A COMPARISON OF THE EFFECTIVENESS OF SCIENCE EDUCATION IN KOREA AND SOUTH AFRICA:
A MULTILEVEL ANALYSIS OF TIMSS 2003 DATA

BY MEE-OH KO

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Supervisors: Dr. Estelle Gaigher and Dr. Vanessa Scherman
Science education becomes more important for future national development globally in high-technology-based society. In reaction to the trend, the International Association for the Evaluation of Educational Achievement (IEA) has conducted achievement tests in science along with mathematics, called TIMSS every four years. In TIMSS 2003, while Korea was a higher-performing country, South Africa was ranked in the lower-performing countries. Korea features homogenous demography, centralized curriculum, and competitive educational zeal while South Africa is characterized by multicultural demography with various languages, and previously segregated schools based on races. The current research, which is a secondary analysis of TIMSS 2003 data, aimed at explaining the differences and similarities by identifying factors most likely to influence science achievement in the two countries.

A conceptual research framework was built on the comprehensive literature review which involved mainly school effectiveness research and factors related to science achievement. The conceptual framework consists of multi-levels, viz., student, classroom, school, and context, and three key concepts, namely time on task, opportunity to learn, and quality.

Two research questions were formulated to reach the goal of the research and the first question is: To what extent does TIMSS 2003 reflect factors related to effective science education? Data from the student, teacher and school questionnaires were included in conjunction with the achievement data and analysed by means of factor, reliability and correlation analyses. The factors found to influence science achievement in three levels are as follows: at the student level, books at home, attitudes towards science, time on task; at the classroom level, time scheduled for science and teacher interaction; at the school level, school size, community size, and student background.

The second research question is: To what extent do the factors derived from the analysis explain the differences in the achievement of Korean and South African students? To answer this question, the current research used multilevel modelling
techniques to deconstruct the total variance in achievement into within- and between-classroom/school level. The strongest predictor is attitudes towards science in both countries at the student level. Student background in Korea and safety in school in South Africa is the strongest predictor of science achievement at the classroom/school level. Furthermore, educational resources such as books at home and educational level of father are significant in Korea while language, teacher qualification, physical resources, and educational leadership are significant in South Africa. For Korea, 93% of total variance in science achievement occurred at the student level while only 7% was attributable to the classroom/school level. For South Africa, 41% of the total variance was assigned at the student level and 59% at the class/school level.

From this comparative study, it was recommended that development of student-centred teaching practices to address negative attitudes to science in Korea be considered as opposed to basic issues such as improving teachers’ subject knowledge, developing language skills, and fostering a culture of learning to improve science performance in South Africa.

Key words: science education, school effectiveness, South Africa, Korea, factor analysis, reliability analysis, correlation analysis, multilevel analysis, TIMSS
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List of Acronyms

AIC – Akaike Information Criterion
ANC – African National Congress
C 2005 – Curriculum 2005
DBE – Department of Basic Education
DET – Department of Education and Training
DoE – Department of Education
FET – Further Education Training
FIMS – First International Mathematics Study
FISS – First International Science Study
FML – Full Maximum Likelihood
FRD – Foundation for Research Development
GDP – Gross Domestic Product
GET – General Education and Training
HE – Higher Education
HSRC – Human Sciences Research Council
IAEP – International Assessment of Educational Progress
ICT – Information-Communication Technology
IEA – International Association for the Evaluation of Educational Achievement
IGLS – Iterative Generalized Least Square
IIEP – International Institute for Educational Planning
IRT – Item Response Theory
ISC – International Study Centre
IT – Information and Technology
KICE – Korea Institute of Curriculum and Evaluation
KMO – Kaiser-Meyer-Olkin
MAR – Missing At Random
MCAR – Missing Completely At Random
MEHRD – Ministry of Education and Human Resources Development
MIP – Mathematics Improvement Program
ML – Maximum Likelihood
MLA – Monitoring Learning Achievement
MNAR – Missing Not At Random
MOS – Measure Of the Size
NAEP – Nation Assessment of Education Progress
NCS – National Curriculum Statement
NELS – National Education Longitudinal Study
NRC – National Research Coordinator
NSAECE – National Scholastic Achievement Examination for the College Entrance
OBE – Outcomes-Based Education
OECD – Organization for Economic Cooperation and Development
OTL – Opportunity to Learn
PIRLS – Progress in International Reading Literacy Study
PISA – Programme for International Student Assessment
PLS – Partial Least Squares
PPS – Probability-Proportional-to-Size
QCM – Quality Control Monitor
RML – Restricted Maximum Likelihood
RNCS – Revised National Curriculum Statement
SACMEQ – Southern and Eastern Africa Consortium for Monitoring Educational Quality
SD – Standard Deviation
SE – Standard Error
SER – School Effectiveness Research
SES – Socio-Economic Status
SIMS – Second International Mathematics Study
SISS – Second International Science Study
SPSS – Statistical Package for the Social Sciences
STS – Society, Technology and Science
TCMA – Test-Curriculum Matching Analysis
TER – Teacher Effectiveness Research
TIMSS – Trend in International Mathematics and Science Study
UNESCO – United Nations Educational, Scientific, and Cultural Organization
UNICEF – United Nations Children’s Fund
VIF – Variance Inflation Factor