Andrews & Larson, 2019). One previous report compared explanations given by Norwegian student teachers to those given by Swedish (Larson & Larsson, 2021). This study revealed, for example, differences between the countries regarding how the additive steps in the solution process were explained.

This paper presents an ongoing study, where other groups of student teachers in Norway and Sweden evaluate scripts from the previous data collection. A sample of 20 scripts from each country was selected to get a variation of how the solution was explained, based on the earlier analysis by low-inference codes. All scripts were copied by the first author's handwriting and the language was adjusted to the group of judges, which meant it was not possible for the judges to identify the origin of a script.

Comparative judgement in the ongoing study

An evaluation by comparative judgment is made by repeated pairwise comparisons, where the judge decides which of the two scripts that provides the best reply. This study utilises the web engine No More Marking (NMM), which distributes scripts such that

each script gets approximately the same number of judgements. Then, NMM applies an algorithm to produce a ranking of the scripts. The purpose of this ongoing project is to investigate how the participants rank different explanations, and what kind of differences that can be identified between the rankings in the two countries, for example if Norwegian student teachers tend to prefer scripts produced by Norwegians.

Initial results from Norwegian judgements

A first judging session was made with a group of Norwegian student teachers for compulsory school, years 5–10. They were invited to do minimum 11 and maximum 20 judgements. After removing judges who did not agree to let their data be used for research, as well as one judge who made the judgements with a very short median time, 43 judges and in total 829 judgements remained. NMM computed the SSR-value (a measure of the reliability) to be 0.86, which indicated the result to be of high quality.

A first analysis of this judging session showed that two Norwegian scripts were ranked as number 1 and 2, followed by a Swedish script. The lowest ranked script was Swedish. The mean value of the "scaled score" computed by NMM was 58.5 for the Norwegian scripts and 47.7 for the Swedish, on a scale where the highest ranked gets 100 and the lowest gets 0. This may indicate that Norwegian student teachers prefer scripts written by Norwegians, with explanations that are more common in Norway. However, previous reports have shown the Norwegian scripts to be more complete than the Swedish (Larson & Larsson, 2021), possibly because 43 % of the Norwegian student teachers voluntarily had chosen mathematics as one of their subjects, while all Swedish student teachers had mathematics as mandatory subject. This difference in the quality of the scripts might also be an alternative reason to why the Norwegian scripts were ranked higher, although the sample aimed to include scripts with a variation of strengths.

Further data collection and analysis

At this time, it is too early to conclude why the Norwegian judges as an average ranked Norwegian scripts higher than Swedish. Our expectation is that judgements made by Swedish student teachers will enlighten this issue. Currently, a judgement is ongoing at one university in Sweden, and further data collection is planned at two other universities.

A further analysis of both the existing Norwegian data and the future Swedish data, may also consider what qualities are included in the highest ranked scripts, independent of which country they come from. This has the potential of revealing what explanations to solutions of linear equations student teachers in Norway and Sweden prefer.

References

Andrews, P., & Larson, N. (2019). The development of a set of low-inference codes for uncovering students' understanding of linear equations: Facilitating comparative analysis. In L. Harbison & A. Twohill (Eds.) *Proceedings of the Seventh Conference on Research in Mathematics Education in Ireland* (pp. 35–42). Dublin City University.

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