Review of: "Statistical Implicative Analysis of Students' Algebra Performance"

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Potential competing interests: No potential competing interests to declare.

This paper contributes significantly to our understanding of algebraic learning by using a novel data mining technique, **Statistical Implicative Analysis**, to uncover the complex relationships between algebraic tasks. The findings suggest new ways to approach algebra instruction by focusing on key foundational skills that support more advanced competencies. However, further validation of these findings and refinement of the methods used, especially concerning missing data and implicative thresholds, would strengthen the research's impact on the field of educational mathematics. The authors discuss the implications of their findings for teaching algebra. The results show that SIA uncovers a rich structure of relationships between algebraic tasks, with some expected relationships (such as between variable conventions and algebraic reasoning) and some unexpected ones (such as the separation between certain types of algebraic modeling). The results suggest that certain algebraic skills, such as setting up expressions to represent numbers or operations, are central to mastering other algebraic competencies. These tasks should be prioritized in teaching sequences. The paper also highlights some missing implications, such as those between canceling in fractions and rational expressions. This could indicate that students find these tasks more difficult, potentially due to unfamiliarity with algebraic letters in calculations. The authors caution that the study's findings should be treated with care due to several limitations:

1. There is no universally accepted threshold for what constitutes a "strong" implication, and the paper presents results across different cut-off levels to provide an impression of the relationship's strength.
2. The study uses one version of SIA, and it is not clear if this is the best method for uncovering algebraic implications.
3. The findings are interpreted through the lens of known algebraic learning phenomena, but these interpretations could be challenged by further studies.
4. The authors suggest further research to validate these findings using other datasets and to explore the theoretical implications of the detected relationships. This could involve testing the findings with data from different educational contexts or using more advanced versions of SIA.

Strengths of the Paper:

1. The paper demonstrates a novel application of **Statistical Implicative Analysis** (SIA) in educational research, particularly in exploring the structural relations in algebraic learning.
2. By uncovering the implicit structures in student performance, the paper provides valuable insights for designing

teaching sequences that could enhance algebraic understanding.

3. The findings reveal both expected and unexpected relations between algebraic tasks, contributing to a deeper understanding of how students develop algebraic competence.

Areas for Improvement:

1. The paper could further elaborate on how to determine the significance of implicative intensity, providing clearer guidelines for educators and researchers using this method.
2. The approach to handling missing data could be improved by incorporating techniques that account for cases where students omit questions due to lack of knowledge, rather than mere oversight.