THE EFFECT OF A STRUCTURED PROBLEM SOLVING STRATEGY ON PERFORMANCE AND CONCEPTUAL UNDERSTANDING IN PHYSICS: A STUDY IN DISADVANTAGED SOUTH AFRICAN SCHOOLS

by

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SUMMARY

Title: The effect of a structured problem solving strategy on performance and conceptual understanding in physics: A study in disadvantaged South African schools

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This study extended existing research on structured problem solving into disadvantaged South African classrooms. Sixteen disadvantaged urban South African high schools participated in a quasi-experimental study to investigate the effect of a structured problem solving strategy in physics on performance and conceptual understanding. The schools were disadvantaged with regard to standards set by the apartheid education system as well as by instruction in English, the second language of the students and most of the teachers. The problem solving strategy incorporated the use of different representations, group work, verbal arguments, written explanations, planning and interpretation of solutions. The strategy was implemented by a cascading model, where the researcher interacted with the teachers, while the teachers interacted with students. The treatment was non-disruptive of the normal school routine. The problem solving strategy was applied throughout the year while learning new content; there were no extra classes or additional work for learners. Normal classroom tests and examinations were utilized as sources of quantitative data.

The treatment group outperformed the control group by 8 % in the midyear examination; this increased average score was statistically significant at the .001 level, indicating enhanced problem solving skills. Evidence of enhanced conceptual understanding was found by analyzing solutions presented in the midyear examination, videotaped problem solving and responses to questionnaires. Two new techniques were developed to assess conceptual understanding. Firstly, “solutions maps” were constructed for specific examination problems. These maps were visual
representations of concepts, formulae, assumptions, substitutions and numerical answers presented by students. The popularity of various routes on the maps was compared for the two groups as a measure of differences in conceptual understanding. Secondly, a “conceptual index” was defined to quantify the extent to which a group of students used a conceptual approach in their solutions, as opposed to an algebraic approach. Learners and teachers regarded the structured problem solving strategy as a viable practice, they believed the students’ problem-solving skills were improved and they commented on the value of the strategy as a facilitator of understanding the language and concepts of physics. Teachers also believed that their own problem solving skills improved.

Greeno’s model for scientific problem solving and reasoning was incorporated to explain the effect of structured problem solving on performance and conceptual understanding. Two complementary theories were offered to explain the results of the study. It was proposed that implementing the strategy fostered (1) the co-development of conceptual understanding and problem solving skills, and (2) the development of a conceptual approach to problem solving.

Implementation of structured problem solving is a small intervention aimed at developing new habits of problem solving. In the South African context, it can make a significant contribution towards the enhancement of learning and teaching physics in disadvantaged schools.
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Dedicated to Horace
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