Theme: Flexibility

THE EFFECT OF PROBLEM FORMAT ON EQUIVALENCE PERFORMANCE

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Mathematical equivalence is a key concept in mathematics as students' understanding of equivalence predicts further arithmetic and algebra achievement. Most primary school students have difficulty understanding mathematical equivalence and thus use incorrect operational strategies when solving equivalence problems. Equivalence problems can be described as equations which have operations on both sides of the equals sign and one of the operands missing (e.g. $a + b = \_ + d$).

Much research has investigated whether particular features of traditional arithmetic problems ($a + b = c$) have an influence on problem difficulty and thus children's and adults' problem-solving performance. Researchers have found that the size of operands, use of particular digits in the operands of a problem, such as addition and subtraction with a unit digit 8 or 9, the position of the missing number, number of digits in each operand, the presence/absence of a borrow procedure, and the type and number of the operations involved in a problem are associated with problem-solving performance and strategy choice for traditional problems (e.g. Caviola et al., 2011; Lemaire & Brun, 2018). There is limited analogous research for *equivalence* problems. Hornburg et al.' s (2018) meta-analysis revealed that accuracy on right-blank equivalence problems ($a + b = c + \_$) was significantly higher than accuracy on left-blank problems ($a + b = \_ + d$) in children aged 6 to 11. In addition, Matthews et al. (2012) found that the placement of operations relative to the equals sign associated with performance, whereas the number of addends and position of the unknown relative to the equals sign had little impact on difficulty.

This work-in-progress explores the problem features that influence students' performance on equivalence problems. Particularly, I am interested to find out whether the position of the unknown (either in relation to the equals sign or within the expression) and problems involving commutativity property of addition influence students' performance. This study is pre-registered. I aim to recruit 156 primary students (age range: 9-11) to take part in the study. Students will complete an online mathematics task involving 48 one-digit addition problems asking them to find out the missing number in equivalence problems. Table 1 provides one example to the different types of problems which were created by manipulating the specific properties of problems, i.e. position of the unknown and involving commutativity.

Table 1.
Equivalence problems in different formats

Types of the Problems	Example
1. Unknown after the equals sign - left blank - commutative	9 + 6 = _ + 9
2. Unknown after the equals sign - left blank – non-commutative	7 + 4 = _ + 5
3. Unknown after the equals sign - right blank - commutative	7 + 4 = 4 + _
4. Unknown after the equals sign - right blank – non-commutative	9 + 5 = 6 + _
5. Unknown before the equals sign - left blank - commutative	_ + 9 = 9 + 6
6. Unknown before the equals sign - left blank – non-commutative	_ + 5 = 7 + 4
7. Unknown before the equals sign - right blank – commutative	9 + _ = 6 + 9
8. Unknown before the equals sign - right blank – non-commutative	5 + _ = 7 + 4

In this online study, I will record students' answers and response times and these will be used as dependent variables in the analyses. I will use a within-subjects design whereby all participants will respond to the same problems, and run ANOVA to explore the effect of problem format on problem-solving performance. Results will make an original contribution to understanding the relation between problem format and equivalence performance and will inform practitioners about why students find particular equivalence problems more difficult.

References

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