

# Measuring interleaving of learning goals through an index for proximity

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## Interleaving learning goals as lesson design

This presentation introduces a new – and easy to implement – proximity coefficient  $P_3$  for quantifying the degree of interleaving. Firth et al. (2021) contrasted interleaving and block study to each other where the latter is to focus only one learning goal during a sequence of exercises while interleaving means to intertwine different learning goals. Organising the order of exercises for students according to interleaving or block study has different consequences for students' learning. In a post-test, Noh et al. (2016) found that when students had practiced according to interleaving, they achieved better on tasks that required the students to integrate information. On the other hand, they also found that when students had practiced according to block-study, they achieved better on tasks that required rule-based skills. Interleaving is relevant not only for the mathematical content, but also for how the content is represented, namely, Rau et al. (2013) found that students achieved better when the lesson design was to present learning goals as interleaving and representations as block-study when compared to the opposite design of their classroom experiment.

## Measuring interleaving in textbooks

Most research on interleaving seem to be classroom studies. However, Rohrer et al. (2020) compared six mathematics textbooks in USA and found that in each textbook, about 10% of all the tasks were interleaved and 80% blocked while about 10% were ambiguous in this respect. If including demonstrational examples in a textbook, the definition of interleaving used in Rohrer et al. (2020) is the same as the one in Firth et al. (2021) and the proximity index in equation (1) should capture the degree of interleaving in a textbook.

$$(1) \quad P_3(\text{learninggoal2} \mid \text{learninggoal1}) = \frac{A}{A+B}$$

The sum  $A + B$  in equation (1) denotes the number of tasks having learning goal 1. In equation (1), letter  $A$  denotes the number of tasks with learning goal 1 that also has learning goal 2 in the same, the previous or the following task, that is, in a proximity of three task, therefore the index 3 in equation (1). This definition implies that  $0 \leq P_3 \leq 1$ , where the case  $P_3 = 0$  corresponds to no interleaving and  $P_3 = 1$  corresponds to full

interleaving. Though there are methods for how to quantify similarity between different textbooks, see Petersson (2022), this proximity coefficient seems to be a new development that also measures interleaving.

## Methods

Equation (1) was used for comparing textbooks with respect to interleaving of Foundational Number Sense – FoNS as defined by Andrews and Sayers (2015). The FoNS framework applies to the number range [0; 20] and mathematical knowledge that pupils should learn by their first year in compulsory school. As data for empirically exploring the proximity coefficient  $P_3$ , units of analysis were all tasks in three Swedish mathematics textbooks (Eldorado, Favorit and Singma) and these were analysed with respect to the occurrence of FoNS.

## Empirical results

Some results are that the textbooks Eldorado and Singma had more interleaving than Favorit for tasks on simple addition and subtraction. Singma had more interleaving through tying together counting pictorial objects and transforming this into an arithmetic situation. This could be connected to the emphasis on concrete-pictorial-abstract in Singapore-based textbooks. Despite that, Singma showed less interleaving for systematic counting (stability in the number track) than Eldorado and Favorit. This presentation gives some more details about these results.

## References

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