Structural Equation Modeling of Knowledge Content Improvement using Inquiry Based Instruction

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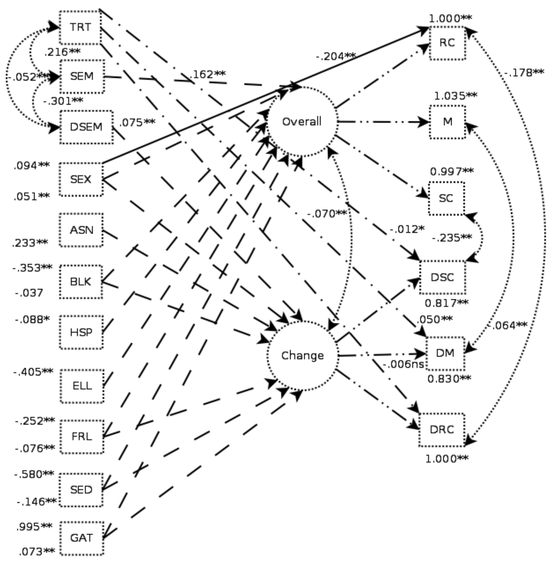
Setting

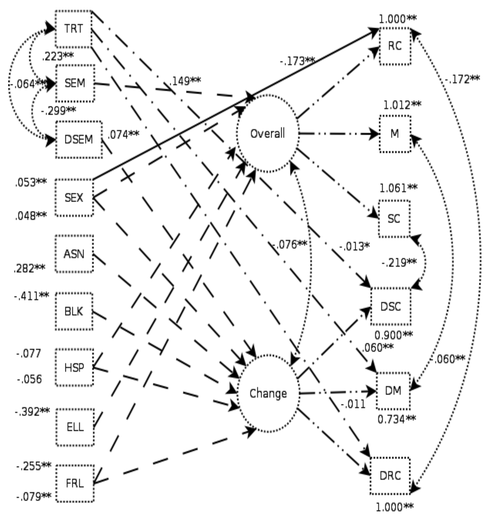
The target of inquiry-based approach is to increase cognitive abilities such as critical thinking. However, students, teachers, and schools are evaluated based on content student knowledge. Statistical modeling choices affect the ability to determine the efficacy of the intervention and the ability to identify those students who receive the greatest and least benefit from the intervention. As it is imperative to determine how an increase in cognitive abilities corresponds to an increase in content across different demographics and learning abilities, the effect of some of the statistical modeling choices were investigated. Student's progress on the Iowa Test of Basic Skills (ITBS) was modeled over two years of implementation of the inquiry-based learning approach. A control group of students not receiving the SWH learning approach was used for comparison.

