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ABSTRACT

The purpose of a study was to provide some practical and theoretical suggestions to science educators in the United States and Korea who are struggling to attract more students to study science and pursue science-related careers. Two research questions were addressed: (1) What are the determinants of Korean high-school students' track choice (science versus humanities) in relation to their higher education and career pursuits? and (2) Is the theory of reasoned action (TRA) applicable to the study of track choice of Korean high school students? First-year high school students from four representative regions of Korea (n=665) participated in the study. The survey instruments were questionnaires developed according to the guidelines of the TRA. The target behavior of interest was Korean students' choice of the science track when they completed the track application forms during the first year of high school. Predictors included the TRA model and external variables. Variables include (1) attitude; (2) subjective norm; (3) academic self-concept; (4) intention; (5) behavior; (6) sex; (7) socioeconomic status; (8) mother's education; and (9) father's education. Multiple regression and structural equation modeling were used to analyze the data. The TRA was found to be applicable for understanding and predicting track choice, with minor modifications. Subjective norm was found to exert a direct influence on the target behavior. (40 references) (KR)

Predicting and Understanding Korean High School School Students' Science Track Choice: Testing the Theory of Reasoned Action by Structural Equation Modeling

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Abstract

The theory of reasoned action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) was used to predict and understand Korean high school students' track choice for college entrance. First year high school students (N = 665) from four representative regions of Korea participated in the study. The survey instruments were questionnaires developed according to the guidelines of the TRA. The target behavior of interest in this study was Korean students' choice of the science track when they completed the track application forms during the first year of high school. Predictors included TRA model and external variables. Multiple regression and the structural equation modeling with LISREL (Jöreskog and Sörbom, 1986) were used to analyze the data. The TRA was found to be applicable for understanding and predicting track choice, with minor modifications. Subjective norm was found to exert a direct influence on the target behavior.

Predicting and Understanding Korean High School School Students' Science Track Choice: Testing the Theory of Reasoned Action by Structural Equation Modeling

The purpose of the present study was to provide some practical and theoretical suggestions to science educators in the United States and Korea who are struggling to attract more students to study science and pursue science-related careers. More specifically, two research questions were addressed: (a) What are the determinants of Korean high-school students' track choice (science vs. humanities) in relation to their higher education and career pursuits? and (b) Is the theory of reasoned action applicable to the study of track choice of Korean high-school students? In an effort to answer these questions, the study tested the theory of reasoned action using the structural equation modeling with LISREL (Jöreskog and Sörbom, 1986).

Background

In the 1970s and 80s, people throughout the United States heard from various sources that the quality of science education in the nation had reached a state of crisis. The decline in public support and the shortage of teachers were serious problems. More ominous phenomena were observed in the areas of student achievement and enrollment in science courses. American students were shown to be equal to or below average on mathematics and science scores when compared with students from other industrialized nations of the world (Raizen & Jones, 1985). The decline in science enrollment was also alarming. It was estimated that only one-sixth of high school juniors or seniors were taking science courses (Sigda, 1983). In the case of physics, the ratio was reduced to one-fourteenth.

Concerns have increased among researchers with respect to students' decision to study science. In particular, researchers have sought to understand the more fundamental causes of the decline in science enrollment, its consequential reduction in the number of scientists, and the decline in scientific literacy. Several studies have been conducted with secondary school students in relation to their choice of science subjects (e.g., see Baird, Lazarowitz, & Allman, 1984; Crawley & Coe, 1990; Koballa, 1988; Stead, 1985), since the secondary school years have been considered a critical period for attracting students into future science-related careers. As Welch (1985) maintained, students' science-choice is one of the much needed research areas.

Similar needs are apparent in the educational context of Korea, although the situation is not exactly identical with that of the United States. The U.S. needs more scientists to maintain its leading role among the industrial countries; whereas Korea needs more scientists to catch up with the more advanced countries. The human resources of Korea in Natural Science and Engineering (NS/E) are far below the levels of the advanced countries. In 1986, the number of NS/E specialists per 10,000 Koreans was 12.5. The 1985 figures for the U.S. and Japan were 33 and 31, respectively (The Dong-A Daily News, April 6, 1987). Considering the fact that there were only 1.4 NS/E specialists per 10,000 Koreans in 1967, the increase to 12.5 persons in about twenty years is remarkable in itself. However, the small number of the NS/E specialists in Korea means that the country's economic and industrial development has relied mainly on imported knowledge and skills. This expertise has lagged one or two steps behind that available to the most advanced countries due in part to the skill-exporting countries' protectionism. Therefore, to catch up with the more industrialized countries that move ahead at an ever-accelerating pace, Korea has decided to put maximum efforts into the development of the nation's human resources in science and technology.

