

DEVELOPMENT OF STUDENTS' LABORATORY
SKILLS USING THREE PROBLEM-SOLVING
MODELS IN PRACTICAL PHYSICS

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ABSTRACT

This study aimed at investigating the development of students' laboratory skills using three problem-solving models in practical physics. The skills considered included the cognitive, manipulative, observational, computational and communicative; while the models were (i) the Researcher's Problem-Solving Model (RPSM), also referred to as the Laboratory Physics Problem-Solving Model (LAPSM); (ii) the Selvarantnam-Frazer's Problem-Solving Model (SPSM), and (iii) the Traditional Practical Physics Pattern (TPPP). Influences of intervening variables like reasoning ability, cognitive style, mathematical ability, problem-solving attitude, motor ability as well as sex of students, were investigated.

A total of four hundred and twenty seven (427) Senior Secondary One (SS2) physics students (272 males and 155 females) from twelve (12) secondary schools in three Local Government Areas of Akwa Ibom State of Nigeria took part in the study. There were three experimental and one control groups.

A pretest-posttest non-randomised group design was used for the study. A total of nine (9) hypotheses were tested using a 4x3x3 factorial analysis of covariance for the first five (5), and a 3x3x2 equivalent for the last four (4).

In all analyses, the Diagnostic Test (DIAT) and practical physics pretest scores were used as covariates. The following outcomes were observed.

The three study conditions (using RPSM, SPSM and TPPP respectively) were each found to be more facilitating than the control condition in the development of cognitive skill ($F_{3, 423} = 636.99, P < .001$); manipulative skill ($F_{3, 423} = 217.92, P < .001$); observational skill ($F_{3, 423} = 377.17, P < .001$); computational skill ($F_{3, 423} = 641.44, P < .001$); and communicative skill ($F_{3, 423} = 520.48, P < .001$). The order of facilitation of the conditions was found to be $RPSM > SPSM > TPPP > CONTROL$ for all skills except the communicative skill. For this skill, the order was $RPSM > SPSM > TPPP = CONTROL$. It was deduced and concluded from this result that the use of TPPP in schools should gradually be phased out while

the use of RPSM or like facilitative models for solving practical physics problems should be encouraged.

Reasoning ability of students was found to influence the development of cognitive skill ($F_{2, 396} = 14.42, P < .001$); observational skill ($F_{2, 396} = 7.34, P < .001$); and computational skill ($F_{2, 396} = 6.05, P < .01$). In all cases high reasoning ability students excelled, followed by low ability students (except for computational skill). The influence of cognitive style was not found significant at .05 alpha level in the development of laboratory skills. However, a direct causal relationship was observed between cognitive style and computational skill. For all other skills, the effect of cognitive style was mediated through reasoning ability.

Motor ability significantly influenced the development of manipulative skill in school students ($F_{2, 389} = 12.19, P < .001$), with direct causal relationship existing between them. The initial significant influence of mathematical ability observed on computational development did not persist in the causal model. Its effect was mediated through reasoning ability.

Students' problem solving attitude was observed to influence their acquisition of computational skill directly and indirectly in the causal model.

The study further revealed a weak causal relationship between sex of student and the development of cognitive and observational skills. Female students were found to perform better than their male counterparts.

In all analyses, none of the intervening variables was found to influence the development of communicative skill significantly. Its development seemed to be totally dependent on the treatment.

Based on the findings of this study, it was concluded that the traditional practical physics pattern currently prevailing in schools is not comparatively effective enough to imbue necessary laboratory skills in secondary students. The use of the more analytical models such as the LAPSM would seem to be more beneficial. Reasons for this were adduced, and the need for the construction, adaptation, and use of LAPSM-related approaches for solving practical physics problems were highlighted. Areas for further research, including the investigation of factors influencing communicative skill in practical physics, were recommended.

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