SEM Models

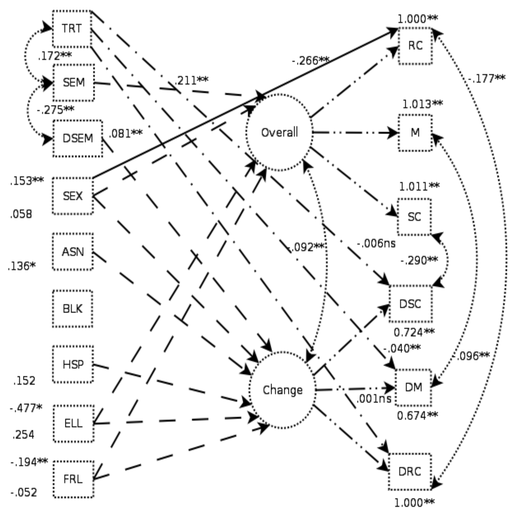
All Students



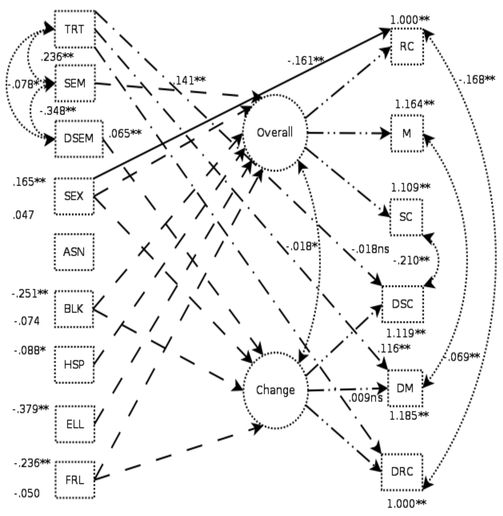
Traditional Student



Gifted and Talented



Special Education



Results

Analyzing the mutually exclusive subgroups reveals some important findings that were masked by when all the students were analyzed simultaneously. The effect of the number of semesters of SWH exposure on the change in the math score for special education students is 0.116 which is nearly double the 0.060 estimated for traditional students. In contrast, the same effect for the gifted and talented students is -0.040. Further, the estimated path coefficients from the variable 'change' to the science and math score improvement variables is much larger for the special education students than in any of the other models. In the special education model, both of these path coefficients were estimated to be greater than 1.0 at 1.119 and 1.185 respectively. In the other three models these path coefficients were less than 1.0. This indicates that the special education students are benefitting from prolonged exposure to the SWH curriculum, particularly in math and science.

A number of the paths originating from demographic and learning variables were significant in the model for all the students, but they were not important for all subsets of the students. The path originating from the black student variable going to overall test ability was important for all students and the special education subset. However, this path was not important for traditional and gifted and talented students. The path from Hispanic students to overall testing ability also was not important for gifted and talented students while being important for the other two subsets and the model with all students. The path from Asian students to the Change in knowledge variable is important for all models except the special education model. The path from black student to the change variable has some substantial differences across the models. The path is not included in the gifted and talented model. In the traditional student model it is -0.411 which is more than 10 times larger than in the all students model where the estimate is -0.036.

Model	All Students	Special Education	Gifted and Talented	Traditional
Overall				
SEM	0.162**	0.141**	0.211**	0.149**
SEX	0.094**	0.165**	0.153**	0.053**
BLK	-0.353**	-0.251**	-	-
HSP	-0.088*	-0.088*	-	-0.077
ELL	-0.405**	-0.379**	-0.477*	-0.392**
FRL	-0.252**	-0.236**	-0.194**	-0.255**
SED	-0.580**	-	-	-
GAT	0.995**	-	-	-
RC	1.000**	1.000**	1.000**	1.000**
M	1.035**	1.164**	1.013**	1.012**
SC	0.997**	1.109**	1.011**	1.061**
Change				
DSEM	0.075**	0.065**	0.081**	0.074**
SEX	0.051**	0.047	0.058	0.048**
ASN	0.233**	-	0.136*	0.282**
BLK	-0.037	-0.074	-	-0.411**
HSP	-	-	0.152	-0.056
ELL	-	-	0.254	-
FRL	-0.076**	-0.050	-0.052	-0.079**
SED	-0.146**	-	-	-
GAT	0.073**	-	-	-
DSC	0.817**	1.119**	0.724**	0.900**
DM	0.830**	1.185**	0.674**	0.734**
DRC	1.000**	1.000**	1.000**	1.000**
Direct				
TRT - DSC	-0.012*	-0.018	-0.006	-0.013*
TRT - DM	0.050**	0.116**	-0.040**	0.060**
TRT -DRC	-0.006	0.009	0.001	-0.011
SEX - RC	-0.204**	-0.161**	-0.266**	-0.173**
Variances				
Overall-Change	-0.070**	-0.018*	-0.092**	-0.076**
RC - DRC	-0.178**	-0.168**	-0.177**	-0.172**
M-DM	-0.064**	-0.069**	-0.096**	-0.060**
SC-DSC	-0.235**	-0.210**	-0.290**	-0.219**
TRT-SEM	0.216**	0.236**	0.172**	0.223**
TRT-DSEM	-0.052**	-0.078*	-	-0.064**
SEM-DSEM	-0.301**	-0.348**	-0.275**	-0.299**

Conclusions

Structural equations modeling of student test scores in reading, math and science content were created. Modeling mutually exclusive subsets of the data provided for results, that in some cases, were substantially different from a structural equation model created using all of the student data. The separate models identified that the special education students have the greatest improvement in their mathematics test scores with increased exposure to the science writing heuristic. Traditional student's math scores also benefit from the science writing heuristic learning approach. However, this does not appear to be the case for gifted and talented students.

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