In 1986, in an effort to enhance the overall levels of the country's science and technology, the Minister of Science and Technology of Korea announced the extensive "Long-Range Plan for the Development of Science and Technology Aiming for the 2000s". The Minister outlined a development plan for 229 highly technological products in order to boost Korea to the rank of one of the ten most industrialized countries by the year 2001 (Kwon, 1988, p. 131). For this goal to be achieved, he emphasized the importance of cultivating a social atmosphere that will readily embrace science and technology and of securing enough highly trained, creative brainpower for advanced scientific/technological research and development. The plan calls for the government to increase its investment in science and technology from 1.22 % of the GNP in 1984 up to 3.1 % of the GNP by the year 2001.

Although this plan seems impressive, it may fall short of success if the nation's educational system cannot produce sufficient manpower to carry out the plan. According to the results of a recent survey of high-school teachers, however, there has been a gradual increase in the number of high school students who choose the NS/E track in preparation for college (Lee & Park, 1987). Also, more academically talented students than before have tended to choose the NS/E track. Unfortunately, the projected shortage of essential human resources for the period 1987-1991 still amounts to over 10,000 in the field of science and technology (Korea Educational Development Institute, 1985, p. 163).

Theoretical Base

The theory of reasoned action (TRA) proposed by Fishbein and Ajzen (1975) has gained increased interest among science education researchers who are concerned about understanding students' science-related behaviors. The TRA rests on the assumption that most actions that are socially relevant are controlled by a person's will. The model proposes a causal chain of variables that influence behavior. Individual differences in behavior are brought about by differences in behavioral intention, which in turn is caused by differences in the relative contribution of two variables, attitude toward the behavior and subjective norm. Underlying attitude and subjective norm, respectively, are beliefs about the consequences of performing the behavior and beliefs about social support for performing the behavior. What a person believes about the consequences of and social support for engaging in a behavior, therefore, indirectly cause differences in behavior through their effect on attitude and subjective norm, respectively, which in turn direct motivation to engage in behavior. These variables alone explain behavior, according to the TRA model, provided that behavioral performance is under the control of the individual.

The explanatory power of the TRA model has been extended to situations in which the individual lacks complete control over performance of the behavior with the addition of a third component, perceived behavioral control. With this addition, the TRA became known as the theory of planned behavior (see Ajzen, 1985; Ajzen & Madden, 1986; Shifter & Ajzen, 1985).

The TRA model has prompted several research efforts in science education (e.g., Chen, 1988; Crawley, 1990; Crawley & Coe, 1990; Koballa, 1986, 1988; Ray, 1990; Stead, 1985). Most of these studies produced meaningful results, demonstrating the validity of the theory; however, they did not examine the relationship between the behavioral intention and actual behaviors.

Science education research to date that employed the TRA has adopted almost invariably simple correlation and multiple regression analyses, the statistical analyses originally suggested by Fishbein and Ajzen (1975). However, recent studies in other academic disciplines that employ such models as the TRA indicate that simple or multiple regression analyses may not explain fully the relationships between the independent and dependent variables, since these variables are latent variables with causal relationships (e.g., Bentler, 1980; Bentler & Speckart, 1981; Borg & Gall, 1989). As an alternative, researchers suggest use of structural equation modeling, since this statistical approach can handle causal relationships among latent variables with greater accuracy.

Structural equation models (henceforth, SEMs) are said to have been "useful in attacking many substantive problems in the social and behavioral sciences" (Jöreskog & Sörbom, 1986, p. I.1). Structural equation modeling is a combination of multiple regression analysis and factor analysis (Ecob & Cuttance, 1987). Multiple regression analysis shows the relationship between a dependent variable and multiple independent variables. Factor analysis finds a number of underlying or "latent" variables (or factors) that explain the common relationship among multiple variables. The SEM finds the causal relationship among the latent variables using the measured variables. In other words, a SEM is a regression equation in the context of a causal model.

A latent variable is "a variable that an investigator has not measured and, in fact, typically cannot measure" (Bentler, 1980, p. 420). The unobservable, unmeasurable latent variables are "hypothetical constructs" conceptualized by an investigator to understand a research area. These variables are related to each other in a model that the investigator of the model specifies for a certain research purpose (Bentler, 1980, p. 420). In the TRA, constructs such as attitude, subjective norm, and intention are latent variables because they are abstractions that supposedly underlie the measured variables (i. e., the scores on the scales used to measure each construct). These latent variables are assumed to underlie the measured variables, which, in this study, are scores on the 7-point bipolar scales in each category.

The SEM, then, is a conceptual model in which a certain number of latent variables are linked to each other and to measured variables in a way specified by the investigator of such a theory. What the statistics do, then, is to test the model in relation to the data for the goodness-of-fit. That is, once a model is conceptualized, it can be compared to the gathered data. If the proposed model fails to fit the data, the model is rejected as a plausible structure underlying the measured variables. If, however, the model cannot be rejected statistically, it is regarded as a plausible model to represent the underlying structure.

Method

Instrumentation and Study Design

The study was conducted in two phases. The first phase consisted of clearly identifying the target behavior. Next, an open-ended questionnaire was developed to elicit students' salient beliefs and referents in relation to the target behavior, which was choice of the science (rather than humanities) track in high school. The questionnaire was administered to a sample consisting of 109, 10th grade students from a coeducational high school in Taegu, Korea, who had recently completed track-choice forms. These students were thought to be more sensitized to the consequences of their track choices and would provide more detailed information. Students' responses were then analyzed to find "modal salient beliefs" following the guidelines given by Ajzen and Fishbein (1980, p. 262), and these beliefs were used to construct the final, closed questionnaire.

The second phase of the research consisted of preliminary and main studies. The preliminary study was conducted in order to determine the test-retest reliability of the final, closed questionnaire. Instruments were administered on two occasions separated by a three-day interval to identify possible problems and weaknesses in the questionnaire items or in the administration procedures. Test-retest reliability coefficients were computed to be: (a) .87 for intention, (b) .92 for the direct measure of attitude, (c) .77 for the indirect measure of attitude, (d) .75 for the direct measure of subjective norm, and (e) .82 for the indirect measure of subjective norm.

The final instrument consisted of 45 scales that measured the theoretical constructs of the TRA model and self-report items that sought information on five external variables (sex, socioeconomic status, mother's education, father's education, and three indicators of academic self-concept). All model construct employed 7-point, bipolar adjectival scales with the exception of the direct measure of attiutde. Four evaluative, semantic differential scales were used to measure this construct. (Myeong, 1990).

Subjects

A total of 665 students enrolled in their first year of high school participated in the main study. These students were selected through a stratified cluster sampling procedure to represent the overall student population of Korea. Participants were selected from 11 schools, coeducational or single-sex, located in 4 different cities: (a) 5 schools from Seoul, the largest city in Korea with a population of over 10 million, (b) 2 schools from Taejon, representing the central part of the country, (c) 2 schools from Jeonju, representing the southwestern part of the country, and (d) 2 schools from Masan, representing the southeastern part of the country.

Variables

Variables tested in this investigation were classified as either: (a) latent or measured and (b) independent or dependent. Five latent variables and nine measured variables were examined. These consisted of: (a) attitude (direct and indirect measures), (b) subjective norm (direct and indirect measures), (c) academic self-concept (mathematics, science, and general academic self-concept measures), (d) intention (direct measure only), and (e) behavior (direct measure only). The independent variables included: (a) attitude, (b) subjective norm, (c) self-concept, and (d) intention. Behavior served as the dependent variable in this investigation. Variables outside the TRA model included: (a) sex, (b) socioeconomic status, (c) mother's education, (d) father's education, and (e) the three indicators of academic self-concept.

Data Analyses

Descriptive analyses consisted of conducting tests for differences in beliefs between humanities- and science-track choosers using t-tests and tests for differences in beliefs for combinations of external variable and track choice using ANOVA techniques. Four hypotheses, corresponding to four causal models of the latent variables in the TRA Model, were tested using LISREL 6 (Jöreskog & Sörbom, 1986).

1. Hypothesis 1: For Korean high school students' track-choice, attitude and subjective norm have an indirect influence on behavior by means of intention. (The test of this hypothesis was designated a test of Model A)

2. Hypothesis 2: For Korean high school students' track-choice, subjective norm has a direct influence on behavior in addition to its indirect influence by means of intention. (The test of this hypothesis was designated a test of Model B)
3. Hypothesis 3: For Korean high school students' track-choice, attitude has a direct influence on behavior in addition to its indirect influence by means of intention. [The test of this hypothesis is designated a test of Model C. The simultaneous test of both direct and indirect contributions from subjective norm (Hypothesis 2) and attitude (Hypothesis 3) to behavior (called the saturated model) was designated a test of Model D]
4. Hypothesis 4: For Korean high school students' track-choice, the students' self-concept of performance has a direct influence on behavior in addition to its influence by means of intention. (The test of this hypothesis was designated a test of the extended model, Model E)

Justification for Hypothesis 2 is found in the socio-cultural context of Korea. Lee (1988, p. 17) noted that, because of the big differences in income and social prestige between the humanities and science careers, an increasing number of students have been attracted to the science and technology track. In Korea, parents exert considerable influence upon their children, especially when such an important issue as career choice is concerned. Kang and Park (1984) reported that as many as 17.4% of the surveyed high school students chose their career tracks in compliance with their parents' wishes. This means that some students may apply for the career track against their intention, based on their perceptions of subjective norms. Parental influence is more likely to be stronger for the science track than for the humanities track. If parents favor the humanities track, they may not force their children to comply with their wishes. On the other hand, if parents favor the science track, they will be more determined that their children choose the science track, since they perceive that this choice will bring the child more income and privilege. Thus, it was hypothesized that subjective norm would not only influence behavior through the mediation of the intention but also would influence behavior directly.

The causal relation from attitude to behavior, Hypothesis 3, is justified by results of a recent review relating attitude to behavior (Shrigley, 1990). Of the five perspectives presented, conceptual and empirical support for the attitude-to-behavior link is provided in at least two cases: (a) attitude and behavior are reciprocally related, and (b) attitudes precede behavior. In the former perspective attitude and behavior were seen as complementary opposites. In the latter, it was concluded that the attitude-behavior link would be strengthened when measurements are highly specific, as they are in the present study.

Hypothesis 4 resulted from the literature review concerning the influence of students' self-concept of ability on their science choice. In the review, Deboer's studies (1984, 1987) indicated that students' sense of competence in science was a central variable in science enrollment. Other studies also supported the influence of students' past performance and science self-concept on their science choice (Khoury & Voss, 1989; Salters, Lockard, & Stunkard, 1987). Thus, it was hypothesized that the inclusion of students' self-concept of performance (in mathematics, in science, and in general) would enhance the predictive power of the model. The tests of hypotheses 1-3 are depicted as tests of models A-D in Figure 1.

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Results

Descriptive Results

Twenty salient beliefs about the consequences of or social support for choosing the science or the humanities track were identified from a representative sample of students. Including these beliefs on the final questionnaire supports its content validity.

Beliefs were salient provided they were mentioned by 10% or more or the sample, which surpassed the 75% criterion for cutoff recommended by Ajzen and Fishbein (1980, p 70-71). Of these beliefs fourteen represented common behavioral beliefs or common consequences associated with track-choice. Students believed that the choice of the science (or humanities) track would:

1. help them get a job easily,
2. help them get good grades in high school,
3. provide them with more choices of majors in college,
4. lead to the study of practical information,
5. result in higher scores on college entrance exams,
6. lead to the study of interesting topics,
7. lead to subjects that were easy to study,
8. help them get a job that they like,
9. mean that they study more subjects in high school,
10. have a wide range of jobs from which to choose,
11. get a job for which they have the aptitude,
12. study subjects for which they have the aptitude,
13. have a good classroom atmosphere, and
14. enter the desired department in college.

Six salient referents were identified regardless of track-choice. These included: (a) parents, (b) brothers/sisters, (c) homeroom teacher, (d) science/mathematics teachers, (e) friends, and (f) senior class members.

Attitudinal differences were detected between science- and humanities-track choosers on the final questionnaire. Students who chose the science track after completing the questionnaire registered more favorable attitudes (direct measure, obtained by summing three scale scores) than did humanities-track choosers. Indirect measures of attitude were obtained from the expectancy-value beliefs. According to the expectancy-value model, the value of an attribute (an outcome or referent) is weighted by an expectancy that the attribute is associated with performing a behavior (Ajzen, 1985). Differences were detected between the two groups on 13 of the 14 expectancy-value beliefs, which is evidence of the discriminant validity of the final questionnaire. In particular, expectancy-value judgments related to aptitude, desired college department, and desired career were strongly positive from the science-track group and differed significantly between the two groups.

Science-track and humanities-track students differed in their perceptions of social support. Scores on the direct measure of subjective norm for the science-track students differed from those registered by members of the humanities-track group. Furthermore, all expectancy-value measures of subjective norm (indirect measures of subjective norm) were found to differ between the two groups. Science-track students perceived greater social support for choosing the science track from each of the six referent groups than did members of the humanities track. Parents and siblings were perceived to provide the most influence on science-track choice, and science/math teachers and homeroom teachers were perceived to provide the least influence.

Significant differences between the two groups were detected also on intention and each of the three measures of academic self-concept. Science-track students were more intent on choosing the science track before doing so than were humanities-track students. In addition, science-track members recorded more positive scores on mathematics, science, and general self-concept measures.

Structural Equation Modelling Results

LISREL analyses were conducted in two stages: model testing stage and post-hoc model fitting stage. In the model testing stage hypotheses 1-4 were examined. The results of model testing then were used to explore other causal paths and in the process develop additional models that might represent a better fit to the data obtained from study participants. The LISREL program permits exploration through a procedure called "post-hoc model fitting" (Byrne, 1989). Although opinions vary regarding the rationale and usefulness of such a practice, Byrne (1989) says that as long as researchers are aware of their exploratory nature post-hoc analyses "can be substantially meaningful" (p. 66).

Testing the TRA and Alternative Models. The first step of the LISREL analyses was to test the goodness-of-fit of the TRA model. Since the goodness-of-fit index indicates only whether a given model fits the data and thus is a plausible representation of the causal relationships underlying the data, it does not necessarily mean that the given model is the only correct representation of the data even when the model is not rejected on statistical grounds. Moreover, the chi-square value of the goodness-of-fit index is sensitive to sample size. The smaller the sample size, the more likely the model is to fit; the larger the sample size, the more likely the model is to be rejected. If the sample size is very large, almost all the models are rejected (Bentler, 1980). For this reason, it has been suggested that competing models which are hierarchically nested within a given model be compared with the given model to test the relative superiority of the goodness-of-fit (Bentler, 1980; Loehlin, 1987).

Four competing models were set up for comparison, including the TRA model. Testing the goodness-of-fit of the four models was equivalent to testing hypotheses 1-3. The test of hypothesis 4 was a test of the extended model, in which academic self-concept was designated a latent, dependent variable, with three measures. Scores on nine variables, therefore, were used to test hypotheses 1-4. The input data matrix consisted of Pearson product-moment correlation coefficients computed between variable-pairs, except for the coefficients between behavior and other variables. Point-biserial correlation coefficients were computed for these correlations, since behavior was scored as a dichotomous variable. These variables included behavior (B); behavioral intention (BI); attitude toward the behavior, direct [AB(D)] and indirect [AB(I)] measures; subjective norm, direct [SN(D)] and indirect [SN(I)] measures; and mathematics

(Math.), science (Sci.), and general (Gen.) academic self-concept measures. The input correlation matrix for testing models A-E in hypotheses 1-4 is presented in Table 1.

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The measurement models for the four hypotheses 1-3 were tested to see if they fit the data. Standardized factor loadings indicated the regression of the observed indicators on the latent constructs. For each of the models a *t*-value was computed, which indicated the ratio of the unstandardized factor loading to the standard error. Values larger than 2.00 are considered to be significant (Jöreskog & Sörbom, 1986). The *t*-values ranged from 18.1 to 28.9, indicating that the four structural models in hypotheses 1-3 were significant. The square of the factor loading was determined, which is the reliability index of each observed variable with respect to its latent construct. This value indicated how well the observed variables measure the underlying latent construct. For strictural models A-D, the R^2-values were computed to be .82, .71, .61, and .79, respectively. The total coefficient of determination for independent variables is "an indication of how well the observed variables, in combination, serve as measuring instruments for all the latent variables jointly" (Byrne, 1989, p. 54). The coefficient of determination for all models was either .96 or .97. Based on the results of these tests the measurement models were judged to measure their latent constructs quite adequately.

The LISREL analysis used four indices to describe the goodness-of-fit: (a) χ^2 with its associated degrees of freedom and probability level, (b) the goodness-of-fit index (GFI), (c) the adjusted goodness-of-fit index (AGFI), and (d) the root-mean-square residual (RMR). Chi-square is a likelihood ratio test statistic that tests the fitness between the "restricted hypothesized model and the unrestricted sample data" (Byrne, 1989, p. 55). The probability level of χ^2 represents "the probability of obtaining a χ^2 value larger than the value actually obtained given that the model is correct" (Jöreskog

& Sörbom, 1986, p. I.38). Unlike the general χ^2 test in which $p < 0.01$ or $p < 0.05$ is the probability value to reject the null hypothesis, the χ^2 test in LISREL seeks the probability level of $p > .01$ or $p > .05$ to fail to reject the null hypothesis in order to show that the given (or hypothesized) structural model does not differ statistically from a correct model that would ideally represent the measured data. Since χ^2 is sensitive to the sample size, Jöreskog and Sörbom (1979, p. 39) suggested use of a χ^2/df ratio as an additional guide for model comparison. In general, if the χ^2/df ratio is larger than 2.00, the model is not considered to fit the data adequately (Loehlin, 1987). The GFI is "a measure of the relative amount of variances and covariances jointly accounted for by the model" (Jöreskog & Sörbom, 1986, p. I. 41). Unlike χ^2, GFI is not sensitive to the sample size and is robust against abnormalities. The AGFI, on the other hand, takes into account the degrees of freedom of GFI in the model. Both GFI and AGFI values range from 0 to 1. The closer the index is to 1, the better the model fits the data. The RMR is a measure of the average of the residual variances and covariances. It is a mean of the absolute differences between the observed and implied matrices. The value of RMR ranges from 0 to 1. The closer the value is to 0, the better the model fits. A good model should have a value less than .05.

Based on GFI, AGFI, and RMR, all four models were found to be reasonably good fits to the data. However, judging from all five indices in combination, Model B was judged to be relatively better than any other model. The χ^2-value was small, and the probability level of Model B was the greatest, indicating that the model is closer to an ideal model-data fit than is any other model. Moreover, Model B's χ^2/df was the smallest of all the models, indicating that it is closest to the acceptable value of 2.00. Model B's RMR value of .014 was also closer to 0 than were the values for Model A and Model C. Therefore, Model B was judged to be the model that best fit the data. Table 2 shows the goodness-of-fit indices of the four competing structural models.

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Follow-up tests were conducted by comparing each structural model with the other. The purpose of all possible comparisons of models with one another was to determine if the addition of a particular path to the model (e.g., model A vs. model B) significantly reduceed the overall χ^2-value, thus confirming the additional path. Considering the results of the follow-up tests, models B and D were judged to be superior to models A and C. Model B was preferred to model D, since the addition of the path from attitude to behavior did not improve upon model B, as evidenced by non-significant difference in χ^2 values.

Hypothesis 4 tested the effects of adding an additional latent, independent variable to the TRA model. The addition of academic self-concept, it was hypothesized, would increase the predictive power of the model. To test this, the complete correlation matrix (Table 1) was subjected to LISREL analyses. Two models were compared, the TRA model (model A) and the Extended Model (model E) which represented Hypotheses 1 and 4, respectively.

Results of the test of hypothesis 4 showed that adding self-concept to the TRA model did not improve the fit of the model to the data. The R^2-values for the prediction of behavioral intention by model A and model E were computed to be .83 and .85, respectively. Whereas model E explained slightly more of the overall variance in behavioral intention than did model A, the explained variance in behavior was identical for the two models ($R^2 = .59$). Inclusion of self-concept of performance, therefore, slightly improved the prediction of behavioral intention, but it did not improve the prediction of behavior. Since the ultimate concern of this study was to predict behavior, model A was preferred, as it was the most parsimonious of the two models. Hypotheses 4, therefore, was rejected.

Post-Hoc Fitting with Model B. Model B (which included the direct path from subjective norm to behavior) was found to be superior to other models within the general framework of the TRA. Since this result supported the hypothesis (i. e., Hypothesis 2) regarding the direct influence of subjective norm on behavior in addition to an indirect influence, the analysis of the data could have stopped here. However, LISREL permits further exploration of the more fitting model with Model B through an exploratory procedure called "post-hoc model fitting" (Byrne, 1989). Therefore, Model B was further analyzed to determine the fitness of each path and to locate any missing path(s).

To determine whether a path in the model is essential or insignificant, a *t*-value was used as a goodness-of-fit index for each parameter. A *t*-value greater than 2.00 indicates that the parameter is significantly different from 0 and, therefore, the path is essential to the model. If a *t*-value is smaller than 2.00, the parameter is insignificant. With this result, the path is deleted from the model.

For model B, all *t*-values but one were found to be greater than 2.00, which means that these parameters are essential to the model. The *t*-value for the path from subjective norm to intention (SN→BI) was determined to be -0.71, far below 2.00. Given this result, it was concluded that subjective norm has no direct influence on intention when attitude is controlled. The path from subjective norm (SN) to behavioral intention (BI) was deleted from model B to produce model B-1, a modified version of model B. Model B-1 is basically the same as the model A except that the path from subjective norm to intention has been deleted and a path from subjective norm to behavior has been added. Although the parameter estimates for model B-1 (i. e., standardized coefficients and variances) are the same as model B, the goodness-of-fit has been improved with model B-1.

A further step of exploration leads to examining the "modification indices" (henceforth, MIs). When a model is considered to have failed to fit the data adequately, MIs provide information that will lead to a decision on how to modify the model. Jöreskog and Sörbom (1986, p. III.19) stated: "For each parameter which is fixed in the model there is a modification index equal to the expected decrease in χ^2 if this single parameter alone would be free." MIs for free parameters are automatically set to zero. MIs are used for fixed parameters, whereas *t*-values are used for free parameters.

The maximum MI was computed to be 12.90 for the element for indirect attitude measures and subjective norm. This meant that a path from subjective norm to the indirect measure of attitude was needed to improve the model's fit to the data. The path from subjective norm to the indirect measure of attitude was added to produce model B-2. The additional path meant that indirect attitude measures (expectancy-value beliefs) were tapping not only attitude (the target factor) but also subjective norm (a nontarget factor). Considering the fact that attitude and subjective norm were highly correlated, the association between indirect attitude measures and subjective norm was not surprising.

The addition of this new path indicated that students' behavioral beliefs and outcome evaluations reflected to some degree their perception of the social pressures and expectations of referents. In other words, students seemed to adjust their beliefs and values to accommodate their perception of social expectations. This effect may be due to a psychological adjustment to avoid inner, emotional conflicts--a speculation that seems supported by the absence of the path from subjective norm to intention. Korean high school students' intention was not directly influenced by subjective norm; instead, the influence of subjective norm may have been mediated by attitude.

Model B-2 was obtained from the examination of MIs. The model was tested to see how well it represented the observed data. All indices indicated that model B-2 was a better representation of the observed data than was model B-1. The probability associated with likelihood statistics dramatically increased, indicating that model B-2 approached the acceptable model. The GFI and AGFI values were improved, and the RMR was reduced. Results of tests of goodness-of-fit for models B-1 and B-2 are found in Table 3.

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Insert Table 3 about here

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Conclusions and Recommendations

Model B-2 was determined to be the model that best fit the data on Korean high school students' choice of the science track. The model reveals that attitude toward choosing the science track directly influences the intentions of students to do so. Attitudes can be represented by the beliefs and values students hold about the consequences of science-track choice. Subjective norm, which represents students' perceptions of support from salient referents for science-track choice, has been shown to influence the beliefs students' hold about choosing the science track as well as exert a direct influence on the behavioral outcome, namely choice of the science track. What was not supported by the analyses is a direct influence of subjective norm on behavioral intention, contrary to the predictions of the TRA model. Behavioral intention, on the other hand, was shown to exert a direct influence on the behavior, science-track choice. Path coefficients for model B-2 are depicted in Figure 2.

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Insert Figure 2 about here

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One of the most significant findings of the present study concerns the role played by subjective norm in Korean high school students' track choice. According to LISREL results, students' subjective norm had no direct influence on their intention; instead, it had a small but direct influence on behavior. What does this finding mean? One possible explanation is that, when such an important issue as students' track choice is concerned, parental pressure exerts a direct effect on the final decision. In other words, parents' last minute persuasion may override students' "reasoned" intentions.

Subjective norm was seen to be subsumed within attitude and had an indirect influence through the mediation of attitude. In LISREL, this interaction was shown by a high correlation between subjective norm and attitude and by a moderate path coefficient from subjective norm to indirect measures of attitude. This phenomenon has been shown to be a characteristic of Korean people's social psychology by Oh (1982), who noted that Koreans tend to adjust to social expectations in their formation of attitude. Is this, then, only a Korean phenomenon? Liska's (1984) claim shows it is not. This issue deserves future researchers' attention.

The LISREL analysis also demonstrated that, unlike subjective norm, attitude did not have a direct influence on behavior. This result is different from that of Bentler and Speckart (1981), whose LISREL analysis showed a direct influence of attitude upon behavior in addition to its indirect influence through intention. Is the difference attributable to cultural differences between American and Korean students? Or is the difference due to the different nature of behaviors? These questions should be explored in future studies of track choice among students in other cultures.

Korean parents' strong preference for the science-track and their influence upon students' track-choice deserve attention. The lower the mothers' level of education, it was later determined, the more students tended to choose the science track. Considering the fact that subsequent analysis showed that socioeconomic status alone did not influence students' track-choice, the relationship between parents' educational level and track-choice is not easily explained.

Four hypotheses were posed and tested in this research in an attempt to answer a larger question as to whether the theory of reasoned action is applicable to predicting and understanding Korean high school students' track choice. Questions seeking information regarding the determinants of science track choice were also presented.

Results of the study demonstrated that the general principle of the TRA can be applied to predicting and understanding Korean students' science track choice, provided adjustments are made in the model. In the Korean culture the TRA model must be modified somewhat to better describe the causal relationships of the TRA's theoretical constructs.

Science teachers in any part of the world can learn an important lesson about attracting students to science courses and careers. This study demonstrates that students' science-track choice is determined mainly by their intention, which in turn is influenced primarily by attitudes toward science-track choice. Attitude, it was shown, consists of expectancy-value judgements (i.e., the joint effect of behavioral beliefs and outcome evaluations). Therefore, science teachers should learn from this study that changing students' beliefs concerning the consequences of science choice may lead to changes in students' intention and subsequent behavior.

This study also reveals a rather undesirable phenomenon attributable to Korean science/math teachers. It is alarming to report that they ranked lowest among the major referents on students' normative belief scales. This result was observed for both science-track and humanities-track groups. Science/math teachers scored lowest also on the indirect subjective norm measure (i.e., expectancy-value estimates). Science/math teachers exert the least social pressures on students to pursue further study in science/math. In case of humanities-track choosers, science/math teachers appear to have dissuaded these students from choosing the science track.

The educational implication derivable from the weak influence of science/math teachers is obvious. Science and math teachers need to realize that one of their missions is to inspire students to pursue further science study and perhaps a science career. To fulfill this mission, science teachers must do more than convey scientific knowledge to students. They must put in time and effort to inspire students to pursue a science career, through addressing the specific personal beliefs that students associate with enrolling in science.

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Table 1

Correlation Matrix for the Models A-D

							Self-Concept		
	B	BI	AB(D)	AB(I)	SN(D)	SN(I)	Math.	Sci.	Gen.
B	1.000								
BI	.771	1.000							
AB(D)	.833	.647	1.000						
AB(I)	.759	.621	.765	1.000					
SN(D)	.511	.448	.502	.499	1.000				
SN(I)	.578	.512	.561	.598	.693	1.000			
Math.	.364	.270	.389	.435	.212	.345	1.000		
Sci.	.376	.300	.396	.473	.205	.334	.626	1.000	
Gen.	.167	.099	.250	.244	.135	.236	.544	.486	1.000

Table 2

Goodness-of-Fit Indices for Competing Models

Models	χ^2	df.	p	χ^2/df	GFI (AGFI)	RMR
A (TRA)	28.69	7	.0000	4.10	.98 (.97)	.024
B (SN→B)	18.00	6	.0060	3.00	.99 (.99)	.014
C (AB→B)	24.79	6	.0000	4.13	.99 (.98)	.019
D (Saturated)	17.99	5	.0030	3.60	.99 (.99)	.014

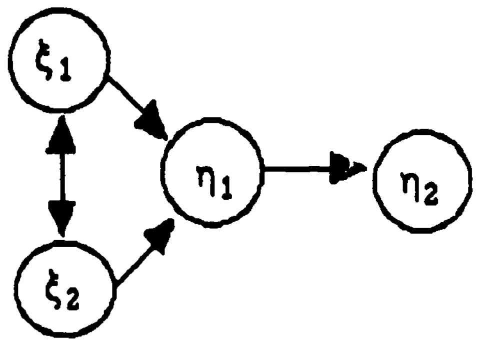
Table 3

Goodness-of-Fit Indices of Models B-1 and B-2

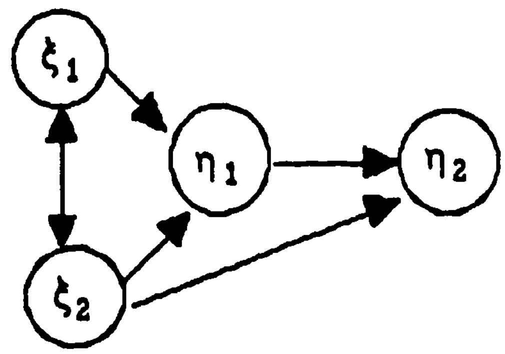
	χ^2 /df	χ^2	(df)	p	GFI	(AGFI)	RMR
Model B-1	2.62	18.48	(7)	(.01)	.990	(.985)	.015
Model B-2	.96	5.76	(6)	(.45)	.997	(.996)	.007

Figure Caption

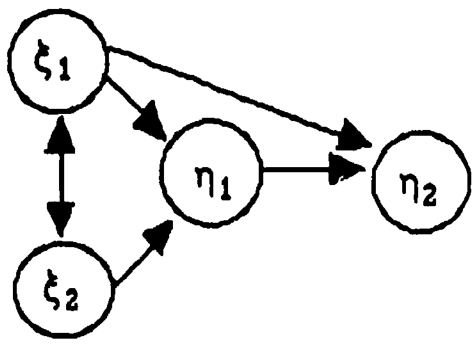
Figure 1. Causal links between model variables.



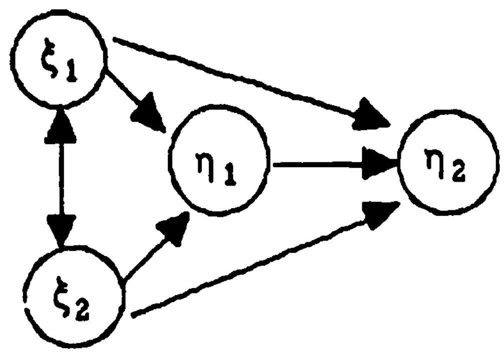
Model A (The TRA)



Model B (TRA with Path SN to B)



Model C (TRA with Path AB to B)

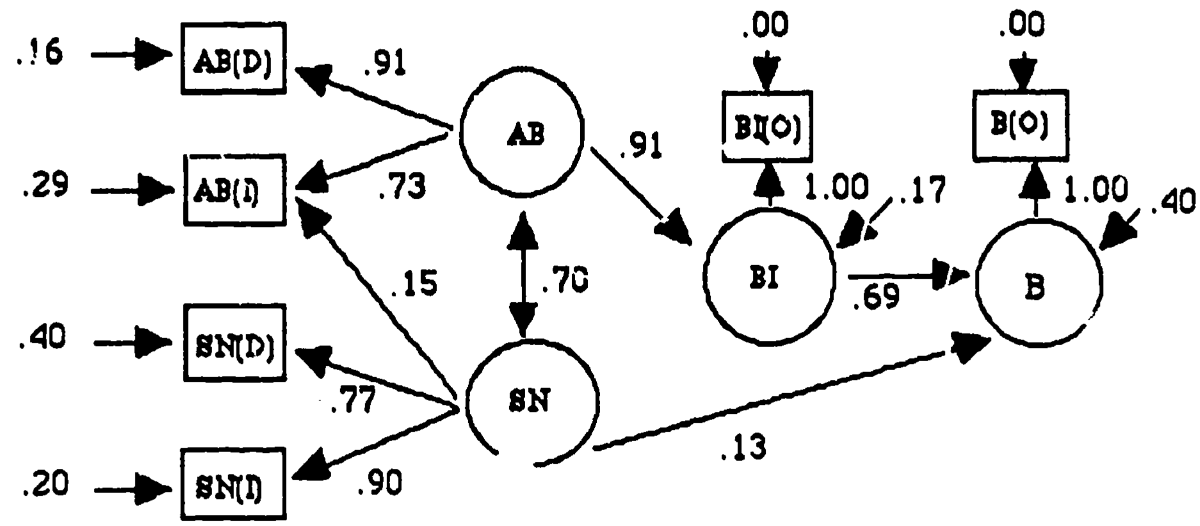


Model D (Saturated Model)

Key to Symbols. ξ_1 = Attitude, ξ_2 = Subjective Norm, η_1 = Behavioral Intention, and η_2 = Behavior.

Figure Caption

Figure 2. Path diagram for model B-2.



Key to symbols. AB(D) = Direct measure of Attitude toward the Behavior; AB(I) = Indirect measure of Attitude toward the Behavior; SN(D) = Direct measure of Subjective Norm; SN(I) = Indirect measure of Subjective Norm; BI = Behavioral Intention; BI(O) = Observed Behavioral Intention B = Behavior; B(O) = Observed Behavior.